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# BMJ Open

## Diagnostic Reliability in Teledermatology: A Systematic Review and a Meta-Analysis

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**Title:** Diagnostic Reliability in Teledermatology: A Systematic Review and a Meta-Analysis

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## Abstract

**Objectives:** To compare TD and F2F agreement in primary diagnoses of dermatological conditions.

**Design:** Systematic review and Meta-Analysis

**Methods:** MEDLINE, Embase, Cochrane Library (Wiley), CINAHL, and medRxiv were searched between January 2010 and May 2022. Observational studies and randomized clinical trials that reported percentage agreement or kappa concordance for primary diagnoses between TD and F2F physicians were included. Titles, abstracts, and full-text articles were screened in duplicate. From 6,945 citations, 44 articles were included. A random-effects meta-analysis was conducted to estimate pooled estimates. The QUADAS-2 tool and the Cochrane RoB2 tool were used to evaluate the risk of bias. Primary outcome measures were mean percentage and kappa concordance for assessing diagnostic matches between TDs and F2F. Secondary outcome measures included agreement between TDs, F2F dermatologists, and TD and histopathology results.

**Results:** 44 studies were extracted and reviewed. The pooled agreement rate was 68.9%, and kappa concordance was 0.67. When both F2F and TD consults were conducted by dermatologists, the overall diagnostic agreement was significantly higher at 71%, compared to 44% for non-specialists. Kappa concordance was 0.69 for TD vs specialist, and 0.52 for non-specialists. Higher diagnostic agreements were also noted with image acquisition training, and the use of digital photography. Agreement rate was 76.4% between TDs, 82.4% between F2F physicians, and 55.7% between TD and histopathology.

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3 Conclusions and Relevance: TD can be an attractive option particularly in resource poor settings.

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5 Future efforts should be placed on incorporating image acquisition training and access to high  
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8 quality imaging technologies.

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10 Registration number: 10.17605/OSF.IO/FJDVG

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14 **Keywords:** teledermatology, dermatology consultations, store-and-forward, telemedicine,  
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16 remote consultation, dermatology hospitalists

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21 **Article Summary:**

22 Strengths and limitations of this study:

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  - 27 • This is the most comprehensive systematic review and meta-analysis of the topic to date
  - 28 without language restrictions applied.
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  - 31 • Inclusion criteria was broad, permitting the inclusion of all types of dermatological
  - 32 diseases, imaging technologies, in person physician specializations (GPs, hospitalists, and
  - 33 dermatologists), and presence or absence of image acquisition training.
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  - 36 • Article search was limited to 2010 and later due to the recent incorporation of
  - 37 smartphones in teledermatology practices.
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  - 41 • Due to considerable heterogeneity between studies, meta-analysis and synthesis of
  - 42 predictors for accurate diagnoses remotely was limited even after subgrouping.
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## Introduction

With the emergence of COVID-19, the introduction of virtual consults in healthcare settings, especially dermatology, has been expanded to allow many patients the opportunity for equitable access to care when in-person appointments pose a challenge and risk to patients.<sup>1</sup> Different modalities were introduced to support Teledermatology (TD). This involves the remote sharing of patient data, which includes synchronous video-streaming TD, and asynchronous sharing of still images- via emails, or text messages, or store-and-forward TD (SFTD).

Although both synchronous and asynchronous approaches have been shown to be cost effective, SFTD is particularly popular as it requires fewer resources and less coordination than synchronous TD.<sup>2, 3</sup> With the advent of higher resolution smartphone cameras, relatively minimal training is required to correctly capture data for remote dermatologists; multiple SFTD studies opted to provide no training in image capture and still found value in TD.<sup>4, 5</sup>

There is valid concern over the reliability of TD given the significant variability in diagnostic accuracy predicted across pre-pandemic research.<sup>6</sup> This is expected given the lack of standardization across studies and the potential for confounds across TD methodologies and applications, e.g., level of training or skin lesion type. This variability in approach may benefit from an increased demand, which could provide greater impetus to optimize and standardize TD.

To our knowledge, this is the first and most inclusive meta-analysis (MA) that compares dermatology TD consults to face-to-face (F2F) that looked at all relevant studies without overly exclusive inclusion criteria. The primary objective of this study was to compare the reliability of

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3 TD diagnoses to F2F consults, as determined by Cohen's kappa interrater agreement and total  
4 agreement rates. TD can assume important roles as a routine complement to primary care and an  
5 alternate route to the typical in-person referrals. Consequently, we wanted to determine agreement  
6 for TD and all F2F consults, TD and F2F primary care consults, and finally TD and F2F  
7 dermatologist consults, which would arguably best capture the limitations introduced by the  
8 change in medium from F2F to TD.  
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12 Additional subset analyses were performed to control for potential confounds (e.g., inflammatory  
13 vs. malignant, staff training for image acquisition, teledermoscopy, and smartphone vs digital  
14 cameras) introduced by the heterogenous methodology. The secondary objectives sought to  
15 determine the agreement rate within TD diagnoses and within F2F consults to provide an idea of  
16 each medium's consistency, and for the agreement rate between TD and histopathology, provides  
17 the best estimate of accuracy.  
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## Methods

### Protocol Registration

This study was performed in accordance with the Preferred Reporting Items for Systematic review and Meta-Analysis Protocols (PRISMA-P) 2015 guidelines.<sup>7</sup> The protocol for this review was registered on Open Science Framework (<https://osf.io/fjdvg>).

### Search Strategy

A comprehensive search of major bibliographic databases, MEDLINE, Embase, Cochrane Library (Wiley), CINAHL, and medRxiv was performed in August 2021, and MEDLINE was searched again between August 2021 and May 2022 to screen any new articles published after our protocol was registered. The search strategy was developed by a medical librarian at Queen's University (Kingston, ON).

No restrictions were placed on language or status of the publications. Search results were limited to studies published between January 2010 and May 2022 due to the novelty of incorporating smartphones in teledermatology remote consultations.<sup>8</sup> The International Prospective Register of Systematic Reviews (PROSPERO) and OSF were searched up to May 2022 for relevant ongoing systematic reviews using the terms 'telemedicine', 'teledermatology', 'dermatology', 'diagnostic accuracy', and 'diagnostic concordance'. Reference lists of included studies were screened to identify additional studies not identified in the search.

### Eligibility Criteria

Studies evaluating the diagnostic reliability of TD that reported on patients with dermatological conditions who were evaluated by a clinician using SFTD (asynchronous) or live video-based (synchronous) telemedicine systems were included. It was required that all articles compared the tele- to a F2F diagnosis conducted by a physician. Inclusion and exclusion criteria are summarized in **eTable 1**, available in the supplementary appendix.

### Data Selection & Extraction

Following the removal of duplicated citations, the titles and abstracts were screened. Following this step, a full text assessment was conducted. At both stages, screening was performed independently by two reviewers [AB and NB]. Any disagreements were resolved through consensus by two reviewers and when necessary, through discussion with a third reviewer [JLRG].

A data collection form was created on the *Covidence* website and piloted by two reviewers [AB, NB]. Three additional reviewers assisted with data extraction [JLRG, MB, MM]. Two reviewers were assigned to each paper. One reviewer extracted all characteristics of the included literature, and the second reviewer validated the characteristics for accuracy. Any disagreements were resolved by consensus. In the supplementary appendix, **eTable 2** summarizes the information extracted from full-text articles.

### Data Synthesis

This MA assessed the effectiveness of SFTD technologies and live video conferencing in diagnosing skin conditions. Outcomes regarding complete diagnostic percentage agreement rates

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3 and Cohen's kappa concordance were assessed separately, with some studies being part of both  
4 analyses if they reported both variables. The patient, intervention type, lesion, and geographic  
5 characteristics were summarized qualitatively. Please see supplementary appendix and **eTable 3**  
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8 for more details on data synthesis and nomenclature for each study grouping.  
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### 14 Risk of Bias

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16 Three reviewers [AB, NB, MB] completed the risk of bias assessment; all studies were  
17 independently reviewed. Version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB  
18 2) was used to assess the risk of bias in three randomized trials.<sup>9-11</sup> RoB 2 is structured into a fixed  
19 set of domains of bias, focusing on different aspects of trial design, conduct, and reporting.<sup>12</sup> The  
20 Quality Assessment of Diagnostic Assessment of Diagnostic Accuracy (2<sup>nd</sup> Edition, QUADAS-2)  
21 was used to assess risk of bias. Uncertain risk of bias was assigned to studies with insufficient  
22 information except for studies that were likely to be biased due to missing data. In the latter case,  
23 high risk of bias was assigned.  
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### 38 Search Strategy, and Data Analysis

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40 Please see supplementary appendix for additional information on search strategy and interpretation  
41 of kappa values.  
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### 47 Patient and Public Involvement

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49 Patients or the public were not involved in the design, or conduct, or reporting, or dissemination  
50 plans of our research.  
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## Results

6,945 studies were screened for eligibility of which 44 were included in this study. Of these, 40 studies reported diagnostic agreement rates<sup>4, 5, 9-11, 13-47</sup> and 21 studies reported kappa concordance.<sup>5, 9, 13, 14, 19, 22, 25, 28-33, 35-37, 48-52</sup> Further details are provided in the PRISMA diagram in **Figure 1**. Full list of excluded studies can be found in the supplementary appendix, **eTable 4**.

### Study and patient characteristics

**Table 1** summarizes study characteristics for the 44 papers that were included. Forty-one (93%) of the included studies were observational, of which 31 (76%) were prospective, nine (22%) were retrospective. One (2%) study was ambispective. Three studies were randomized controlled trials and one study was a quasi-randomized trial. Thirteen studies (30%) were from the United States of America (USA), where one study looked at patients living in Botswana who were evaluated by TDs based in the USA. Thirteen (30%) from Europe, eleven (25%) from South America, and seven (16%) from other countries. There were ten primary studies published after January 2020 where a pre and post pandemic analysis was performed.

**Table 2** summarizes participant characteristics. Studies selected for the review included a total of 52,075 patients (Range: 26 to 24,210 patients). Some patients had multiple lesions and the total number of lesions included in the study was 57,222 (Range: 26 to 27,519 lesions). Thirty-seven (83%) of papers examined less than 500 skin lesions.

The mean age reported in 27 (61%) studies was  $54.78 \pm 15.69$  years (Range: 0 to 100 years old). Thirty-four (77%) studies reported participant gender, with a mean of 57% females (Range: 3.2%



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3 to 74%). Only 13 (29%) of studies reported information on Fitzpatrick skin types, ethnicity, or  
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5 race. The dermatoses included in this study were grouped as “all types of skin lesions”, “skin  
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7 cancers only”, and inflammatory or benign skin conditions. Twenty-seven studies (62%) included  
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9 in this analysis were inclusive to all types of dermatoses, 13 (29%) studies looked specifically at  
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11 suspicious lesions, and three (6.8%) studies excluded skin cancers completely. Results on the  
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13 diagnostic reliability between TDs and F2F (specialist and non-specialists combined) and  
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15 diagnostic agreement between TDs, F2F dermatologists, and TD vs Histopathology are included  
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17 in the supplementary appendix.  
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#### 24 Diagnostic reliability of TD when compared to F2F (specialist and non-specialists) evaluation

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26 Agreement was assessed by measuring the complete agreement of primary diagnoses between TD  
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28 and F2F physicians (both specialist and non-specialists) by analyzing diagnostic agreement rates  
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30 (percentage) and concordance (Cohen’s kappa coefficient). The overall diagnostic agreement rate  
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32 and concordance were 68.9% (CI 64.4% to 73.1%), and 0.67 (CI 0.60 to 0.74). See **eFigure 1** and  
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34 the supplementary appendix for further details.  
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#### 40 Diagnostic agreement between TD and TD, F2F and F2F, and TD and Histopathology

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42 Diagnostic agreement rates were also compared within rater groups, as well as between TD and  
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44 histopathology, when values were available. Diagnostic agreement rate between TDs, F2F  
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46 dermatologists, and TD vs histopathology were: 76.4% (CI 69% to 82.5%), 82.4% (CI 76.7% to  
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48 87.0%), and 55.7% (CI 53% to 58.4%). See **eFigure 2** and the supplementary appendix for further  
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50 details.  
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## Sub-group analyses

### Diagnostic reliability of TD when compared to the current gold standard (F2F evaluation by a dermatologist) vs non-specialist

Thirty-five studies reported diagnostic agreement rates.<sup>4, 5, 9-11, 13-20, 22, 25-33, 35-46</sup> **Figure 2A** shows that the percentage agreement between TD and F2F dermatologists ranged from 38% to 98%, with 44 out of 64 comparisons having percentage agreement above 60% and seven studies having over 90% agreement. The diagnostic agreement rate between TD and F2F dermatologist was 70.96% (CI 69.8% to 72.1%) while the diagnostic agreement rate between TD and F2F of non-specialists was 44.1% (CI 39.9% to 48.4%). When non-specialists were compared to dermatologists for F2F vs. TD the agreement rate was significantly lower among non-specialists ( $p < 0.001$ , heterogeneity:  $I^2 = 98\%$ ). The percent agreement ranged from 13.9% to 71.7%, with six out of eight having concordance values below 50%.<sup>20, 21, 23, 24, 30, 32, 34, 47</sup>

Thirteen studies with 28 unique comparisons made between TD and F2F dermatologists that reported concordance values.<sup>9, 13, 14, 19, 22, 28, 31-33, 37, 42, 49, 51</sup> When kappa concordance values were compared, **Figure 2B** shows diagnostic agreement between TD and F2F dermatologists had a mean of 0.69 (CI 0.60 to 0.75) and it ranged between 0.213 (CI 0.20 to 0.23) to 0.96 (CI 0.92 to 0.98). When comparing TDs to non-specialists, the mean concordance value for diagnostic agreement from four studies had a mean of 0.52 (CI 0.25 to 0.71).<sup>30, 32, 48, 50</sup> When non-specialists were compared to dermatologists for F2F vs. TD, diagnostic concordance was significantly lower among non-specialists ( $p = 0.031$ , heterogeneity:  $I^2 = 100\%$ ).

### Diagnostic reliability of TD vs F2F by training involved and type of technology used related to image acquisition

Twenty studies with 37 unique comparisons that compared TDs with F2F physicians stated explicitly that training was provided to those in charge of image acquisition shown in **Figure 3**.<sup>9-11, 14-16, 19, 20, 23, 26, 29, 32, 35-41, 43, 44</sup> The mean agreement rate shown in **Figure 3A** was higher at 75.9% (CI 74.4% to 77.27%) compared to no training provided 62.1% (CI 60.5% to 63.7%), and this difference was statistically significant ( $p = 0.033$ , heterogeneity:  $I^2 = 98\%$ ). Concordance values in **Figure 3B** were also higher between TD and F2F when training was provided, with a mean 0.77 (CI 0.66-0.84), and 0.60 (CI 0.49-0.69) without training. This difference was statistically significant ( $p = 0.01$ ,  $I^2=98\%$ ).

### Other sub-group analyses

Statistically significant trends related to diagnostic agreement by image capturing technologies (**eFigure 5**) were also identified. No statistically significant patterns could be identified with the use of teledermoscopy, lesion type, grouping studies as pre- or post-pandemic, or risk of bias. Please see supplementary appendix for further details.

### **Quality assessment**

The results of quality assessment for risk of bias and applicability in individual studies are displayed in the supplementary appendix and **eTable 5**.

### **Discussion:**

This study constitutes the largest systematic review and MA on TD to our knowledge, including 44 studies across four languages.

We noted an overall agreement rate of 68.9% and overall concordance of kappa = 0.67 between TDs and F2F physicians. Through sub-group analyses, we found that the agreement was significantly higher for studies that compared TD to in-person assessments by dermatologists compared to non-specialists (difference of 26.86%,  $p < 0.001$ ). The lower concordance when F2F non-specialists are used suggests that lowered reference test accuracy reduces agreement rates: and for the purposes of clinical practice, it implies a greater need for TD to supplement primary over specialist care.

We noted greater agreement rates ( $p = 0.033$ ) between in-person and remote care when standardized training on image acquisition was incorporated into clinical workflow – suggesting a benefit to training primary care providers supporting TD.<sup>24, 53, 54</sup> Digital photography was also associated with more frequent agreement rates between TD and F2F physicians ( $p = 0.029$ ). Although the exact reason for this trend is less clear, this could be attributed to better image resolution and more experienced staff taking clinical images in a standardized manner for virtual consultations.

Pathological assessment of skin lesions is the cornerstone of skin cancer diagnosis. This MA found a 55.7% (CI 53.0% to 58.4%) agreement rate between TD and histopathology. This low agreement rate reflects all skin biopsies, and specific diagnostic accuracy rates could not be calculated by

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3 lesion type due to the small number of studies that reported this value. Through sub-group  
4 analyses, we were able to compare cancerous and non-cancerous lesions; slightly higher  
5 concordance was seen with skin cancers compared to studies that also included non-suspicious  
6 lesions like dermatitis and psoriasis. However, data was too heterogeneous for any significant  
7 conclusions. We also looked at the use of teledermoscopy, another technique that could help  
8 improve diagnostic accuracy of TD for suspicious lesions, but no significant trends could be  
9 identified. These findings reflected the results of a 2016 systematic review on TD.<sup>6</sup>  
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21 Many teledermoscopy studies grouped statistics from lesions analyzed with and without  
22 dermoscopy, preventing the assessment of the dermatoscope's incremental contributions without  
23 the influence of potentially less accurate, dermatoscope-free analysis. Supporting this explanation,  
24 the three teledermoscopy studies that focused on cancer lesions demonstrated greater concordance  
25 rates than the teledermoscopy studies targeting broader lesions. One study identified agreement  
26 rates between TD and F2F dermatology of 92.3% (24/26) and between TD and histopathology of  
27 66.7% (17/26), both above our identified median.<sup>45</sup> Another study found an agreement rate of 90%  
28 (37/41) when targeting pigmented lesions, although the rate may have been inflated due to recall  
29 bias introduced by having the same dermatologist perform TD and F2F consults.<sup>16</sup> Finally, one  
30 study diagnosed keratotic lesions in sun-exposed areas, finding a high agreement rate of 92%  
31 (915/1000).<sup>37</sup> However, this study also risked bias from its experimental design, which excluded  
32 lesions with poor image quality. This fails to recapitulate the complexities of practical TD, which  
33 must contend with potentially difficult image acquisition.  
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3 The 68.9% (CI 64.4% to 73.05%) combined agreement rate between TD and F2F is lower than the  
4 agreement rates outlined in a recent review.<sup>55</sup> This suggests our greater sample size introduces  
5 more studies with poor agreement, which may better reflect the reality of adopting TD at a larger  
6 scale and signal risk from a lack of standardization.<sup>54,55</sup> Our date cut-off of 2010 means our dataset  
7 has little overlap with existing reviews, and more heavily features new relevant technologies like  
8 smartphone apps for image acquisition.<sup>6,56</sup> The most recent MA<sup>56</sup> on TD limited its dataset to  
9 studies with multiple TD and F2F consults, and variably choosing to filter low-frequency  
10 diagnoses from certain studies.<sup>46</sup> Our results had greater heterogeneity compared to this MA,  
11 drawing attention to a key issue in the literature: unless results are heavily filtered – introducing  
12 bias, omitting most research, and weakening statistical power, the data is too heterogenous for  
13 effective metanalytic inferences. However, messy and heterogeneous data likely reflects real-  
14 world evidence and clinical practices.

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33 A possible source of heterogeneity in our analysis could be due to lack of stratification by study  
34 design given the minute number of randomized controlled trials available for analysis. However,  
35 filtering biased studies did not improve the suitability of our data for our proposed random-effects  
36 MA model. Our review also risked publication bias by not actively seeking out unpublished  
37 materials in conference proceedings. This likely reflects the nature of clinical work, highlighting  
38 the variability across different providers and settings and reinforcing the need to develop a  
39 standardized framework for employing and assessing TD.

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51 Current trends suggest that TD will continue to expand, there have been many recent studies  
52 examining its accuracy without the design considerations necessary to allow comparisons beyond  
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3 siloed investigations.<sup>1</sup> The implementation of evidence-informed processes is critical to the  
4 success of TD services, and the accurate assessment of TD will be required to assess which  
5 contexts it should be employed in, e.g., suspected malignancy vs. erythema.  
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12 The factors targeted by our sub analysis are undoubtedly important to standardize with best  
13 practices requiring the inclusion of primary care provider training in image acquisition, explicitly  
14 outlined conditions where dermatoscope attachments are required, and standardized reporting with  
15 a lesion's anatomical site, size, distribution, morphology, and colour. Additional guidelines for  
16 data reporting could be designed with a mind to future research goals, e.g., the inclusion of  
17 Fitzpatrick grading to identify gaps in medical care. Finally, both clinical and research guidelines  
18 must address privacy concerns, as the integration of EMR and the sharing of patient images or  
19 videos presents potential vulnerabilities.  
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### **Conclusion:**

This MA indicates that diagnostic agreement between remote and in person dermatologists is acceptable in select conditions (i.e., when training for image acquisition is provided and technologies for high-quality images are used). Telemedicine adoption rates are accelerating globally, and TD must be considered for enhanced accessibility, flexibility, reduced costs, and safer environments it can provide patients.

The results of this MA represent significant evidence to indicate the suitability of TD for remote care, particularly as a complement to primary care, where it can serve as an intermediate step before F2F specialist consultations. Furthermore, the categorisation of diagnostic concordance highlights important factors to further improve diagnostic accuracy. Additionally, it highlights the lack of standardization in TD studies, calling for greater structure in clinical practice and conducting primary research.

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JLRG is the guarantor of the review and supervised study design. JLRG also contributed to data analysis and provided statistical expertise. AB and NB oversaw study design, data collection, data analysis, and original draft preparation. AB designed the search strategy with the guidance



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## Figure Legends

**Figure 1. PRISMA Flow diagram of study selection.**

**Figure 2. Forest plot representing F2F and TD primary diagnostic agreement by specialization status of the F2F physician.** Studies were sorted into two groups, a) F2F diagnosis completed by a board-certified dermatologist; b) F2F diagnosis completed by a non-specialist (e.g., general practitioner). **(A)** Forest plot representing percentage agreement and 95% C.I. for overall concordance across 40 studies with a total of 72 unique number of comparisons, N of events and total included participants. **(B)** Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants.

**Figure 3. Forest plot representing F2F and TD primary diagnostic agreement by whether imaging acquisition training was indicated by the study.**

Forest plot representing F2F and TD primary diagnostic agreement when image acquisition training is involved. Studies were sorted into two groups, a) Did not conduct or did not report training personnel on image acquisition; b) Stated that person in charge of image acquisition was trained. **(A)** Forest plot representing percentage agreement and 95% C.I. for overall concordance across 39 studies with a total of 71 unique number of comparisons, N of events and total included participants. **(B)** Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants.



## Tables

A

TD vs Derm					
Source	Study design	Country of publ., Study reported funding (Y/N)	Intervention Assessment of diagnostic agreement between...	Outcomes Comparing complete primary diagnostic agreement between F2F and TD (and between Histo and TD if applicable)	Quality rating
<b>Standard of reference: F2F</b>					
Azfar, et al, 2014	Prospective Cohort Study	Botswana, N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate (TD1 46.6%, TD2 56.8%, TD3 48.6%) concordance (TD1 0.41, TD2 0.51, TD3 0.43), N=136	Low
Barcaui, et al, 2018	Prospective Cohort Study	Brazil, N	TD and F2F consult by the same dermatologist via digital photography and dermoscopy images stored in WhatsApp	Diagnostic agreement rate (90%, N=41)	High
Batalla, 2015	Retrospective Cohort Study	Spain, N	TD and F2F dermatologists by via clinical images	Diagnostic agreement rate (55%, N=65)	Moderate
Borve, et al, 2012	Prospective Cohort Study	Sweden, Y	TD and F2F consults by the same dermatologist via smartphone images stored in Tele-Dermis	Diagnostic agreement rate (78%, N=40)	High
Gatica, et al, 2015	Prospective Cohort Study	Chile, N	TD and F2F dermatologists via clinical images taken by digital photography	Diagnostic agreement rate (82%, N=125)	Moderate
Gerhardt, et al, 2021	Observational study	USA, Y	TD and F2F dermatologists via clinical images	Diagnostic agreement rate (75.3%, N=809)	High
Keller, et al, 2020	Prospective Cohort Study	USA, Y	TD and F2F dermatologists or hospitalists on clinical images taken by smartphones and tablets	Derm vs TD: Diagnostic agreement rate (52.5%), concordance (0.45)	Low
Marchell, et al., 2017	Quasi RCT	USA, Y	TD and F2F dermatologists via digital photography, compressed and uncompressed video	SFTD: Diagnostic agreement rate (76%, N=213); uncompressed video (76%, N=101), compressed video (72%, N=112)	Low
Muir, et al,	Prospective	Australia,	TD and F2F	Derm vs TD:	High

Skin cancer, and other common dermatological lesions

2011	Cohort Study	N	emergency derms and non-specialists via clinical images taken by digital photography	Diagnostic agreement rate (98%), concordance (0.93)	
Nami, et al, 2015	Prospective Cohort Study	Italy and Austria, Y	TD and F2F dermatologists via smartphone images stored in MugDerma	Diagnostic agreement rate (91.05%), concordance (0.906), N=391	High
Okita, et al, 2016	Prospective Cohort Study	Brazil, N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate (54%, N=100)	High
Ribas, et al, 2010	Prospective Study	Brazil, Y	TD and F2F dermatologists via digital photography	Diagnostic agreement rate (81.5%) concordance (0.8), N=174	High
Romero Aguilera, et al, 2014	Prospective Cohort Study	Spain, Y	TD and F2F dermatologists via clinical images taken by digital photography stored in DERMARED. A small portion of patients were seen by the same Derm for F2F and TD consult.	Diagnostic agreement rate (77.8%, N=170)	Moderate
Romero, et al, 2010	Randomized Controlled Trial	Spain, Y	TD and F2F consults by the same dermatologist via digital photography and videoconferences via DERMARED software	Diagnostic agreement rate (85%, N=368)	Moderate
Rubegni, et al, 2011	Prospective Cohort Study	Italy, N	TD and F2F dermatologists via digital photography and dermoscopy images stored in Dermo-image.	Diagnostic agreement rate (87.7%), concordance (0.863), N=130	Low
Saleh, et al, 2017	Prospective Cohort Study	Egypt, Y	TD and F2F dermatologists via clinical images taken by digital photography stored in Dropbox	Diagnostic agreement rate (81.3%), concordance (0.46-0.52), N=600	Low
Vano-Galvan, et al, 2010	Retrospective, Cross-sectional study	Spain, N	TD and F2F dermatologists via clinical images taken by digital photography for case conferences	Diagnostic agreement rate (69.05%, N=2000)	High
Zanini, 2013	Prospective Cohort Study	Brazil, N	TD and F2F dermatologists via clinical images taken by digital photography	Diagnostic agreement rate (76.3%, N=100)	Moderate
Carter, et al, 2017	Prospective and retrospective	USA, Y	TD and F2F dermatologists, as well as F2F PCP via	Derm vs TD: Diagnostic agreement rate	High

Skin  
cat  
lesions

	cohort study		clinical images stored using Epic EHR software	(38%)	
Lamel, et al, 2012	Prospective Cohort Study	USA, N	TD and F2F dermatologists via smartphone images stored in ClickDerm	Diagnostic agreement rate (62%), concordance (0.6) N=107	Moderate
Vestergaard, et al, 2020	Prospective Cohort Study	Denmark, N	TD and F2F dermatologists via smartphone and dermoscopy images using FotoFinder Systems	F2F: Diagnostic agreement rate (TD1 62%, TD2 60.2%), concordance (TD1 0.58, TD2 0.57), N=600 Histo: Diagnostic agreement rate (TD1 58.2%, TD2 53.6%), N=292	High
Warshaw, et al, 2015	Prospective, Cross-sectional study	USA, N	TD and F2F dermatologists via digital photography and dermoscopy images	Diagnostic agreement rate and concordance* A1 (75.70%, 0.56), N=753 A2 (75.30%, 0.56), N=752 A3 (80.10%, 0.62), N=684 B1 (52.80%, 0.44), N=651 B2 (53.40%, 0.45), N=652 B3 (60.00%, 0.52), N=595 C1 (51.50%, 0.38), N=583 C2 (50.20%, 0.38), N=579 D1 (45.70%, 0.32), N=1,034 D2 (50.10%, 0.37), N=1,020	Moderate
Zink, et al, 2017, Sept	Prospective Cohort Study	Germany, Y	TD and F2F dermatologists via smartphone and dermoscopy images using Handyfotos	F2F: Diagnostic agreement rate (92.3%) Histo: Diagnostic agreement rate (66.7%), N=26	Low
Giavina-Bianchi, et al, 2020 Oct	Retrospective Cohort Study	Brazil, N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate (78%) concordance (0.743), N=739	High
<b>Standards of reference: F2F and Histopathology</b>					

Skin lesions other than neoplasms

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4	Rios-Yuil, 2011	Randomized Controlled Trial	Panama	TD and F2F dermatologists via clinical images taken by digital photography for case conferences	F2F: Diagnostic agreement rate (83.3%), concordance (0.652) Histo: Diagnostic agreement rate (66.7%) N=30	Moderate
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10	Zink, et al, 2017, July	Prospective Cohort Study	Germany, Y	TD and F2F dermatologists via smartphone images stored in the KLARA app	F2F: Diagnostic agreement rate (58.9%, N=195) Histo: Diagnostic agreement rate (55.6%, N=195)	High
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16	Giavina-Bianchi, et al, 2020 Nov	Retrospective Cohort Study	Brazil, N	TD and F2F dermatologists via smartphone images	F2F: Diagnostic agreement rate (61%), concordance (0.213), N=803 Histo: Diagnostic agreement rate (54%), concordance (0.087), N=289	High
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24	Senel, et al, 2013	Prospective Cohort Study, Repeated measures	Turkey, N	TD and F2F dermatologists via digital photography and dermoscopy images	<b>Without dermoscopy:</b> Concordance (TD1 0.77, TD2 0.75), N=150 <b>With dermoscopy:</b> Concordance (TD1 0.85, TD2: 0.86), N=150	High
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32	Sola-Ortigosa, et al, 2020	Prospective Cohort Study	Spain, N	TD and F2F consults by the same dermatologist via dermoscopy and clinical images taken by digital photography and tablets	<b>Without dermoscopy</b> F2F: Diagnostic agreement rate (TD1 82.1%, TD2 83.2%, TD3 81.3%), concordance (TD1 0.87, TD2 0.83, TD3 0.89) Histo: Diagnostic agreement rate (TD1 87.5%, TD2 83.5%, TD3 88.4%), N=1000 <b>With dermoscopy</b> F2F: Diagnostic agreement rate (TD1 91.5%, TD2 90.2%, TD3 89.9%), concordance (TD1 0.91, TD2 0.90, TD3 0.89) Histo: Diagnostic agreement rate (TD1 91.5%, TD2 91.2%, TD3 90.3%), N=1000	High
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4	Tan, et al,	Prospective	New	TD and F2F consults	F2F: Diagnostic	High		
5	2010	Cohort Study,	Zealand,	by the same	agreement rate			
6		Repeated	Y	dermatologist via	(73.7%, N=681),			
7		measures		digital photography	accuracy (Sn, Sp,			
8					PPV)**			
9	<b>Standards of reference: Histopathology</b>							
10	Borve, et al,	Prospective	Sweden,	TD and F2F consults	F2F: Diagnostic	High		
11	2013	Cohort Study	Y	by the same	agreement rate (TD1			
12				dermatologist via	55%, TD2 57%),			
13				smartphone and	concordance (TD1			
14				dermoscopy images	0.47, TD2 0.48),			
15				stored in iDoc 24 app	accuracy (TD1 51%,			
16					TD2 61%)			
17					Histo: Concordance		Skin cancer lesions only	
18					(TD1 0.51, TD2			
19					0.51), N=69			
20	Clarke, et al,	Prospective	USA,	TD and F2F	F2F: Diagnostic	High		
21	2021	Cohort Study	Y	dermatologists via	agreement rate			
22				clinical images taken	(66.6%),			
23				by digital photography	concordance (0.6),			
24				stored in Research	N=308			
25				Electronic Data	Histo: Diagnostic			
26				Capture	agreement rate			
27	Goulart-	Prospective	Brazil,	TD and F2F	F2F: Concordance	High		
28	Silveira et	Cohort Study	N	dermatologists via	(0.958), accuracy			
29	al, 2019			smartphone images	(Sn, Sp, PPV, NPV)			
30				acquired and stored	Histo: Concordance			
31				via Telederma app	(0.556), N=39			
32	<b>Standards of reference: No clear standard</b>							
33	Altieri, et al,	Prospective	USA,	TD and F2F	Diagnostic	Low		
34	2017	Cohort Study	Y	dermatologists via	agreement rate (TD1			
35				clinical images taken	58.1%, N=160; TD2			
36				by digital photography	53.3%, N=152; TD3			
37					52.6%, N=152),			
38					concordance (TD1			
39					0.51, N=160; TD2			
40					0.51, N=152; TD3			
41					0.57, N=152)			
42	Barbieri, et	Prospective	USA,	TD and F2F	Diagnostic	Moderate		
43	al, 2014	Cohort Study	N	dermatologists via	agreement rate (TD1			
44				smartphone images	64%, TD2 56%),			
45				using the AccessDerm	N=50			
46				smartphone platform				
47	Gabel, et al,	Prospective	USA	TD and F2F	Diagnostic	High		
48	2021	Cohort Study	Y	dermatologists via	agreement rate			
49				clinical images taken	(66.7%),			
50				by digital photography	concordance (0.33),			
51				and tablets	N=41			
52	Tran, et al,	Prospective	Egypt,	TD and F2F	Diagnostic	High		
53	2011	Cohort Study	Y	dermatologists via	agreement rate			
54				smartphone images	(75%, N=30)			
55				stored in ClickDoc				
56							Skin cancer, and other common dermatological lesions	
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Carter, et al, 2017	Prospective and retrospective cohort study	USA, Y	TD and F2F dermatologists, as well as F2F PCP via clinical images stored using Epic EHR software	Derm vs TD: Diagnostic agreement rate (38%)	High	Skin cancer
<p>*A1 (non-biopsied pigmented lesions, Macro                  A2 (non-biopsied pigmented lesions, Macro+PLD)                  A3 (non-biopsied pigmented lesions, Macro+PLD)                  B1 (biopsied pigmented lesions, Macro)                  B2 (biopsied pigmented lesions, Macro+PLD)                  B3 (biopsied pigmented lesions, Macro+PLD)                  C1 (non-biopsied non-pigmented lesions, Macro)                  C2 (non-biopsied non-pigmented lesions,, Macro+PLD)                  D1 (biopsied non-pigmented lesions, Macro)                  D2 (biopsied non-pigmented lesions, Macro+PLD)                  PLD = polarized light dermoscopy</p>						

**B**

Source	Study design	Country of publ., Study reported funding (Y/N)	Intervention Assessment of diagnostic agreement between...	Outcomes Comparing complete primary diagnostic agreement between F2F and TD (and between Histo and TD if applicable)	Quality rating	
Costello, et al, 2019	Prospective Cross-sectional study	USA, Y	TD and F2F PCP via smartphone and dermoscopy images using the Photo Exam app	Diagnostic agreement rate (31.6%, N=37)	High	Skin cancer and other dermatoses
Duong, et al, 2014	Observational study	France, Y	TD and F2F emergency physicians via smartphone images and videoconferences	Videoconference: diagnostic agreement rate (68.7%, N=83) SFTD: diagnostic agreement rate (30.9%, N=110)	High	
Gonzalez-Coloma, et al, 2019	Prospective, Cross-sectional study	Chile, N	TD and F2F PCP via clinical images	Diagnostic concordance (0.50, N=326)	High	
Keller, et al, 2020	Prospective Cohort Study	USA, Y	TD and F2F dermatologists or hospitalists on clinical images taken by smartphones and tablets	ED vs TD: Diagnostic agreement rate (45.3%), concordance (0.4), N=53	Low	
Muir, et al, 2011	Prospective Cohort Study	Australia, N	TD and F2F emergency physicians via clinical images taken by digital photography	ED vs TD: Diagnostic agreement rate (72%),	High	

					concordance (0.42), N=60	
Carter, et al, 2017	Prospective and retrospective cohort study	USA, Y	TD and F2F dermatologists, as well as F2F PCP via clinical images stored using Epic EHR software	PCP vs TD: Diagnostic agreement rate (14%), N=79	High	Skin cancer lesions only
Jones, et al, 2021	Retrospective Cohort Study	New Zealand, Y	TD and F2F PCP via digital photography and dermoscopy images	PCP vs TD (SSC Matched*)	Moderate	
Piccoli, et al, 2015	Retrospective Cross-sectional study	Brazil, Y	TD and F2F PCP via digital photography and dermoscopy images	Diagnostic concordance (0.69, N=184), accuracy		
Chen, et al, 2010	Retrospective Cohort Study	USA, Y	TD and F2F PCP via clinical images stored in Second Opinion Software	Diagnostic agreement rate (48%, N=405)	High	Skin lesions other than melanomas
Patro, et al 2015	Prospective Cohort Study	India, Y	TD and F2F PCP via digital photography	Diagnostic agreement rate (56%, N=206)	High	

\*A1 (non-biopsied pigmented lesions, Macro)  
 A2 (non-biopsied pigmented lesions, Macro+PLD)  
 A3 (non-biopsied pigmented lesions, Macro+PLD)  
 B1 (biopsied pigmented lesions, Macro)  
 B2 (biopsied pigmented lesions, Macro+PLD)  
 B3 (biopsied pigmented lesions, Macro+PLD)  
 C1 (non-biopsied non-pigmented lesions, Macro)  
 C2 (non-biopsied non-pigmented lesions,, Macro+PLD)  
 D1 (biopsied non-pigmented lesions, Macro)  
 D2 (biopsied non-pigmented lesions, Macro+PLD)  
 PLD = polarized light dermoscopy

\*Suspected Skin Cancer Pathway matched for age, sex, and ethnicity.

**Table 1. Study characteristics for all included studies. (A)** Studies that compared TD with F2F dermatologists. **(B)** Studies that compared TD with F2F non-specialists. Studies are in alphabetical order and are grouped according to lesion type reported.

Source	Patient demographics	Special inclusions, and exclusions
	Country where patients resided, number of patients included, percentage by gender/sex, age, number of lesions included	
Skin cancer, and other common dermatological lesions		
Altieri, et al, 2017	USA, 232 p., sex N/A, age: 18+, 232 I.	Inclusion: Adults
Azfar, et al, 2014	Botswana, 76 p., 57% female, 43% male, mean age: 39, 159 I.	Inclusion: HIV+ adults

1	Barbieri, et al, 2014	USA, 50 p., 64% female, 36% male, mean age: 55.2, 50 l.	Inclusion: Adults
2	Barcaui, et al, 2018	Brazil, 31 p., 71% female, 29% male, mean age: 56.5, 41 l.	Inclusion: Adults with pigmented lesions only
3	Batalla, 2015	Spain, 183 p., 66% female, 34% male, mean age: 9, 65 l.	Inclusion: Pediatric patients
4	Borve, et al, 2012	Sweden, 40 p., 57.5% female, 42.5% male, mean age: 49, 40 l.	Inclusion: Adults
5	Costello, et al, 2019	USA, 37 p., 65% female, 35% male, mean age: 47.9, 37 l.	Inclusion: Adults who were under or uninsured
6	Duong, et al, 2014	France, 111 p. SFTD, 83 p. videoconference, sex N/A, age: 18+, 110 l. SFTD, 68 l. videoconference	Inclusion: Adults presenting to emergency department
7	Gabel, et al, 2021	USA, 41 p. sex N/A, age N/A, 41 l.	N/A
8	Gatica, et al, 2015	Chile, 125 p., 57.6% female, 42.4% male, mean age: 37.7, 125 l.	
9	Gerhardt, et al, 2021	USA, 809 p., sex N/A, age N/A, 809 l.	Inclusion: Veteran population; Exclusion: Patients whose lesions resolved early
10	Gonzalez-Coloma, et al, 2019	Chile, 326 p., 59% female, 41% male, mean age: 35.8, 326 l.	N/A
11	Keller, et al, 2020	USA, 100 p., 43.2% female, 56.8% male, age N/A, 100 l.	N/A
12	Marchell, et al, 2017	USA, 216 p., sex N/A, age N/A, 216 l.	N/A
13	Muir, et al, 2011	Australia, 60 p. where F2F was an ED physician, 50 p. where F2F was a dermatologist, 65% female, 35% male, mean age: 47, 60 and 50 l.	Inclusion: Adults; Exclusion: Lesions caused by accident or trauma
14	Nami, et al, 2015	Italy and Austria, 391 p., 52.2% female, 47.8% male, mean age: 54, 391 l.	Exclusion: Pigmented skin lesions
15	Okita, et al, 2016	Brazil, 100 p., sex N/A, age N/A, 100 l.	N/A
16	Ribas, et al, 2010	Brazil, 174 p., 53.4% female, 46.6% male, mean age: 34.7, 174 l.	
17	Rios-Yuil, 2011	Panama, 30 p., 63.3% female, 36.7% male, age range for 30% of patients: 50-59, 30 l.	
18	Romero Aguilera, et al, 2014	Spain, 457 p., 56% female, 44% male, mean age: 36, 170 l.	
19	Romero, et al, 2010	Spain, 158 p. SFTD with videoconference, 170 p. SFTD only, 56% female, 44% male, mean age: 36, 510 l.	
20	Rubegni, et al, 2011	Italy, 130 p., 53.9% female, 46.1% male, mean age: 80.6, 130 l.	Inclusion: Geriatric patients
21	Saleh, et al, 2017	Egypt, 600 p., 50.7% female, 49.3% male, age: 38% >20, 17.3% >10-20, 31.7% 2-10, 13% <2; 600 l.	N/A
22	Tran, et al, 2011	Egypt, 30 p., sex N/A, all ages, 30 l.	N/A



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3	Vano-Galvan, et al, 2010	Spain, 100 p. (50 from derm outpatient clinic, 50 from the ED), sex N/A, age N/A, 100 I.	N/A
4			
5	Zanini, 2013	Brazil, 100 p., sex N/A, age N/A, 100 I.	
6			
7	Zink, et al, 2017, July	Germany, 195 p., 20.5% female, 79.5% male, age range: 1-89 years, 195 I.	
8			
9			
10	<b>Skin cancer lesions only</b>		
11	Borve, et al, 2013	Sweden, 62 p., 38.7% female, 60.3% male, mean age: 64, 69 I.	Inclusion: Adults whose lesions could be biopsied
12			
13			
14	Carter, et al, 2017	USA, 79 patients, 74% female, 26% male, mean age: 47, 79 I.	Inclusion: Adults with mild-to-moderate cases; Exclusion: Patients with melanocytic lesions or emergencies
15			
16			
17			
18	Clarke, et al, 2021	USA, 206 p., 49.5% female, 50.5% male, mean age: 56.9, 308 I.	Inclusion: Adults with a lesion of concern reported by anyone (e.g., patient, family, referring GP) except a dermatologist
19			
20			
21			
22	Giavina-Bianchi, et al, 2020 Nov	Brazil, 17, 233 p., 71.4% female, 28.6% male, age N/A, 803 I.	Exclusions: Mild/complex cases, diagnoses without ICD10 code, and only looked at the 10 most frequent neoplasms
23			
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25			
26	Goulart-Silveira et al, 2019	Brazil, 39 p., 69% female, 31% male, mean age: 68, 39 I.	Inclusion: Adults; Exclusion: Patients with bad quality images
27			
28	Jones, et al, 2021	New Zealand, 481 p., 64% female, 36% male, age range: 0-90+, 528 I.	Inclusion: Adults and children with suspected skin cancers.
29			
30	Lamel, et al, 2012	USA, 86 p., 58.1% female, 41.9% male, mean age: 45.2, 107 I.	N/A
31			
32	Piccoli, et al, 2015	Brazil, 184 p., 73.4% female, 26.6% male, mean age: 54.7, 184 I.	Exclusions: Patients with poorly taken images, patients under concurrent treatment
33			
34			
35	Senel, et al, 2013	Turkey, 150 p., 49% female, 51% male, mean age: 55, 150 I.	Inclusion: Adults with non-melanocytic lesions only
36			
37	Tan, et al, 2010	New Zealand, 200 p., 63% female, 37% male, age range: 11-94, 491 I.	N/A
38			
39			
40	Vestergaard, et al, 2020	Denmark, 519 p., 57% female, 42% male, mean age: 55, 600 I.	Inclusion: Adults
41			
42	Warshaw, et al, 2015	USA, 2,152 p., 3.2% female, 96.8% male, mean age: 68, 3021 I.	Inclusion: Adults
43			
44	Zink, et al, 2017, Sept	Germany, 26 p., sex N/A, age N/A, 26 I.	
45			
46	Sola-Ortigosa, et al, 2020	Spain, 636 p., 43.2% female, 56.8% male, mean age: 72.8, 1000 I.	Inclusion: Adults with keratotic skin lesions only; Exclusion: Patients with poorly taken images
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50	<b>Skin lesions other than skin neoplasms</b>		
51	Chen, et al, 2010	USA, 405 p., 50.6% female, 49.4% male, mean age: 5.9, 405 I.	Inclusion: 12 or younger; Exclusion: Lesions caused by an accident or trauma
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Giavina-Bianchi, et al, 2020 Oct	Brazil, 24,210 p., 70% female, 30% male, age N/A, 739 I.	Exclusions: Mild/complex cases, diagnoses without ICD10 code, and only looked at the 20 most frequent inflammatory dermatoses
Patro, et al 2015	India, 206 p., 58.7% female, 41.3% male, age range: 1+, 206 I.	Exclusions: Pregnant women and patients with concurrent diseases

**Table 2. patient characteristics for all 44 included studies.** Studies in alphabetical order and are grouped according to lesion type reported. Last column describes special inclusion and exclusion criteria that could impact quality of the studies included. NA or N/A: Not available, I.: lesion, SFTD: Store And Forward Technology, GP: General practitioner.

For peer review only

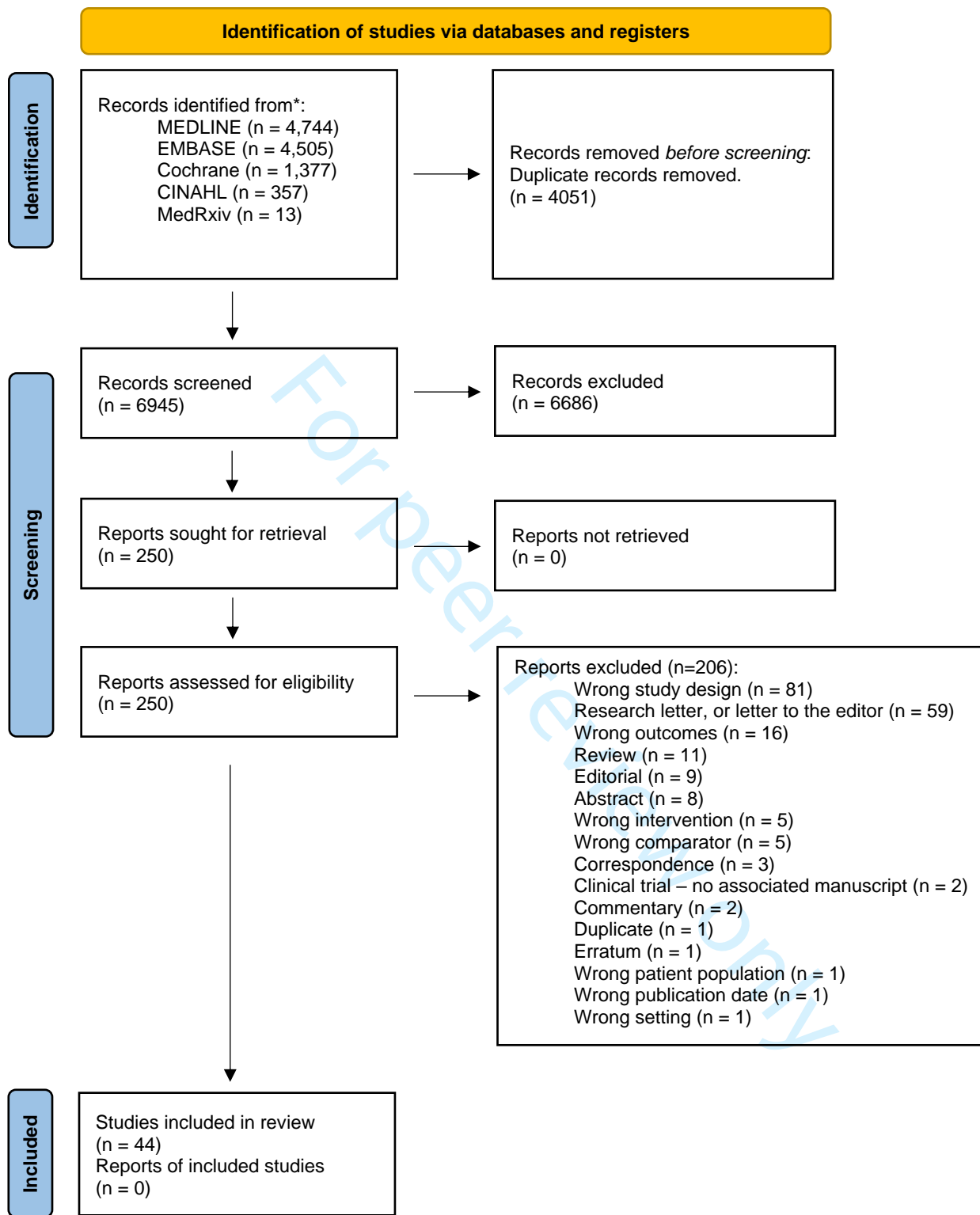


Figure 1. PRISMA Flow diagram of study selection.

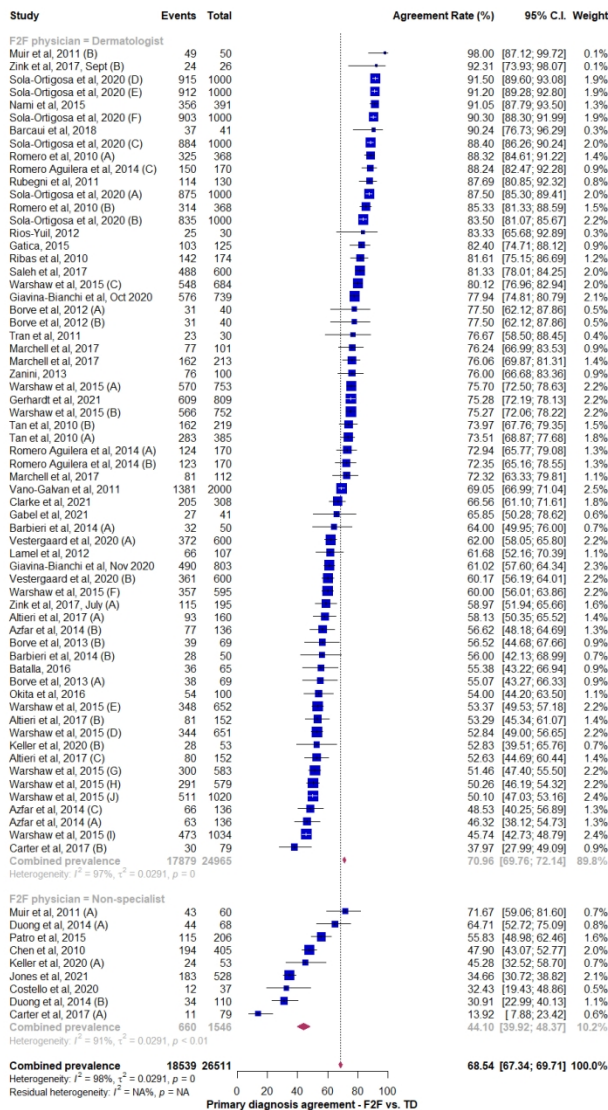


Figure 2. Forest plot representing F2F and TD primary diagnostic agreement by specialization status of the F2F physician. Studies were sorted into two groups, a) F2F diagnosis completed by a board-certified dermatologist; b) F2F diagnosis completed by a non-specialist (e.g., general practitioner). (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 40 studies with a total of 72 unique number of comparisons, N of events and total included participants.

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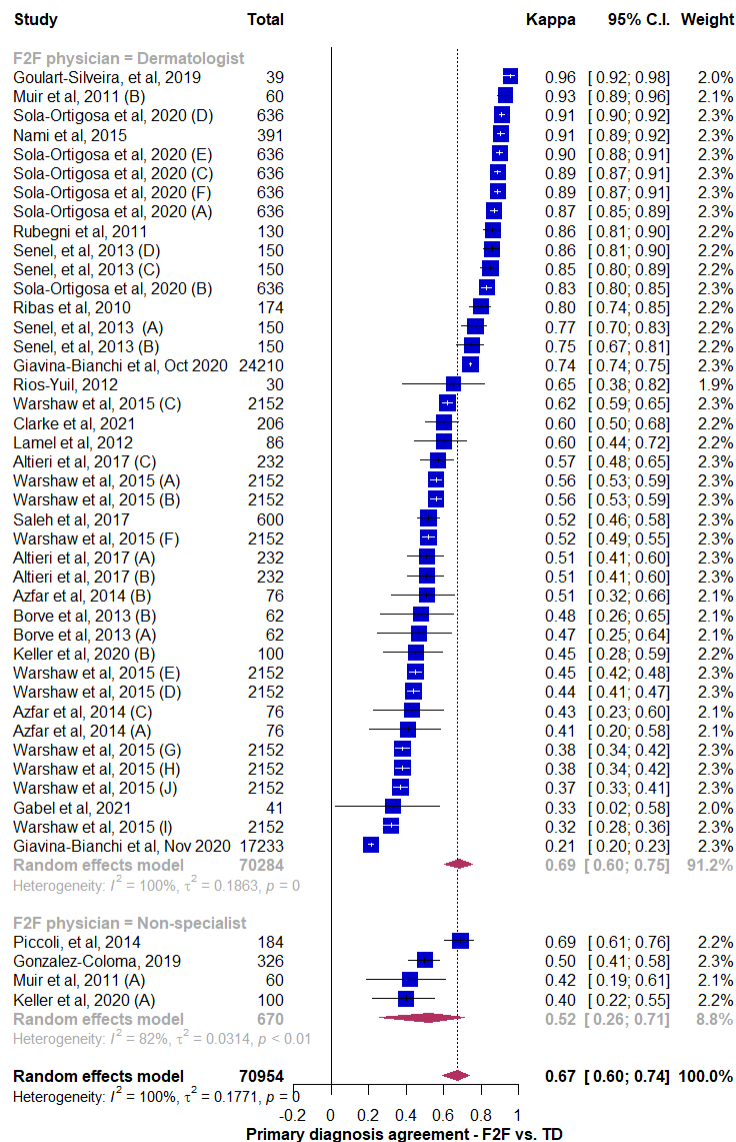


Figure 2. Forest plot representing F2F and TD primary diagnostic agreement by specialization status of the F2F physician. Studies were sorted into two groups, a) F2F diagnosis completed by a board-certified dermatologist; b) F2F diagnosis completed by a non-specialist (e.g., general practitioner). (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants.

264x317mm (96 x 96 DPI)

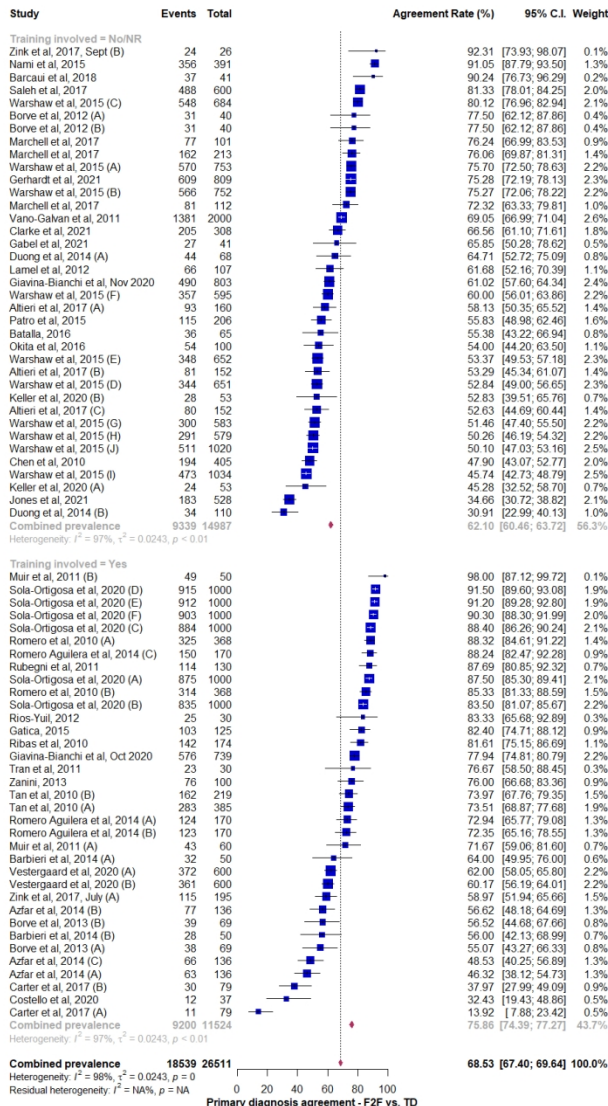


Figure 3. Forest plot representing F2F and TD primary diagnostic agreement by whether imaging acquisition training was indicated by the study.

Forest plot representing F2F and TD primary diagnostic agreement when image acquisition training is involved. Studies were sorted into two groups, a) Did not conduct or did not report training personnel on image acquisition; b) Stated that person in charge of image acquisition was trained. (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 39 studies with a total of 71 unique number of comparisons, N of events and total included participants.

264x476mm (96 x 96 DPI)

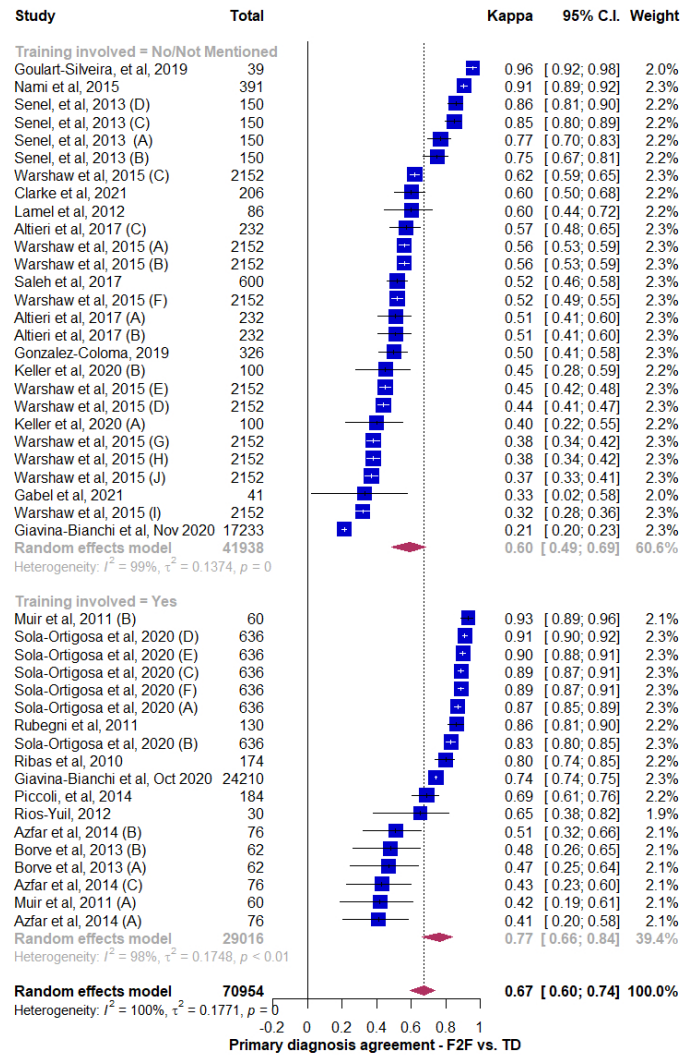


Figure 3. Forest plot representing F2F and TD primary diagnostic agreement by whether imaging acquisition training was indicated by the study.

Forest plot representing F2F and TD primary diagnostic agreement when image acquisition training is involved. Studies were sorted into two groups, a) Did not conduct or did not report training personnel on image acquisition; b) Stated that person in charge of image acquisition was trained. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants.

264x343mm (96 x 96 DPI)



## Supplementary Online Content

**Title:** Diagnostic Reliability in Teledermatology: A Systematic Review and Meta-Analysis

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## 21 Contents

22	Search Strategy	3
23	Ovid MEDLINE Search	3
24	Supplementary eResults	4
25	Diagnostic reliability of TD when compared to F2F (specialist and non-specialists) evaluation	4
26	Diagnostic agreement between TD and TD, F2F and F2F, and TD and Histopathology	4
27	Subgroup analyses	4
28	Diagnostic reliability of TD vs F2F by the inclusion of teledermoscopy in both TD and F2F assessments	4
29	Diagnostic reliability of TD vs F2F by type of technology used related to image acquisition	5
30	Diagnostic reliability of TD vs F2F by pre- and post-pandemic timelines.	5
31	Risk of bias and quality assessment	5
32	Supplementary eFigures and Legends	6
33	eFigure 1. Forest plot representing F2F and TD primary diagnostic agreement.	7
34	eFigure 2. Forest plot representing TD, F2F, and histopathology primary diagnostic agreements.	8
35	eFigure 3. Forest plot representing F2F and TD primary diagnostic agreement by utilization of teledermoscopy.	10
36		
37	eFigure 4. Forest plot representing F2F and TD primary diagnostic agreement by skin lesion category.	12
38	eFigure 5. Forest plot representing F2F and TD primary diagnostic agreement by device type used to capture clinical photographs.	14
39		
40	Supplementary eTables	15
41	eTable 1. Inclusion and exclusion criteria for screening of literature search results.	15
42	eTable 2. Data extraction form with details of domains record.	15
43	eTable 3. Included unique study groupings and letter codes.	7
44	eTable 4. List of studies excluded at the full-text screening stage.	8
45	eTable 5. Risk of Bias (ROB) results.	10
46	eReferences.	11
47		
48		
49		
50		
51		
52		
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54		
55		
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57		
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## Supplementary eMethods

### Search Strategy

The search strategy was written for Ovid Medline and translated using each database's syntax, controlled vocabulary, and search fields. MeSH terms, Emtree terms, and free text words were used for TD and skin conditions such as melanoma and related synonyms. To identify additional articles not captured through the aforementioned search, a manual search was conducted via reference search of the included studies.

All database records were downloaded to EndNote X9 (Clarivate) and uploaded to web-based software for deduplication, screening, and full-text evaluation (Covidence; Veritas Health Innovation). We contacted three study authors to gain access to their published work.<sup>1-3</sup> The search strategy is available below.

### Ovid MEDLINE Search

Ovid MEDLINE(R), Ovid MEDLINE(R) Daily and Epub Ahead of Print, In-Process & Other Non-Indexed Citations <1946 to 2022 May 02>

1. e consult\*.mp. 2. econsult\*.mp. 3. electronic consult\*.mp. 4. e health.mp. 5. ehealth.mp. 6. e visit\*.mp. 7. evisit\*.mp. 8. home video visit\*.mp. 9. internet/ or internet-based intervention/ 10. internet.mp. 11. offsite care.mp. 12. off site care.mp. 13. ontario telemedicine network.mp. 14. Remote Consultation/ 15. remote consultation\*.mp. 16. remote visit\*.mp. 17. tele care.mp. 18. telecare.mp. 19. tele consult\*.mp. 20. teleconsult\*.mp. 21. tele diagnos\*.mp. 22. telehealth.mp. 23. tele health.mp. 24. telemedicine/ 25. telemedicine.mp. 26. tele medicine.mp. 27. telemonitor\*.mp. 28. tele monitor\*.mp. 29. Telepathology/ 30. telepatholog\*.mp. 31. tele patholog\*.mp. 32. telepractice\*.mp. 33. tele practice\*.mp. 34. Therapy, Computer-Assisted/ 35. video consult\*.mp. 36. videoconsult\*.mp. 37. virtual care.mp. 38. web based.mp. 39. Telepathology/ 40. or/1-39 41. Dermatology/ 42. dermatolog\*.mp. 43. dermatopatholog\*.mp. 44. exp Skin Diseases/di [Diagnosis] 45. exp Skin Neoplasms/ 46. skin.mp. 47. exp Skin Abnormalities/ 48. burns/ or burns, chemical/ or burns, electric/ or sunburn/ 49. burn\*.mp. 50. wound healing/ or cicatrix/ 51. wound\*.mp. 52. or/41-51, 53. 40 and 52, 54. teledermatolog\*.mp. 55. tele dermatolog\*.mp. 56. 54 or 55, 57. 53 or 56, 58. limit 57 to dt=20100101-20220402

### Eligibility Criteria

Inclusion and exclusion criteria are summarized in **eTable 1**.

### Data Selection and Extraction

Information extracted from full-text articles is summarized in **eTable 2**.

### Data Analysis: Cohen's kappa Interpretations

Cohen's kappa values for diagnostic concordance between TD and F2F physicians were interpreted based on the following criteria.<sup>4</sup> Values between 0–.20 indicate no agreement, .21–.39 minimal agreement, .40–.59 weak agreement, .60–.79 moderate agreement, .80–.90 strong agreement, and above .90 almost perfect agreement.

### Data Synthesis

Agreement rates and Cohen's kappa concordances for unique study groupings were treated as individual and independent values. A letter was assigned to each unique study grouping as explained in **eTable 3**. Confounding factors including technology type, year of publication, and training of study raters was controlled using meta-regression. Proportions meta-analysis looked at weighted averages and 95% confidence intervals were reported. A random-effects model as proposed by DerSimonian and Laird was chosen as the primary method to estimate all pooled estimates.<sup>5</sup> Heterogeneity was assessed by calculating I<sup>2</sup>. Possible sources of heterogeneity were sought through sub-group analysis. This included different skin conditions, specialization of the F2F physician, whether staff were trained on image acquisition, the technology used for image acquisition, the use of teledermoscopy, studies poster pre-or post-pandemic, and risk of bias.

## Supplementary eResults

### Diagnostic reliability of TD when compared to F2F (specialist and non-specialists) evaluation

Of the 40 studies that reported diagnostic agreement rates there were 72 unique comparisons made between F2F and TD.<sup>6-45</sup> **eFigure 1A** shows that the mean percentage agreement of 68.9% (CI 64.4%-73.1%) ranged from 14% to 98%, where 35/72 had percentage agreement above 70% and 7 studies had over 90% agreement. The studies were heterogeneous ( $I^2=98%$ ,  $p < 0$ ).

Of the 21 studies that reported concordance values, there were 45 unique comparisons made.<sup>6, 7, 12, 15, 18, 21-26, 29, 30, 33-35, 46-50</sup> **eFigure 1B** shows that the mean diagnostic concordance of 0.67 (CI 0.60 to 0.74) ranged from 0.213 (CI 0.20 to 0.23) to 0.96 (CI 0.92 to 0.98), with 21 studies (47%) having moderate agreement ( $k=0.6$  and above), and 13 (29%) studies having strong agreement. The studies were heterogeneous ( $I^2=100%$ ,  $p < 0.001$ ).

### Diagnostic agreement between TD and TD, F2F and F2F, and TD and Histopathology

Of the ten studies that reported diagnostic agreement rates between TDs, there were 17 unique comparisons made between F2F and TD. **eFigure 2A** shows that the mean percentage agreement of 76.4% (CI 69% to 82.5%) ranged from 37% to 91.5%, with 10/17 having percentage agreement above 70% and two studies having over 90% agreement. The studies were heterogeneous ( $I^2=97%$ ,  $p < 0.001$ ).

From four studies that reported diagnostic agreement rates between F2F dermatologists there were 6 unique comparisons. **eFigure 2B** shows that the mean percentage agreement 82.4% (CI 76.7%-87.0%) ranged from 75.5% to 91%. The studies were heterogeneous ( $I^2=68%$ ,  $p < 0.001$ ).

Five studies compared TDs to histopathology data, and there were six unique comparisons. **eFigure 2C** shows that the mean percentage agreement of 55.7% (CI 53% to 58.4%) ranged from 53.8% to 65.4%. The mean agreement rate between histopathology and TD was 55.7% (CI 53.0 to 58.4). The studies were homogeneous ( $I^2=0%$ ,  $p = 0.49$ ).

## Subgroup analyses

### Diagnostic reliability of TD vs F2F by the inclusion of teledermoscopy in both TD and F2F assessments

Overall, twelve studies with 22 unique comparisons used teledermoscopy for diagnosing suspicious lesions.<sup>9, 12, 16, 30, 33, 35, 39, 40, 43, 45</sup> **eFigure 3A** shows that with teledermoscopy, the mean diagnostic agreement rates was 69.1% (CI 66.8% to 71.4%), and this percentage ranged between from 31.6% to 92.3%. Without the use of teledermoscopy, the mean agreement rate was 68.3% (CI 66.8% to 69.8%). The means were not significantly different between the two groups and the studies were heterogeneous ( $I^2=97%$ ,  $p < 0.001$ ). **eFigure 3B** shows concordance values of seven studies that adapted teledermoscopy had a mean of 0.71 (CI 0.58 to 0.80).<sup>12, 30, 33, 35, 40, 48, 49</sup> Without teledermoscopy, the mean was 0.65 (CI 0.54 to 0.74). This difference was not statistically significant, and the studies were heterogeneous ( $I^2=100%$ ,  $p < 0.001$ ).

### Diagnostic reliability of TD vs F2F by the inclusion of lesion category

Twenty-six studies with 39 unique comparisons reporting percentage agreement rates that were inclusive to all lesion types as shown in **eFigure 4A**.<sup>6-11, 16-20, 23, 25-27, 29-34, 37, 38, 41, 42, 44</sup> The mean percentage agreement was 69.9% (CI 67.9% to 71.7%) and ranged from 30.9% to 98%, with the majority (26/39) having percentage agreement above 60% and 4 studies having over 90%. Eleven studies only looked at suspicious lesions<sup>12, 13, 15, 21, 24, 35, 36, 39, 40, 43, 45</sup>, and the mean percentage agreement was 68.1% (CI 66.3% to 69.8%). Three studies excluded skin cancers<sup>14, 22, 28</sup> and the mean percentage agreement was 62.2% (CI 56.2% to 67.8%). No statistical significance could be identified between the three lesion groups and the studies were heterogeneous ( $I^2=98%$ ,  $p < 0.001$ ).

Concordance values for studies inclusive to all lesions seen in **eFigure 4B** were reported in ten studies with a mean of 0.62 (CI 0.48 to 0.74).<sup>6, 7, 18, 23, 25, 26, 29, 30, 33, 34</sup> Six studies that looked at cancerous skin lesions only reported a mean of 0.70 (CI 0.59 to 0.78).<sup>12, 15, 21, 24, 35, 40</sup> Only one study that looked at all lesions except cancerous ones reported a concordance value.<sup>22</sup> No statistical significance could be identified between the three lesion groups and the studies were heterogeneous ( $I^2=100%$ ,  $p < 0.001$ ).

### 155 **Diagnostic reliability of TD vs F2F by type of technology used related to image acquisition**

156 Approximately half of the studies with 41 unique comparisons that compared TDs with F2F physicians used digital  
157 cameras for image acquisition. Eighteen studies comparing F2F and TD agreement rates with 26 unique  
158 comparisons reported the use of smartphones and tablets for image acquisition. **eFigure 5A** shows that the mean  
159 percentage agreement rate was 71.7% (CI 70.3% to 73.1%) for digital cameras compared to 59.8% (CI 57.2% to  
160 62.3%) for smartphones or tablets. The higher agreement rate with digital photography was statistically significant  
161 ( $p = 0.029$ , heterogeneity:  $I^2=98\%$ ).

162 Concordance values for digital photography were reported for twelve studies with a mean of 0.70 (CI 0.61 to 0.76)  
163 shown in **eFigure 5B**. Concordance values for smartphone or tablet technologies were reported for eight studies  
164 with a mean of 0.62 (CI 0.38 to 0.78). The higher concordance with digital photography was statistically significant  
165 ( $p = 0.003$ , heterogeneity:  $I^2=100\%$ )  
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### 167 **Diagnostic reliability of TD vs F2F by pre- and post-pandemic timelines.**

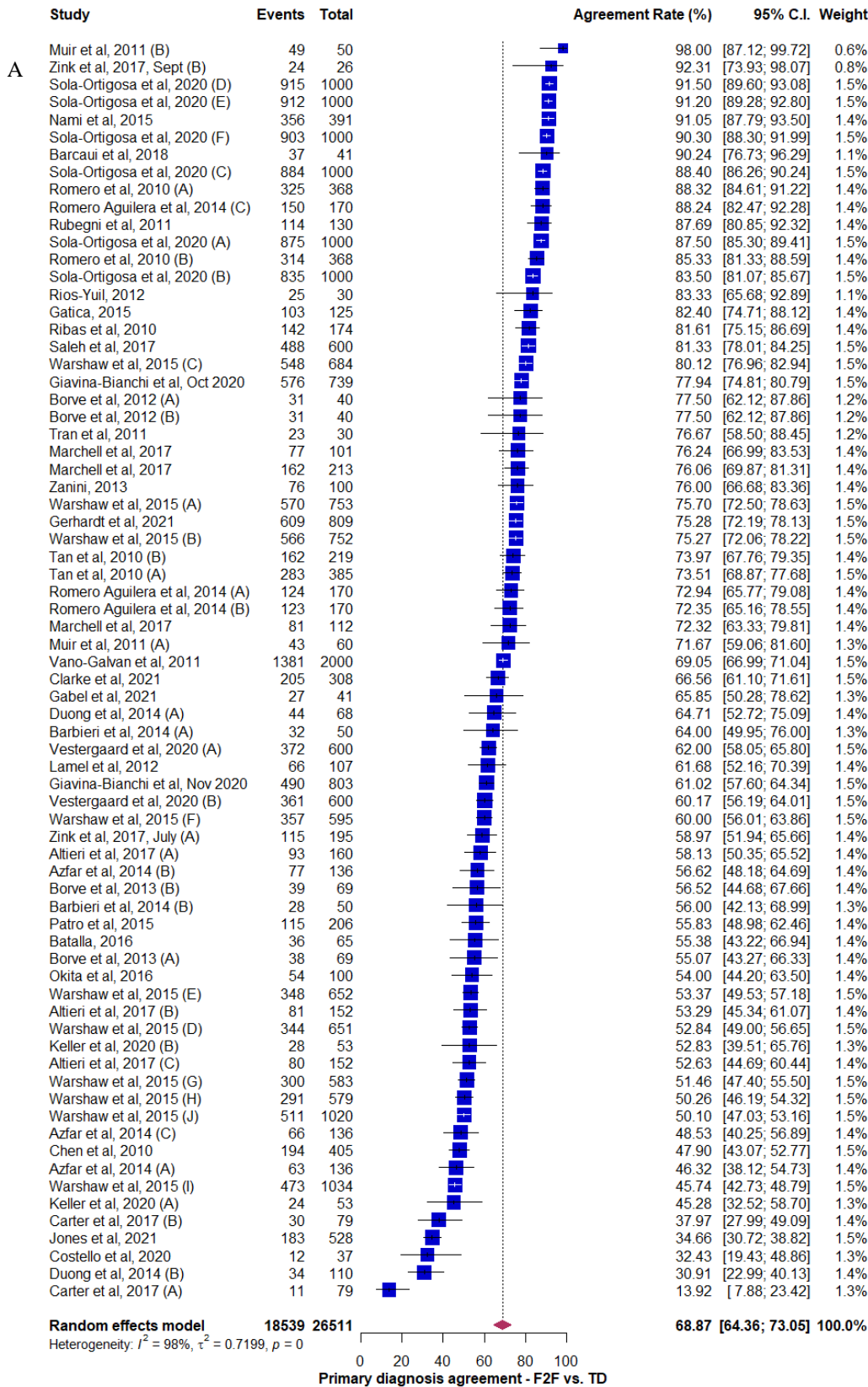
168 When comparing TDs to all F2F physician, the average agreement rate was 65.5% (CI 64.0-66.9) for pre-pandemic  
169 studies, and 75.3% (CI 73.4% to 77.2%) for studies published after January 2020. When the percentage agreements  
170 were compared between the two groups, they were not statistically significant ( $p = 0.421$ ) and also heterogeneous  
171 ( $I^2=98\%$ ,  $p<0.001$ ). eTable not included.  
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### 174 **Risk of bias and quality assessment**

175 The results of quality assessment for risk of bias and applicability in individual studies are displayed in. **eTable 4.**  
176 Five (11.4%) of the studies had low risk of bias, 11 (25%) had moderate risk, and 28 (63.6%) had high-risk of bias.  
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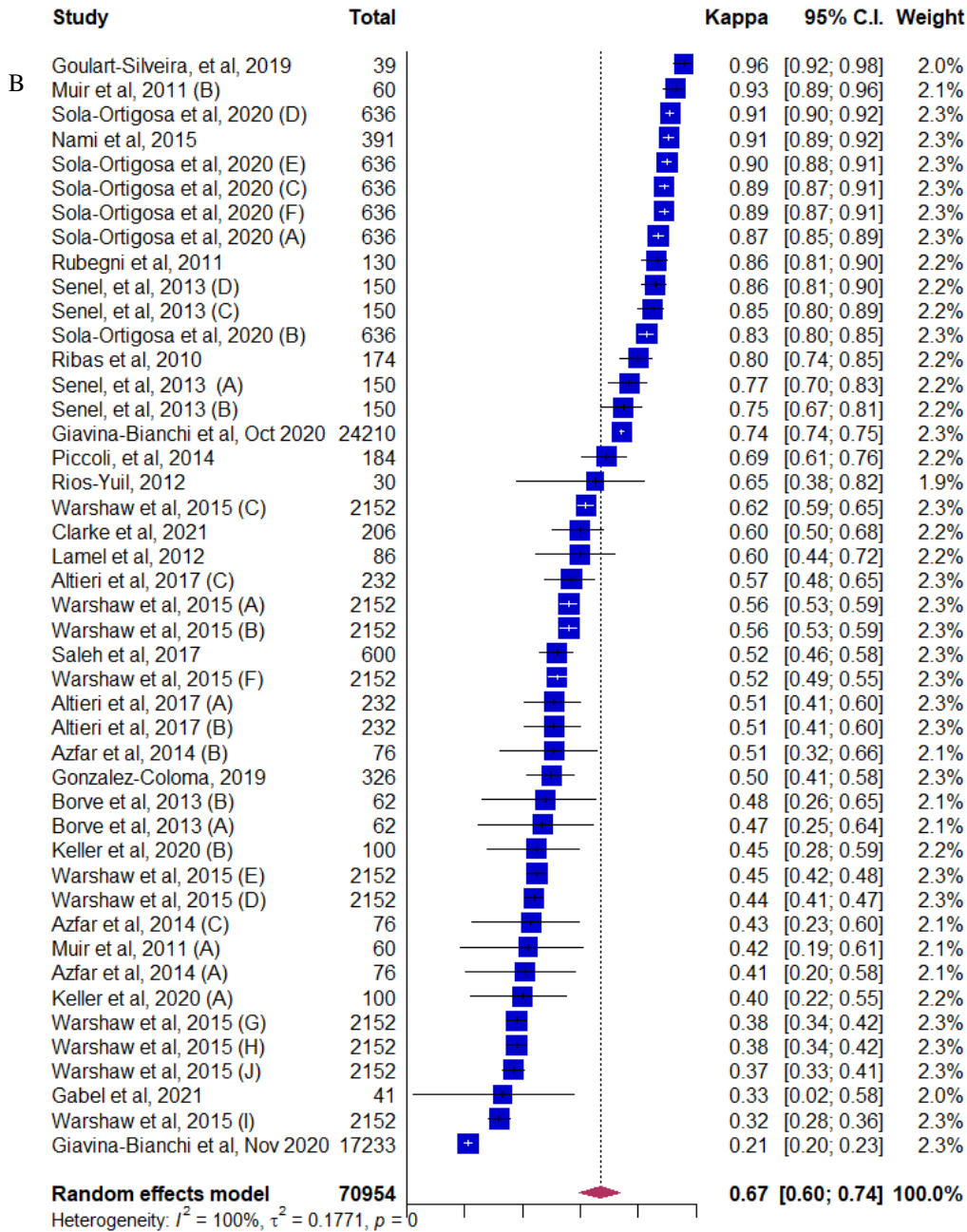
178 There were no systematic differences between the results of studies that attempted to reduce risk of bias, compared  
179 with those with higher risk of bias. The mean diagnostic agreement rate between F2F and TD was 66.4% (CI 62.4%  
180 to 70.1%) for low risk, and 69.1% (CI 67.6% to 70.6%) for high risk ( $p = 0.932$ ). When the percentage agreements  
181 were compared between groups, they were heterogeneous ( $I^2=98\%$ ,  $p<0.001$ ). eTable not included.

182 **Supplementary eFigures and Legends**



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**eFigure 1. Forest plot representing F2F and TD primary diagnostic agreement.**

(A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 39 studies with a total of 71 unique number of comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants.

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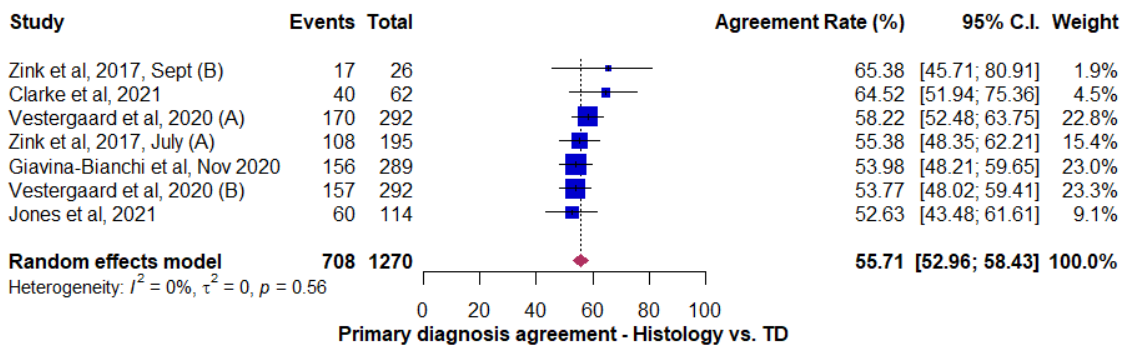
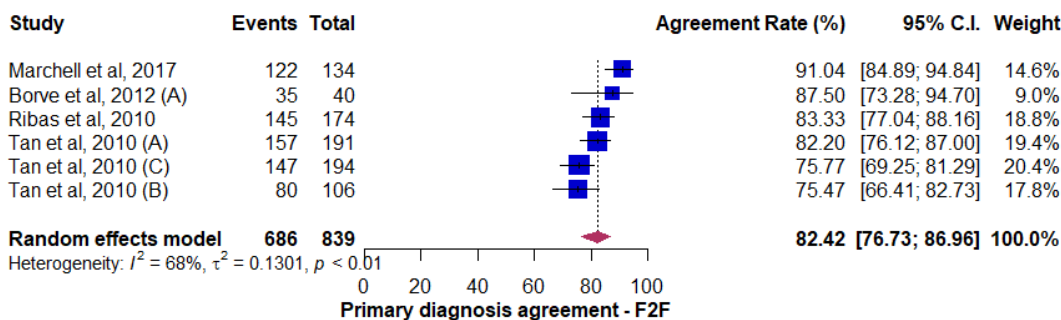
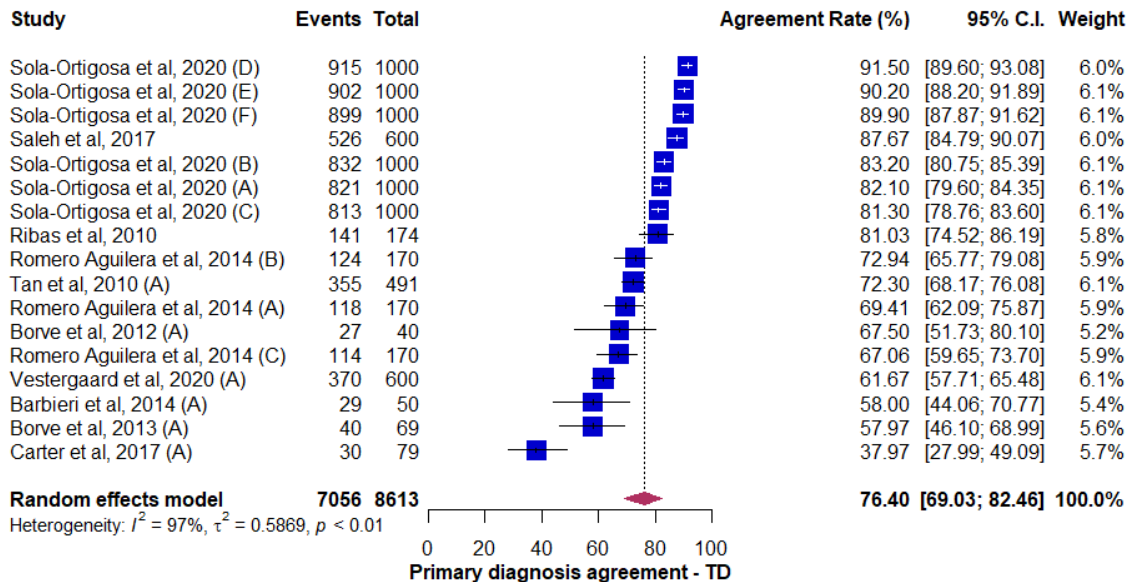
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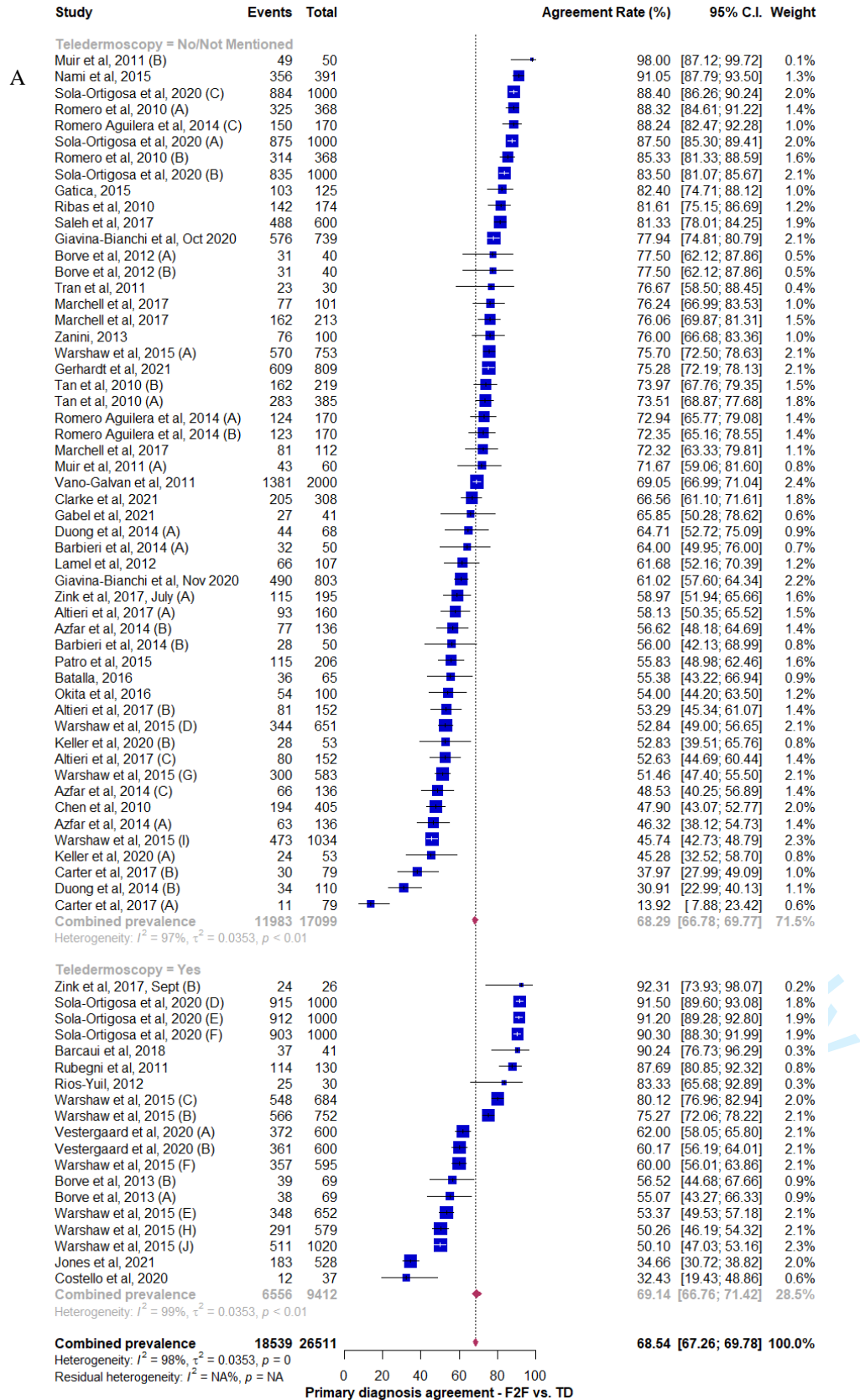
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**eFigure 2. Forest plot representing TD, F2F, and histopathology primary diagnostic agreements.**

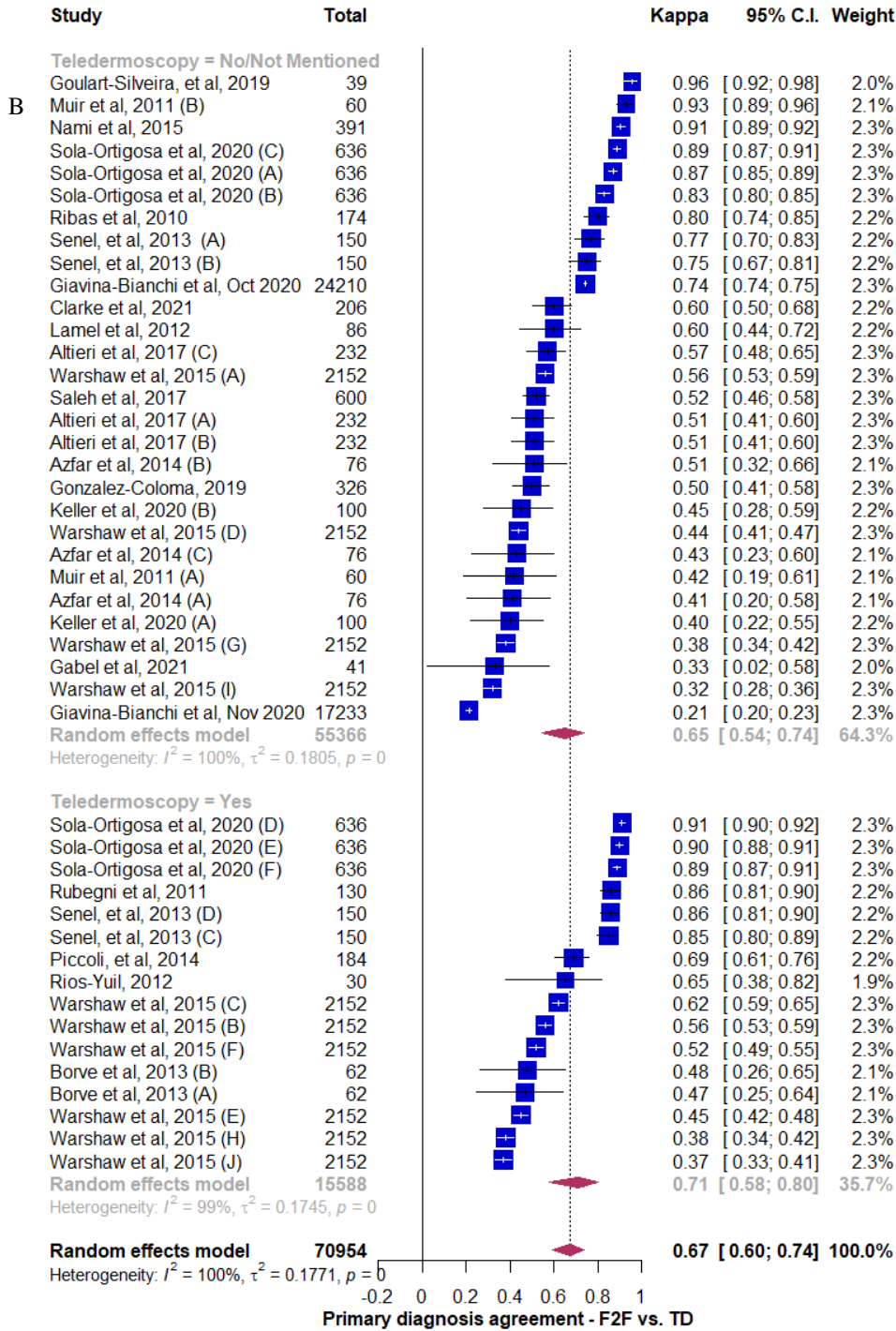
(A) Forest plot representing percentage agreement between TD and TD and 95% C.I. for overall concordance across 10 studies with a total of 17 unique number of comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance between two F2F physician diagnoses across 4 studies with a total of 6 unique number of comparisons, N of total included participants. (C) Forest plot representing percentage agreement between TDs and histopathology with 95% C.I. for overall concordance across 6 studies, N of events and total included participants.

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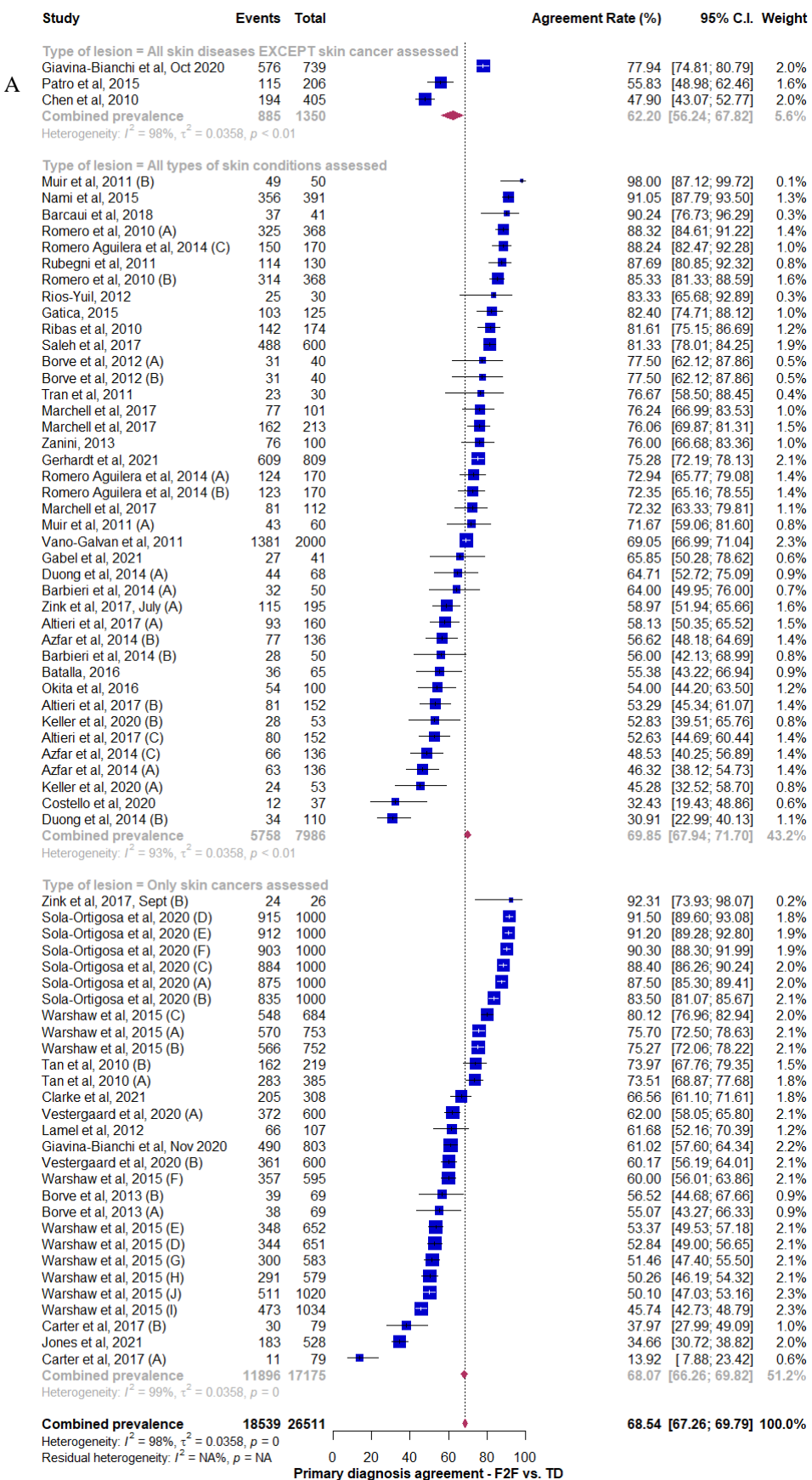




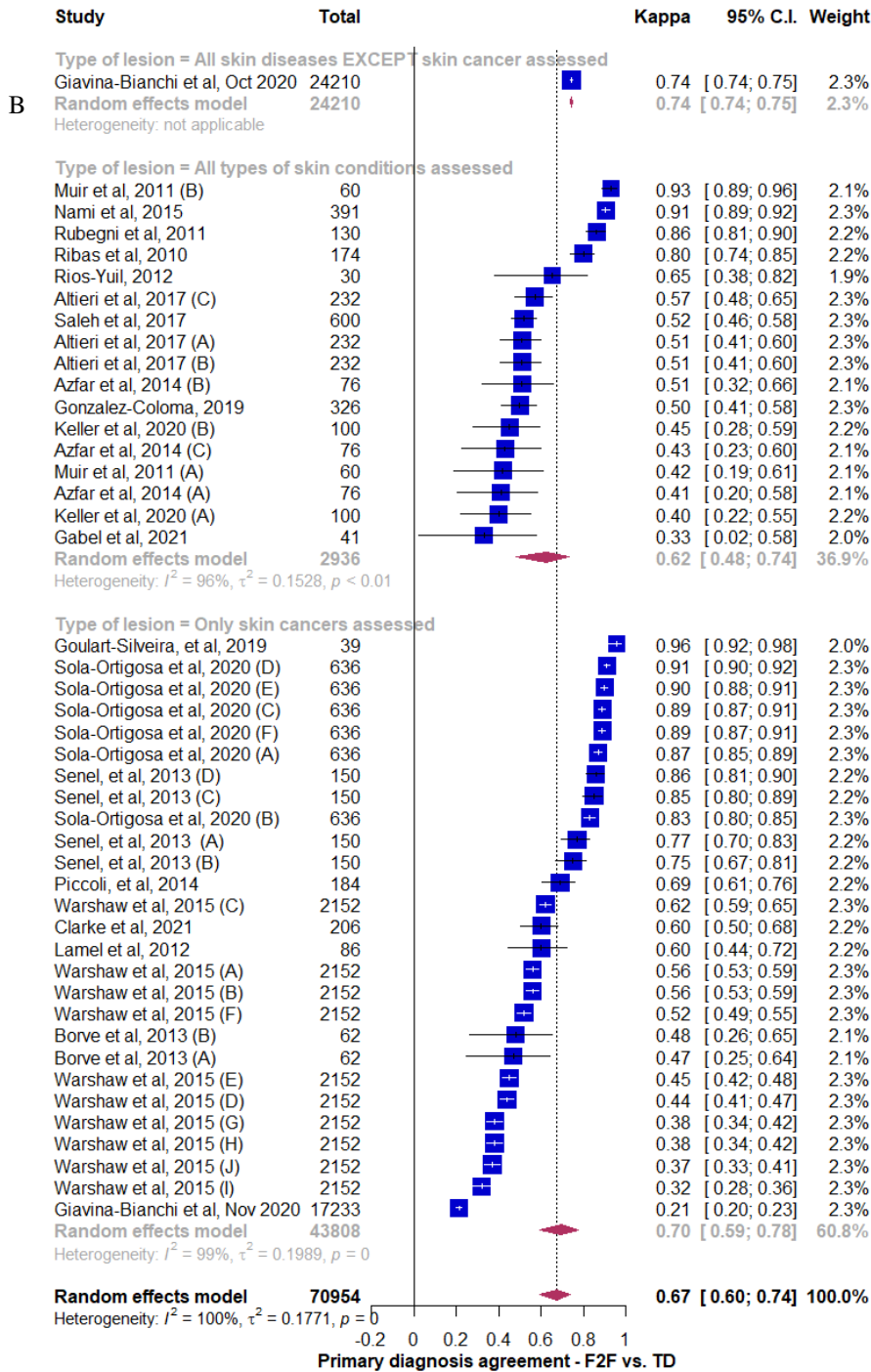
**eFigure 3. Forest plot representing F2F and TD primary diagnostic agreement by utilization of teledermoscopy.**

Studies were sorted into two groups, i) Did not use or did not report the use of teledermoscopy; ii) Used teledermoscopy. (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 39 studies with a total of 71 unique number of comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants.

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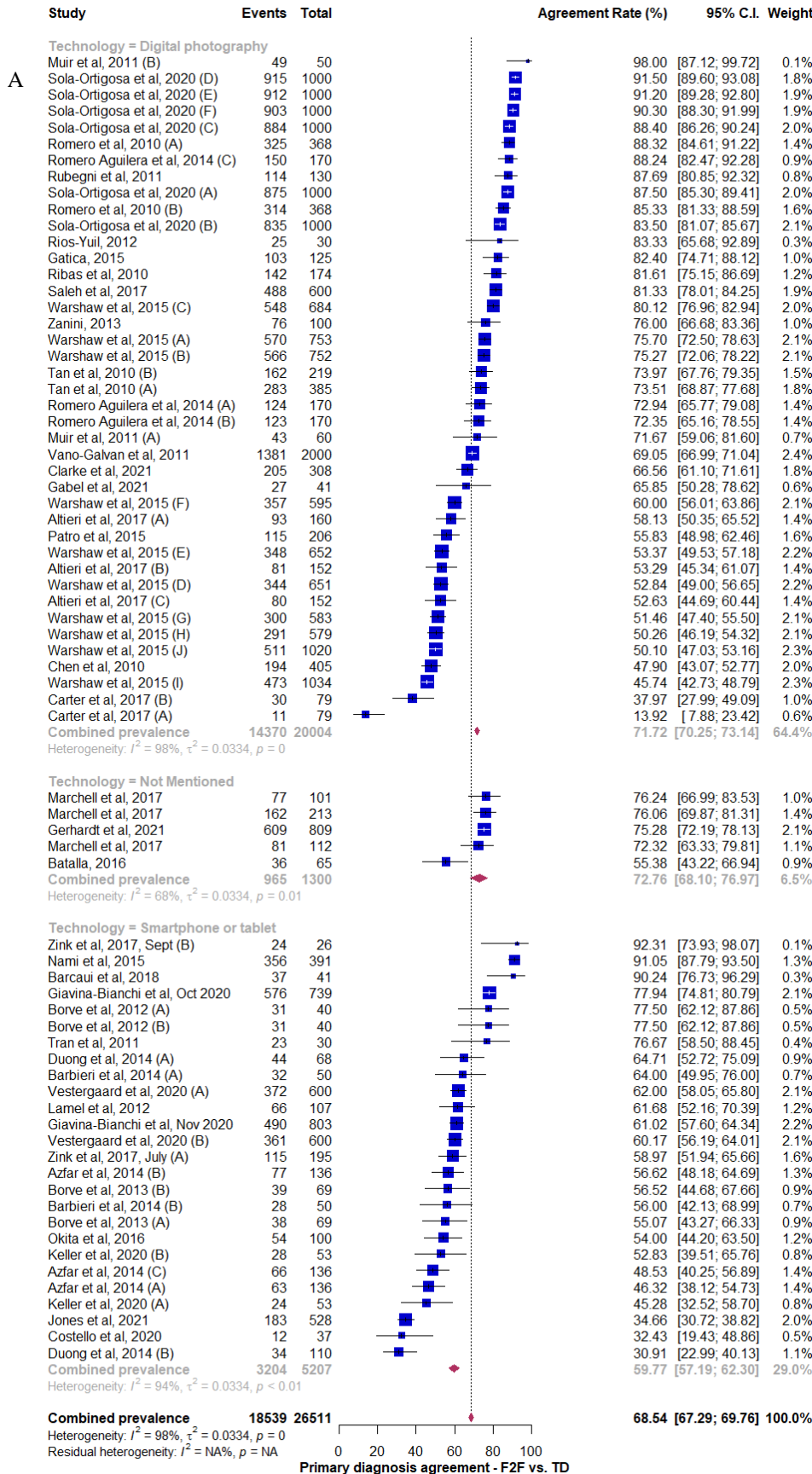


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**eFigure 4. Forest plot representing F2F and TD primary diagnostic agreement by skin lesion category.** Studies were sorted into three groups according to the type of included lesions, i) All skin conditions except likely malignant lesion; ii) All skin conditions; iii) Likely malignant lesions only. (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 39 studies with a total of 71 unique number of comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants.

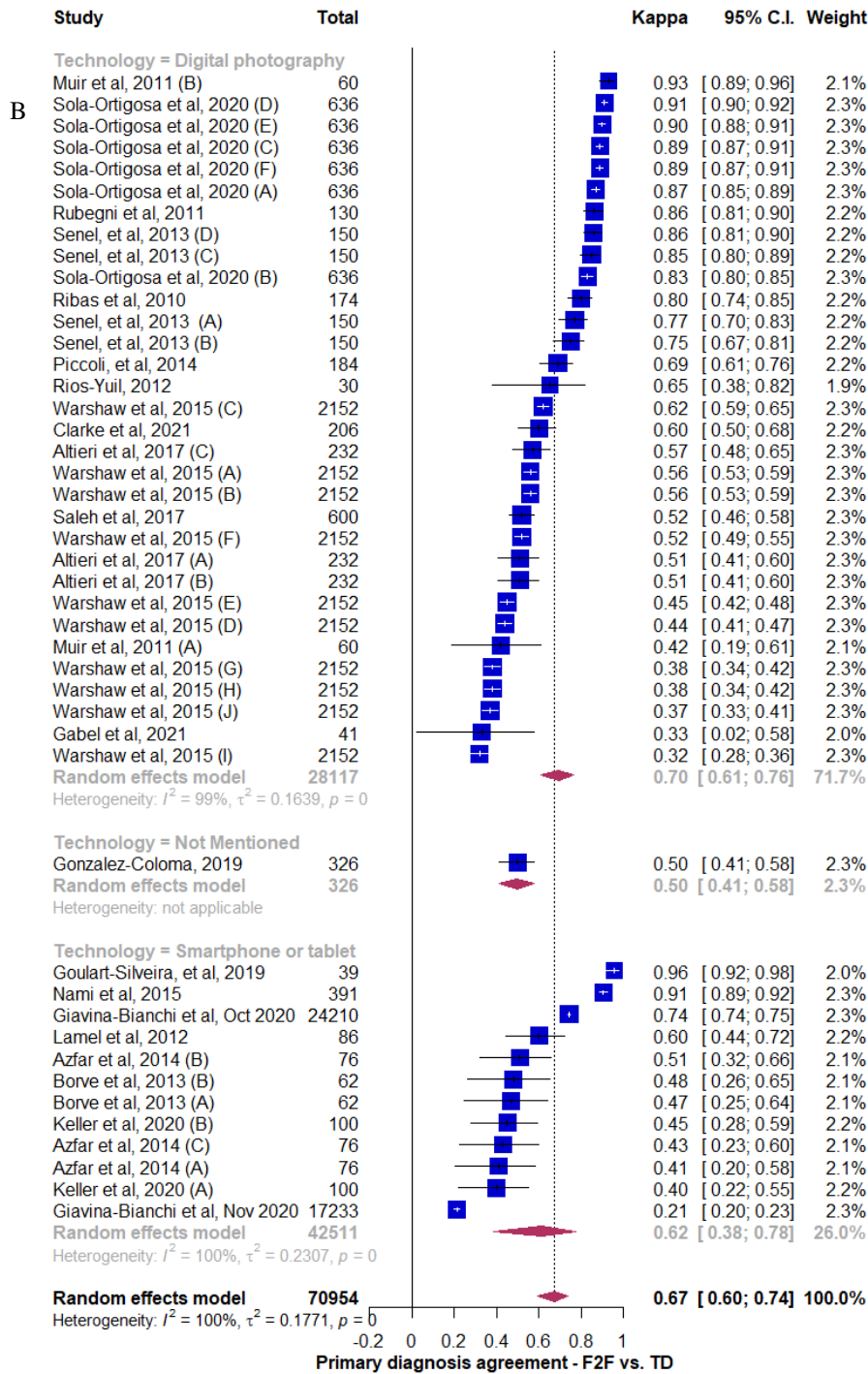
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**eFigure 5. Forest plot representing F2F and TD primary diagnostic agreement by device type used to capture clinical photographs.**

Forest plot representing F2F and TD primary diagnostic agreement by imaging technology used. Studies were sorted into three groups, i) Digital photography ii) Imaging technology not mentioned iii) Smartphone or tablet. (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 39 studies with a total of 71 unique number of comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants.

Supplementary eTable Titles and Legends

230 **Supplementary eTables**

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Inclusion criteria	Exclusion criteria
Primary articles assessing diagnostic agreement where store-and-forward technology or live video conference consults were compared with a control group who attend in-person visits.	Survey articles, feasibility studies, studies regarding other forms of telemedicine unrelated to dermatology, cost-effectiveness studies, editorials, and review articles.
Primarily comparing TD to F2F, sometimes using histopathology as the gold standard.	Studies that clearly stated they used TDs as the gold- or reference standard.
	Studies that only compared dermatoscopic images in the absence of clinical images.
	Studies where patients captured their own photographs.

232 **eTable 1. Inclusion and exclusion criteria for screening of literature search results.**

233 TD: TeleDermatology, TDs: TeleDermatologists, F2F: Face-to-Face.

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**Study characteristics**

Author, year, title, study type, objective, country of publication. Patient characteristics: total number of participants included declaration of funding source, number of participants per study, mean age +/- SD, age range, gender, mean BMI and range, race/ethnicity, type of lesions evaluated, type of patients evaluated.

**Methodology - TD and F2F consults**

Method of correspondence, platform used for the TD consult, training on TD platform, length of TD and F2F consult, experience of the TD and F2F physician, location of TD, number of TDs and F2F physicians who made a diagnosis for each patient, total number of TDs and F2F physicians in study, order of visits, wait time between TD and F2F, whether same specialist conducted TD and F2F visit, specialization of the F2F physician, number of reviews; qualifications of the individual who acquired the clinical photographs and whether they received additional training on taking clinical photographs.

**Metrics and results**

Technology used for image acquisition and for viewing images with, distance between camera and lesion, number of images taken, use of teledermoscopy & dermoscopy, brand of dermatoscope, use of histopathology, referral content provided to TD, primary and differential diagnoses agreement and concordance rates, diagnostic accuracy values (if available) such as sensitivity, specificity, PPV and NPV.

237 **eTable 2. Data extraction form with details of domains record.**

238 TD: TeleDermatology, F2F: Face-to-Face, PPV: Positive Predictive Value, NPV: Negative Predictive Value.

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Author and Year	Unique Study Grouping	n_participants	n_lesions	%_primary diagnosis agreement_in_person	N_primary diagnosis agreement_in_person	n_agreement	%_primary diagnosis agreement_TD	N_primary diagnosis agreement_TD	n_agreement	%_primary diagnosis agreement (TD and F2F)	N_primary diagnosis agreement (TD and F2F)	n_agreement	%_primary diagnosis agreement (TD & Histo)	N_primary diagnosis agreement (TD & Histo)	n_agreement	Inter_Kappa (primary diagnosis, TD and F2F)	N_Inter_Kappa (primary diagnosis, TD and F2F)	Inter_Kappa (primary diagnosis, TD and Histo)
Altieri et al, 2017 (A)	F2F Derm vs TD1	232	232							58	160	93				0.51	160	
Altieri et al, 2017 (B)	F2F Derm vs TD2	232	232							53	152	81				0.51	152	
Altieri et al, 2017 (C)	F2F Derm vs TD3	232	232							53	152	80				0.57	152	
Azfar et al, 2014 (A)	F2F Derm vs TD1	76	159						40	47	136	63				0.41	136	
Azfar et al, 2014 (B)	F2F Derm vs TD2	76	159						63	57	136	77				0.51	136	
Azfar et al, 2014 (C)	F2F Derm vs TD3	76	159						59	49	136	66				0.43	136	
Barbieri et al, 2014 (A)	F2F Derm vs TD1	50	50				58	50	29	64	50	32						
Barbieri et al, 2014 (B)	F2F Derm vs TD2	50	50							56	50	28						
Barcaui et al, 2018	F2F Derm vs TD	31	41							90	41	37						
Batalla, 2016	F2F Derm vs TD	183	183							55	65	36						

1	Borve et al, 2012 (A)	F2F Derm vs TD1	40	40	88	40	35	68	40	27	78	40	31						
2	Borve et al, 2012 (B)	F2F Derm vs TD2	40	40							78	40	31						
3	Borve et al, 2013 (A)	F2F Derm vs TD1	62	69				58	69	40	55	69	38		0.47	69	.51		
4	Borve et al, 2013 (B)	F2F Derm vs TD2	62	69							57	69	39		0.48	69			
5	Carter et al, 2017 (A)	F2F nonspecialist vs TD	79	79				38	79	30	14	79	11						
6	Carter et al, 2017 (B)	F2F Derm vs TD	79	79							38	79	30						
7	Chen et al, 2010	F2F nonspecialist vs TD	405	405							48	405	194						
8	Clarke et al, 2021	F2F Derm vs TD	206	308							67	308	205	65	62	40	0.6	308	
9	Costello et al, 2020	F2F nonspecialist vs TD	37	37							32	37	12						
10	Duong et al, 2014 (A)	F2F nonspecialist vs TD (Videoconference)	111	110							65	68	44						
11	Duong et al, 2014 (B)	F2F nonspecialist vs TD (SFTD)	111	110							31	110	34						
12	Gabel et al, 2021	F2F Derm vs TD	41	41							67	41	27		0.33	41			
13	Gatica, 2015	F2F Derm vs TD	125	125							82	125	103						
14	Gerhardt et al, 2021	F2F Derm vs TD	809	809							75	809	609						
15	Giavina-Bianchi et al, Nov 2020	F2F Derm vs TD	17233	17233							61	803	490	54	289	156	0.21	803	.09
16	Giavina-Bianchi et al, Oct 2020	F2F Derm vs TD	24210	27519							78	739	576		0.74	739			



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Gonzalez-Coloma, 2019	F2F nonspecialist vs TD	326	326								0.5	326	
Goulart-Silveira, et al, 2019	F2F Derm vs TD	39	39								0.96	39	.56
Jones et al, 2021	F2F nonspecialist vs TD (Suspicious Skin Cancer pathway)	NA	528			35	528	183	53	114	60		
Keller et al, 2020 (A)	F2F nonspecialist vs TD	100	100			45	53	24				0.4	53
Keller et al, 2020 (B)	F2F Derm vs TD	100	100			53	53	28				0.45	53
Lamel et al, 2012	F2F Derm vs TD	86	107			62	107	66				0.6	107
Marchell et al, 2017	F2F Derm vs TD (SFTD)	216	216	91	134	122		76	162	213			
Marchell et al, 2017	F2F Derm vs TD (Uncompressed video)	216	216					76	76.8	101			
Marchell et al, 2017	F2F Derm vs TD (Compressed video)	216	216					72	80.6	112			
Muir et al, 2011 (A)	F2F nonspecialist vs TD	60	60					72	60	43		0.42	60
Muir et al, 2011 (B)	F2F Derm vs TD	60	60					98	50	49		0.93	50
Nami et al, 2015	F2F Derm vs TD	391	391					91	391	356		0.91	391
Okita et al, 2016	F2F Derm vs TD	100	100					54	100	54			
Patro et al, 2015	F2F nonspecialist vs TD	206	206					56	206	115			
Piccoli, et al, 2014	F2F nonspecialist vs TD	184	184									0.69	184

1	Ribas et al, 2010	F2F Derm vs TD	174	174	83	174	145	81	174	141	82	174	142	0.8	174	
2	Rios-Yuil, 2012	F2F Derm vs TD	30	30							83	30	25	67	0.65	30
3	Romero Aguilera et al, 2014 (A)	F2F Derm vs TD1	457	192			69	170	118	73	170	124				
4	Romero Aguilera et al, 2014 (B)	F2F Derm vs TD2	457	192			73	170	124	72	170	123				
5	Romero Aguilera et al, 2014 (C)	F2F Derm vs TD3	457	192			67	170	114	88	170	150				
6	Romero et al, 2010 (A)	F2F Derm vs TD (SFTD)	457	192							88	368	325			
7	Romero et al, 2010 (B)	F2F Derm vs TD (SFTD and videoconferencing)	457	176							85	368	314			
8	Rubegni et al, 2011	F2F Derm vs TD	130	130							88	130	114	0.86	130	
9	Saleh et al, 2017	F2F Derm vs TD	600	600			88	600	526	81	600	488	0.46-0.52	600		
10	Senel, et al, 2013	F2F Derm vs TD1 (no dermoscopy)	150	150										0.77	150	
11	Senel, et al, 2013	F2F Derm vs TD2 (no dermoscopy)	150	150										0.75	150	
12	Senel, et al, 2013	F2F Derm vs TD1 (dermoscopy)	150	150										0.85	150	
13	Senel, et al, 2013	F2F Derm vs TD2 (dermoscopy)	150	150										0.86	150	
14	Sola-Ortigosa et al, 2020 (A)	F2F Derm vs TD1 (no dermoscopy)	636	1000			82	1000	821	88	1000	875	0.87	1000		
15	Sola-Ortigosa et al, 2020 (B)	F2F Derm vs TD2 (no dermoscopy)	636	1000			83	1000	832	84	1000	835	0.83	1000		

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Sola-Ortigosa et al, 2020 (C)	F2F Derm vs TD3 (no dermoscopy)	636	1000				81	1000	813	88	1000	884			0.89	1000
Sola-Ortigosa et al, 2020 (D)	F2F Derm vs TD1 (dermoscopy)	636	1000				92	1000	915	92	1000	915			0.91	1000
Sola-Ortigosa et al, 2020 (E)	F2F Derm vs TD2 (dermoscopy)	636	1000				90	1000	902	91	1000	912			0.9	1000
Sola-Ortigosa et al, 2020 (F)	F2F Derm vs TD3 (dermoscopy)	636	1000				90	1000	899	90	1000	903			0.89	1000
Tan et al, 2010 (A)	F2F Derm vs TD1, F2F Derm 1 vs F2F Derm 2	200	491	82	191	157	72	491	355	74	385	283				
Tan et al, 2010 (B)	F2F Derm vs TD2, F2F Derm 2 vs F2F Derm 3	200	491	76	106	80				74	219	162				
Tan et al, 2010 (C)	F2F Derm 1 vs F2F Derm 3	200	491	76	194	147										
Tran et al, 2011	F2F Derm vs TD	30	30							75	30	23				
Vano-Galvan et al, 2011	F2F Derm vs TD	100	100							69	2000	1381				
Vestergaard et al, 2020 (A)	A F2F Derm vs TD1	519	600				62	600	370	62	600	372	58	292	170	
Vestergaard et al, 2020 (B)	F2F Derm vs TD2	519	600							60	600	361	54	292	157	
Warshaw et al, 2015 (A)	F2F Derm vs TD (non biopsied pigmented lesions, Macro)	2152	3021							76	753	570			0.56	753
Warshaw et al, 2015 (B)	F2F Derm vs TD (non biopsied pigmented lesions, Macro+PLD)	2152	3021							75	752	566			0.56	752



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Zink et al, 2017, Sept (B)	F2F Derm vs TD	26	26	92	26	24	67	26	17
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**eTable 3. Included unique study groupings and letter codes.**  
 TD: TeleDermatology, TDs: TeleDermatologists, Derm: Dermatologist, F2F: Face-to-Face, SFTD: Store And Forward Technology, PLD: Polarized Light Dermoscopy, Macro: Macroscopic clinical images.

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Study ID	Journal	Reason For Exclusion
NCT03034694, 2016	<a href="http://ClinicalTrials.gov">ClinicalTrials.gov</a>	Wrong study design
Andersson et al, 2017	Lakartidningen	Wrong study design
Romero et al, 2018	Actas dermo-sifiliograficas	Wrong study design
Orruno et al, 2016	Health Technology Assessment Database	Wrong study design
Batalla et al, 2016	Piel	Wrong study design
Kroemer et al, 2011	British Journal of Dermatology	Wrong study design
Ernstberger et al, 2014	Zentralblatt fur Chirurgie	Wrong study design
Totty et al, 2018	Journal of wound care	Wrong study design
Wurm et al, 2013	Journal of Telemedicine and Telecare	Wrong study design
Wang et al, 2017	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
Singh et al, 2011	Australasian Journal of Dermatology	Wrong study design
Grey et al, 2017	Dermatitis	Wrong study design
Crompton et al, 2010	Journal of Visual Communication in Medicine	Wrong study design
Ali et al, 2021	JMIR formative research	Wrong study design
Boyce et al, 2011	Dermatology	Wrong study design
Berg et al, 2017	Sarcoidosis Vasculitis and Diffuse Lung Diseases	Wrong study design
Shin et al, 2014	Journal of telemedicine and telecare	Wrong study design
Gacto-Sanchez et al, 2020	Burns : journal of the International Society for Burn Injuries	Wrong study design
Tian et al, 2017	Journal of Cosmetic Dermatology	Wrong study design
Thind et al, 2011	Clinical and Experimental Dermatology	Wrong study design
Silveira et al, 2014	BMC Dermatology	Wrong study design
O'Connor et al, 2017	JAMA Dermatology	Wrong study design
Janda et al, 2020	The Lancet. Digital health	Wrong study design
Day et al, 2020	Military medicine	Wrong study design
Karlsson et al, 2015	Acta Dermato-Venereologica	Wrong study design
Seghers et al, 2015	Australasian Journal of Dermatology	Wrong study design
Hazenberget al, 2010	Journal of Medical Engineering and Technology	Wrong study design
Borve et al, 2015	Acta Dermato-Venereologica	Wrong study design
Boissin et al, 2015	Burns	Wrong study design
Da Silva et al, 2018	Dermatology online journal	Wrong study design
Devrim et al, 2019	BMC pediatrics	Wrong study design
Danielsson et al, 2016	Health Technology Assessment Database	Wrong study design

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4	Berglund et al, 2020	Journal of the European Academy of Dermatology and Venereology : JEADV	Wrong study design
5			
6	Forsblom et al, 2013	Clinical Infectious Diseases	Wrong study design
7	G Bianchi et al, 2020	Journal of medical Internet research	Wrong study design
8			
9	Congalton et al, 2015	Journal of the European Academy of Dermatology and Venereology	Wrong study design
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11	Ferrandiz et al, 2012	Archives of Dermatology	Wrong study design
12			
13	Ismail et al, 2018	International Journal of Women's Dermatology	Wrong study design
14			
15	Gamus et al, 2019	International journal of medical informatics	Wrong study design
16			
17	Paudel et al, 2020	Case reports in dermatological medicine	Wrong study design
18			
19	Georgesesen et al, 2020	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
20			
21	Gagnon et al, 2015	Dermatology Times	Wrong study design
22			
23	Philp et al, 2013	Pediatric Dermatology	Wrong study design
24			
25	Mooney et al, 2011	Skin Research and Technology	Wrong study design
26	Do Khac et al, 2021	JMIR mHealth and uHealth	Wrong study design
27			
28	Chambers et al, 2012	Journal of the American Academy of Dermatology	Wrong study design
29			
30	Garcia-Romero et al, 2011	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
31			
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33	Ahmed et al, 2020	Annals of internal medicine	Wrong study design
34			
35	Marwaha et al, 2019	Journal of the American Academy of Dermatology	Wrong study design
36			
37	NCT02122432, 2014	<a href="https://clinicaltrials.gov">ClinicalTrials.gov</a>	Wrong study design
38	Lowe et al, 2021	Clinical and experimental dermatology	Wrong study design
39	Bowling et al, 2011	Wound Repair and Regeneration	Wrong study design
40			
41	Marin-Gomez et al, 2020	Journal of primary care & community health	Wrong study design
42			
43	Veronese et al, 2021	Diagnostics (Basel, Switzerland)	Wrong study design
44			
45	Ismail et al, 2018	International journal of dermatology	Wrong study design
46	NCT02905851, 2016	<a href="https://clinicaltrials.gov">ClinicalTrials.gov</a>	Wrong study design
47			
48	Trinidad et al, 2020	Journal of the American Academy of Dermatology	Wrong study design
49			
50	Tensen et al, 2019	Studies in health technology and informatics	Wrong study design
51			
52	Karavan et al, 2014	Journal of telemedicine and telecare	Wrong study design
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54	Viola et al, 2011	Archives of Dermatology	Wrong study design
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56	van Netten et al, 2017	Scientific reports	Wrong study design
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4	Cai et al, 2016	Burns : journal of the International Society for Burn Injuries	Wrong study design
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6	Hazenberg et al, 2010	Diabetes Technology and Therapeutics	Wrong study design
7	Jacoby et al, 2021	Journal of drugs in dermatology : JDD	Wrong study design
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10	Pak et al, 2018	Wound repair and regeneration : official publication of the Wound Healing Society [and] the European Tissue Repair Society	Wrong study design
11			
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13	Kummerow Broman et al, 2019	JAMA surgery	Wrong study design
14			
15			
16	Munoz-Lopez et al, 2021	Journal of the European Academy of Dermatology and Venereology : JEADV	Wrong study design
17			
18	Markun et al, 2017	Medicine	Wrong study design
19	Piette et al, 2017	Journal of telemedicine and telecare	Wrong study design
20	Tan et al, 2010	British Journal of Dermatology	Wrong study design
21			
22	Watson et al, 2010	Archives of Dermatology	Wrong study design
23			
24	Wiseman et al, 2016	Journal of vascular surgery. Venous and lymphatic disorders	Wrong study design
25			
26	Wolf et al, 2013	JAMA dermatology	Wrong study design
27			
28	Laggis et al, 2020	The American Journal of dermatopathology	Wrong study design
29			
30	Kazi et al, 2021	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
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33	Kanthraj et al, 2013	Indian Journal of Dermatology, Venereology and Leprology	Wrong study design
34			
35	Shah et al, 2016	Journal of the American Academy of Dermatology	Wrong study design
36			
37	Kim et al, 2018	Skin research and technology	Wrong study design
38			
39	Nguyen et al, 2017	Journal of Clinical and Aesthetic Dermatology	Wrong study design
40			
41	Rizvi et al, 2020	PloS one	Wrong study design
42	Mehrtens et al, 2019	Clinical and experimental dermatology	Wrong study design
43			
44	Knudsen et al, 2012	Lakartidningen	Research letter or letter to the editor
45			
46	Korman et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
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49	Mercer et al, 2014	Journal of Cutaneous Medicine and Surgery	Research letter or letter to the editor
50			
51	Grunig et al, 2015	JAMA Dermatology	Research letter or letter to the editor
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53	Cartron et al, 2020	Dermatologic therapy	Research letter or letter to the editor
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4	McAfee et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
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6	Wong et al, 2021	JAMA dermatology	Research letter or letter to the editor
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8	Baranowski et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
9			
10	Micheletti et al, 2014	Journal of the American Academy of Dermatology	Research letter or letter to the editor
11			
12	Osei-Tutu et al, 2013	Journal of the American Academy of Dermatology	Research letter or letter to the editor
13			
14	Nair et al, 2015	International Journal of Dermatology	Research letter or letter to the editor
15			
16	Miller et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
17			
18	Keleshian et al, 2017	Journal of the American Academy of Dermatology	Research letter or letter to the editor
19			
20	Keleshian et al, 2017	Journal of the American Academy of Dermatology	Research letter or letter to the editor
21			
22	HAYES; Inc et al, 2016	Health Technology Assessment Database	Research letter or letter to the editor
23			
24	Jacob et al, 2017	Journal of telemedicine and telecare	Research letter or letter to the editor
25			
26	Perkins et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
27			
28	Halpern et al, 2010	British Journal of Dermatology	Research letter or letter to the editor
29			
30	Newman et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
31			
32	Hunt et al, 2020	Clinical and experimental dermatology	Research letter or letter to the editor
33			
34	Hunt et al, 2020	Clinical and experimental dermatology	Research letter or letter to the editor
35			
36	2018	Nursing	Research letter or letter to the editor
37			
38	Taneja et al, 2021	Indian journal of dermatology, venereology and leprology	Research letter or letter to the editor
39			
40	Echeverria-Garcia et al, 2019	Actas dermo-sifiliograficas	Research letter or letter to the editor
41			
42	Henning et al, 2010	Archives of Dermatology	Research letter or letter to the editor
43			
44	Demo et al, 2019	Clinical and experimental dermatology	Research letter or letter to the editor
45			
46	Demo et al, 2019	Clinical and experimental dermatology	Research letter or letter to the editor
47			
48	Byamba et al, 2015	British Journal of Dermatology	Research letter or letter to the editor
49			
50	Gupta et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
51			
52	De Giorgi et al, 2017	Journal of the European Academy of Dermatology and Venereology	Research letter or letter to the editor
53			
54	Duong et al, 2016	Annales de Dermatologie et de Venereologie	Research letter or letter to the editor
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4	Mortimer et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
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6	Gravely et al, 2010	Journal of the American Academy of Dermatology	Research letter or letter to the editor
7			
8	Choi et al, 2021	International journal of dermatology	Research letter or letter to the editor
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11	Motley et al, 2012	BMJ: British Medical Journal (Clinical Research Edition)	Research letter or letter to the editor
12			
13	Leavitt et al, 2016	Journal of the American Academy of Dermatology	Research letter or letter to the editor
14			
15	Cheng et al, 2020	Dermatitis : contact, atopic, occupational, drug	Research letter or letter to the editor
16			
17			
18	Clark et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
19			
20	Fuesl et al, 2010	MMW-Fortschritte der Medizin	Research letter or letter to the editor
21			
22	English III et al, 2013	Journal of the American Academy of Dermatology	Research letter or letter to the editor
23			
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25	Cotes et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
26			
27	Abi Rafeh et al, 2021	Journal of cutaneous medicine and surgery	Research letter or letter to the editor
28			
29	Okeke et al, 2020	The Journal of dermatological treatment	Research letter or letter to the editor
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32	Splete et al, 2014	Emergency Medicine (00136654)	Research letter or letter to the editor
33			
34	Khosravi et al, 2021	Clinical and experimental dermatology	Research letter or letter to the editor
35			
36	Sivesind et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
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38			
39	Stoecker et al, 2013	JAMA dermatology	Research letter or letter to the editor
40			
41	Skayem et al, 2020	Journal of the European Academy of Dermatology and Venereology : JEADV	Research letter or letter to the editor
42			
43	Su et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
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46	Massone et al, 2021	Anais brasileiros de dermatologia	Research letter or letter to the editor
47			
48	Li et al, 2021	The Journal of infection	Research letter or letter to the editor
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51	Afanasiev et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
52			
53	Varma et al, 2011	British Journal of Dermatology	Research letter or letter to the editor
54			
55	Van Der Heijden et al, 2010	Journal of the European Academy of Dermatology and Venereology	Research letter or letter to the editor
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4	Motley et al, 2012	BMJ (Online)	Research letter or letter to the editor
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6	Villani et al, 2020	Dermatologic therapy	Research letter or letter to the editor
7			
8	Portnoy et al, 2018	The journal of allergy and clinical immunology. In practice	Research letter or letter to the editor
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11	Tschandl et al, 2018	British Journal of Dermatology	Research letter or letter to the editor
12			
13	Poolworaluk et al, 2020	Future healthcare journal	Research letter or letter to the editor
14			
15	Anonymous et al, 2020	Journal of drugs in dermatology : JDD	Research letter or letter to the editor
16			
17	Tan et al, 2021	Annals of the Academy of Medicine, Singapore	Research letter or letter to the editor
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20	Silva et al, 2021	Anais brasileiros de dermatologia	Research letter or letter to the editor
21			
22	de Giorgi et al, 2016	International Journal of Dermatology	Wrong outcomes
23	Senel et al, 2014	Journal of telemedicine and telecare	Wrong outcomes
24			
25	Goodier et al, 2021	Contact dermatitis	Wrong outcomes
26	Foolad et al, 2017	International Journal of Dermatology	Wrong outcomes
27			
28	Wells et al, 2020	The Journal of clinical and aesthetic dermatology	Wrong outcomes
29			
30	Arzberger et al, 2016	Acta Dermato-Venereologica	Wrong outcomes
31	Creighton-Smith et al, 2017	International Journal of Dermatology	Wrong outcomes
32			
33			
34	Marwaha et al, 2019	Journal of the American Academy of Dermatology	Wrong outcomes
35			
36	Pasquali et al, 2021	Actas dermo-sifiliograficas	Wrong outcomes
37	Vestergaard et al, 2020	Family practice	Wrong outcomes
38			
39	Kravets et al, 2018	Acta dermatovenerologica Alpina, Pannonica, et Adriatica	Wrong outcomes
40			
41	Speiser et al, 2014	American Journal of Dermatopathology	Wrong outcomes
42	N/A	Journal of the American Academy of Dermatology	Wrong outcomes
43			
44	Whited et al, 2013	Journal of Telemedicine and Telecare	Wrong outcomes
45			
46	Abhishek et al, 2021	medRxiv	Wrong outcomes
47	Villa et al, 2020	Internal and emergency medicine	Wrong outcomes
48	Lubeek et al, 2016	Tijdschrift voor gerontologie en geriatrie	review
49			
50	Ndegwa et al, 2016	Health Technology Assessment Database	review
51			
52	Moreno-Ramirez et al, 2017	Acta dermato-venereologica	review
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54	Moreno-Ramirez et al, 2017	Acta Dermato-Venereologica	review
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3	Van Der Heijden et al, 2010	Huisarts en Wetenschap	review
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5	Walocko et al, 2017	Dermatologic Clinics	review
6			
7	Roman et al, 2014	Journal of the Dermatology Nurses' Association	review
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10	Hart et al, 2011	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	review
11			
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14	Elsner et al, 2020	Journal der Deutschen Dermatologischen Gesellschaft = Journal of the German Society of Dermatology : JDDG	review
15			
16			
17	Kaliyadan et al, 2020	Indian journal of dermatology	review
18			
19	Burch et al,		review
20	Evans et al, 2017	Pharmazeutische Zeitung	Editorial
21			
22	Anonymous. et al, 2016	Journal of AHIMA / American Health Information Management Association	Editorial
23			
24	Luk et al, 2018	Hong Kong Journal of Dermatology and Venereology	Editorial
25			
26	Queen et al, 2018	International wound journal	Editorial
27			
28	Anguita et al, 2014	Nurse Prescribing	Editorial
29	Haworth et al, 2020	Clinical and experimental dermatology	Editorial
30			
31	Romero-Aguilera et al, 2019	Actas dermo-sifiliograficas	Editorial
32			
33	Barrio Garde et al, 2016	Piel	Editorial
34			
35	Morand et al, 2010	Annales de dermatologie et de venereologie	Editorial
36			
37	N/A	Journal of the American Academy of Dermatology	Abstract
38			
39	N/A	Journal of the American Academy of Dermatology	Abstract
40			
41	Bianchi et al, 2020	Journal of the American Academy of Dermatology	Abstract
42			
43			
44	Creadore et al, 2020	Journal of the American Academy of Dermatology	Abstract
45			
46	N/A	Journal of the American Academy of Dermatology	Abstract
47			
48	Tognetti L et al, 2020		Abstract
49	SPLETE et al, 2014	Emergency Medicine (00136654)	Abstract
50			
51	N/A	Journal of the American Academy of Dermatology	Abstract
52			
53	Dahlen Gyllencreutz et al, 2017	Journal of the European Academy of Dermatology and Venereology	Wrong intervention
54			
55	Tandjung et al, 2015	Journal of Evaluation in Clinical Practice	Wrong intervention
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Paradela-De-La-Morena et al, 2015	European Journal of Dermatology	Wrong intervention
Horsham et al, 2015	British Journal of Dermatology	Wrong intervention
Saenz et al, 2018	International Journal of Telemedicine and Applications	Wrong intervention
Kochmann et al, 2016	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong comparator
Markun et al, 2017	Medicine (United States)	Wrong comparator
Feigenbaum et al, 2017	Pediatric Dermatology	Wrong comparator
Massone et al, 2014	Journal of the European Academy of Dermatology and Venereology	Wrong comparator
MacLellan et al, 2021	Journal of the American Academy of Dermatology	Wrong comparator
Koysombat et al, 2021	Journal of plastic, reconstructive & aesthetic surgery : JPRAS	Correspondence
Jakhar et al, 2020	Clinical and experimental dermatology	Correspondence
Alkmim et al, 2013	Journal of Telemedicine and Telecare	Correspondence
NCT02836665, 2016	<a href="https://clinicaltrials.gov/ct2/show/study/NCT02836665">ClinicalTrials.gov</a>	Clinical trial - no associated manuscript
JPRN-UMIN000020873 et al, 2016		Clinical trial - no associated manuscript
Fogel et al, 2016	Journal of the American Academy of Dermatology	Commentary
Hoyer et al, 2020	Cutis	Commentary
Pasadyan et al, 2020	Journal of the American Academy of Dermatology	Duplicate
Moreno-Ramirez et al, 2017	American Journal of Clinical Dermatology	Erratum
Trovato et al, 2011	Eplasty	Wrong patient population
Bowns et al, 2016	Health Technology Assessment Database	Wrong publication date
Gemelas et al, 2019	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong setting

242 **eTable 4. List of studies excluded at the full-text screening stage.**

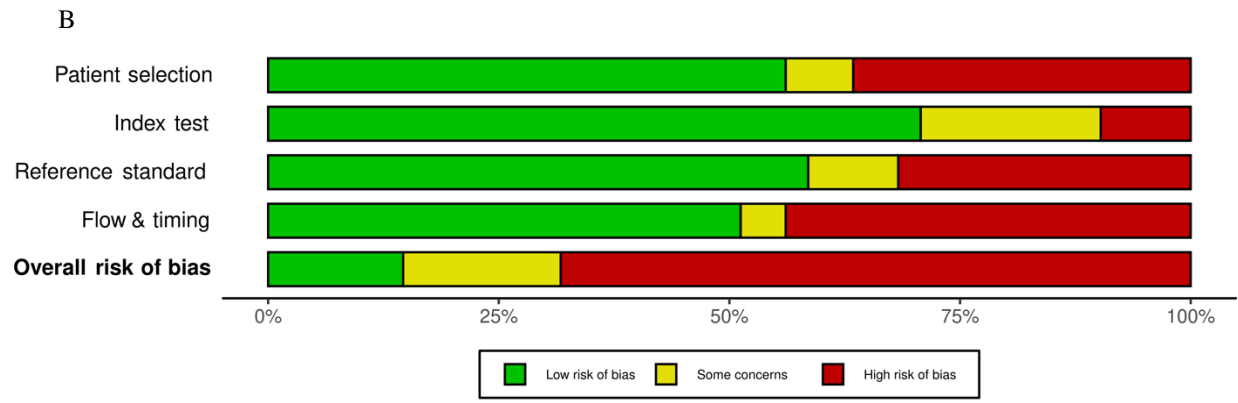
A

Study	Risk of bias domains				Overall
	D1	D2	D3	D4	
Altieri, et al, 2017	+	+	+	+	+
Azfar, et al, 2014	+	+	+	+	X
Barbieri, et al, 2014	+	+	-	+	-
Barcaui, et al, 2018	+	+	X	X	X
Batalla, et al, 2015	-	+	+	+	-
Borve, et al, 2012	+	+	X	X	X
Borve, et al, 2013	X	-	+	+	X
Carter, et al, 2017	X	-	+	X	X
Chen, et al, 2010	+	X	X	-	X
Clarke, et al, 2021	X	X	+	+	X
Costello, et al, 2019	X	+	X	X	X
Duong, et al, 2014	+	-	X	X	X
Gabel, et al, 2021	X	+	+	X	X
Gatica, 2015	+	+	-	+	-
Gerhardt, et al, 2021	X	-	X	X	X
Giavina-Bianchi, et al, Oct 2020	X	+	-	X	X
Giavina-Bianchi, et al, Nov 2020	X	+	-	X	X
Gonzalez-Coloma, et al, 2019	+	X	X	+	X
Goulart-Silveira, et al, 2019	X	+	+	X	X
Jones, et al, 2021	+	-	+	+	-
Keller, et al, 2020	+	+	+	+	+
Lamel, et al, 2012	-	-	+	+	-
Marchell, et al, 2017	+	+	+	+	+
Muir, et al, 2011	X	+	+	X	X
Nami, et al, 2015	X	+	+	+	X
Okita, et al, 2016	+	+	+	+	X
Patro, et al, 2015	+	+	X	+	X
Piccoli, et al, 2015	X	+	X	X	X
Ribas, et al, 2010	X	+	X	X	X
Rubegni, et al, 2011	+	+	+	+	+
Saleh, et al, 2017	+	+	+	+	+
Senel, et al, 2013	X	+	+	X	X
Sola-Ortigosa, et al, 2020	+	+	X	X	X
Tan, et al, 2010	X	X	+	X	X
Tran, et al, 2011	+	+	X	+	X
Vano-Galvan, et al, 2010	+	+	+	+	X
Vestergaard, et al, 2020	+	+	+	X	X
Warshaw, et al, 2015	+	-	+	+	-
Zanini, 2013	-	+	+	-	-
Zink, et al, 2017, July	+	-	X	X	X
Zink, et al, 2017, Sept	+	+	+	+	+

Domains:  
D1: Patient selection.  
D2: Index test.  
D3: Reference standard.  
D4: Flow & timing.

Judgement  
X High  
- Some concerns  
+ Low

Preprint only

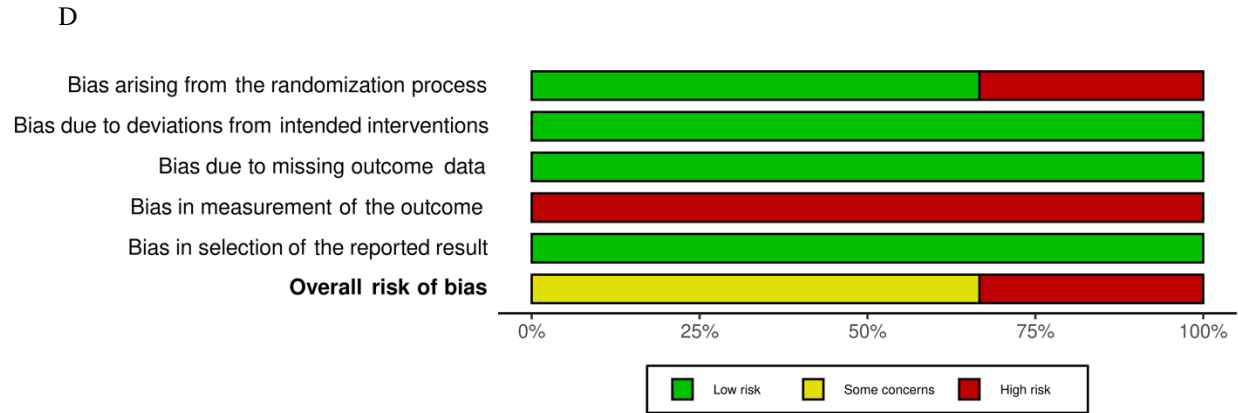


**C**

Study	Risk of bias domains					Overall
	D1	D2	D3	D4	D5	
Rios-Yuil, 2011	High	Low	Low	High	Low	High
Romero, et al, 2010	Low	Low	Low	High	Low	Some concerns
Romero Aguilera, et al, 2014	Low	Low	Low	High	Low	Some concerns

Domains:  
 D1: Bias arising from the randomization process.  
 D2: Bias due to deviations from intended intervention.  
 D3: Bias due to missing outcome data.  
 D4: Bias in measurement of the outcome.  
 D5: Bias in selection of the reported result.

Judgement  
 High (Red X)  
 Some concerns (Yellow -)  
 Low (Green +)



**eTable 5. Risk of Bias (ROB) results.**

(A,B) QUADAS-2 RoB analysis of 41 observational studies. (C,D) ROB-2 analysis of three randomized controlled trials.

250 **eReferences.**

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394 This supplementary material has been provided by the authors to give readers additional information about their  
395 work.

For peer review only

## MOOSE Checklist for Meta-analyses of Observational Studies

Item No	Recommendation	Reported on Page No
Reporting of background should include		
1	Problem definition	4
2	Hypothesis statement	4
3	Description of study outcome(s)	4-5
4	Type of exposure or intervention used	6-8
5	Type of study designs used	6-8
6	Study population	6-8
Reporting of search strategy should include		
7	Qualifications of searchers (eg, librarians and investigators)	6
8	Search strategy, including time period included in the synthesis and key words	6-8
9	Effort to include all available studies, including contact with authors	6-8
10	Databases and registries searched	6-8
11	Search software used, name and version, including special features used (eg, explosion)	6-8
12	Use of hand searching (eg, reference lists of obtained articles)	6-8
13	List of citations located and those excluded, including justification	Supplement
14	Method of addressing articles published in languages other than English	6-8
15	Method of handling abstracts and unpublished studies	6-8, Supplement
16	Description of any contact with authors	6-8, Supplement
Reporting of methods should include		
17	Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	9-12
18	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	9-12
19	Documentation of how data were classified and coded (eg, multiple raters, blinding and interrater reliability)	9-12
20	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	9-12
21	Assessment of study quality, including blinding of quality assessors, stratification or regression on possible predictors of study results	9-12
22	Assessment of heterogeneity	9-12
23	Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	9-12
24	Provision of appropriate tables and graphics	9-12, Supplement
Reporting of results should include		
25	Graphic summarizing individual study estimates and overall estimate	Fig 1-3, Supplement
26	Table giving descriptive information for each study included	Tables 1, 2, Supplement
27	Results of sensitivity testing (eg, subgroup analysis)	9-12
28	Indication of statistical uncertainty of findings	9-12

Item No	Recommendation	Reported on Page No
Reporting of discussion should include		
29	Quantitative assessment of bias (eg, publication bias)	9-12
30	Justification for exclusion (eg, exclusion of non-English language citations)	9-12
31	Assessment of quality of included studies	9-12
Reporting of conclusions should include		
32	Consideration of alternative explanations for observed results	13-17
33	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	13-17
34	Guidelines for future research	13-17
35	Disclosure of funding source	18

From: Stroup DF, Berlin JA, Morton SC, et al, for the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group. Meta-analysis of Observational Studies in Epidemiology. A Proposal for Reporting. *JAMA*. 2000;283(15):2008-2012. doi: 10.1001/jama.283.15.2008.



## PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
<b>TITLE</b>			
Title	1	Identify the report as a systematic review.	p1
<b>ABSTRACT</b>			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p3-4
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	p5-6
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	p5-6
<b>METHODS</b>			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	p8, Supplementary p15
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	p7
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplementary p2
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	p8
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	p8
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Supplementary p15
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	p8 and Supplementary p15
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	p9
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	p8-9
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	p8-9
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	p 8-9 Supplementary p2
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	p 8-9 Supplementary p2
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	p 8-9 Supplementary p2
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	p 8-9 Supplementary p2
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	p9
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA





## PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
<b>RESULTS</b>			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Figure 1, p10
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Supplementary p23-3
Study characteristics	17	Cite each included study and present its characteristics.	p10-11, Table 1, 2
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	p15, Supplementary eTable 5
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	p15, Supplementary eTable 5
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Figure 2, 3, Supplementary eFigure 1-5
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	p 11-13 Supplementary p3
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	p 11-13 Supplementary p3
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Supplementary eTable 5
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	p 11-13 Supplementary p3
<b>DISCUSSION</b>			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	p14
	23b	Discuss any limitations of the evidence included in the review.	p15-16
	23c	Discuss any limitations of the review processes used.	p16
	23d	Discuss implications of the results for practice, policy, and future research.	p17
<b>OTHER INFORMATION</b>			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	p7
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	p7
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	p18
Competing interests	26	Declare any competing interests of review authors.	p18
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71

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# BMJ Open

## Diagnostic Reliability in Teledermatology: A Systematic Review and a Meta-Analysis

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1 **Title:** Diagnostic Reliability in Teledermatology: A Systematic Review and a Meta-Analysis

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For peer review only

## 26 **Abstract**

27 Objectives: To compare teledermatology and face-to-face (F2F) agreement in primary diagnoses  
28 of dermatological conditions.

29 Design: Systematic Review and Meta-Analysis

30 Methods: MEDLINE, Embase, Cochrane Library (Wiley), CINAHL, and medRxiv were  
31 searched between January 2010 and May 2022. Observational studies and randomized clinical  
32 trials that reported percentage agreement or kappa concordance for primary diagnoses between  
33 teledermatology and F2F physicians were included. Titles, abstracts, and full-text articles were  
34 screened in duplicate. From 7,173 citations, 44 articles were included. A random-effects meta-  
35 analysis was conducted to estimate pooled estimates. Primary outcome measures were mean  
36 percentage and kappa concordance for assessing diagnostic matches between teledermatology  
37 and F2F physicians. Secondary outcome measures included the agreement between  
38 teledermatologists, F2F dermatologists, and teledermatology and histopathology results.

39 Results: 44 studies were extracted and reviewed. The pooled agreement rate was 68.9%, and  
40 kappa concordance was 0.67. When dermatologists conducted F2F and teledermatology consults,  
41 the overall diagnostic agreement was significantly higher at 71%, compared to 44% for non-  
42 specialists. Kappa concordance was 0.69 for teledermatologist vs specialist and 0.52 for non-  
43 specialists. Higher diagnostic agreements were also noted with image acquisition training and  
44 digital photography. The agreement rate was 76.4% between teledermatologists, 82.4% between  
45 F2F physicians, and 55.7% between teledermatology and histopathology.

46 Conclusions and Relevance: Teledermatology can be an attractive option particularly in  
47 resource-poor settings. Future efforts should be placed on incorporating image acquisition  
48 training and access to high-quality imaging technologies.

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2  
3 49 Registration number: 10.17605/OSF.IO/FJDVG  
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5  
6 50  
7

8 51 **Keywords:** teledermatology, dermatology consultations, store-and-forward, telemedicine,  
9  
10 52 remote consultation, dermatology hospitalists  
11  
12 53  
13

14 54 **Article Summary:**

15 55 Strengths and limitations of this study:  
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- 19 56 ● This is the most comprehensive systematic review and meta-analysis of the topic to date  
20  
21 57 without language restrictions applied.  
22  
23 58 ● Inclusion criteria were broad, including all types of dermatological diseases, imaging  
24  
25 59 technologies, in-person physician specializations (GPs, hospitalists, and dermatologists),  
26  
27 60 and the presence or absence of image acquisition training.  
28  
29 61 ● The article search was limited to 2010 and later due to the recent incorporation of  
30  
31 62 smartphones in teledermatology practices.  
32  
33 63 ● Due to considerable heterogeneity between studies, meta-analysis and synthesis of  
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35 64 predictors for accurate diagnoses remotely were limited even after subgrouping.  
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## 65 Introduction

66 With the emergence of COVID-19, the introduction of virtual consults in healthcare settings,  
67 especially dermatology, has been expanded to allow many patients the opportunity for equitable  
68 access to care when in-person appointments pose a challenge and risk to patients. <sup>1</sup> Different  
69 modalities were introduced to support teledermatology. This involves remote sharing of patient  
70 data, including synchronous video-streaming teledermatology and asynchronous sharing of still  
71 images via emails, or text messages, or store-and-forward teledermatology (SFTD).

72  
73 Although both synchronous and asynchronous approaches have been shown to be cost-effective,  
74 SFTD is particularly popular as it requires fewer resources and less coordination than synchronous  
75 teledermatology. <sup>2 3</sup> With the advent of higher resolution smartphone cameras, relatively minimal  
76 training is required to capture data for remote dermatologists correctly; multiple SFTD studies  
77 opted to provide no training in image capture and still found value in teledermatology. <sup>4 5</sup>

78  
79 There is valid concern over the reliability of teledermatology given the significant variability in  
80 diagnostic accuracy predicted across pre-pandemic research. <sup>6</sup> This is expected given the lack of  
81 standardization across studies and the potential for confounders across teledermatology  
82 methodologies and applications, e.g., level of training or skin lesion type. This variability in  
83 approach may benefit from an increased demand, which could provide greater impetus to optimize  
84 and standardize teledermatology.

85  
86 To our knowledge, this is the first and most inclusive meta-analysis (MA) that compares  
87 teledermatology consults to face-to-face (F2F) that looked at all relevant studies without overly

1  
2  
3 88 exclusive inclusion criteria. The primary objective of this study was to compare the reliability of  
4  
5 89 teledermatology diagnoses to F2F consults, as determined by Cohen's kappa interrater agreement  
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7  
8 90 and total agreement rates. Teledermatology can assume important roles as a routine complement  
9  
10 91 to primary care and an alternate route to the typical in-person referrals. Consequently, we wanted  
11  
12 92 to determine agreement for teledermatology and all F2F consults, teledermatology and F2F  
13  
14 93 primary care consults, and finally teledermatology and F2F dermatologist consults, which would  
15  
16 94 arguably best capture the limitations introduced by the change in medium from F2F to  
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18  
19 95 teledermatology.  
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21 96  
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24 97 Additional subset analyses were performed to control for potential confounders (e.g.,  
25  
26 98 inflammatory vs. malignant, staff training for image acquisition, teledermoscopy, and smartphone  
27  
28 99 vs digital cameras) introduced by the heterogenous methodology. The secondary objectives sought  
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31 100 to determine the agreement rate within teledermatology diagnoses and F2F consults to provide an  
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33 101 idea of each medium's consistency, and provide the best estimate of accuracy for the agreement  
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35 102 rate between teledermatology and histopathology.  
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## 103 **Methods**

104 This study was performed in accordance with the Preferred Reported Items for Systematic Reviews  
105 and Meta-Analyses (PRISMA) guidelines.

### 107 Protocol Registration

108 Prior to the conduct of this review, a protocol which adhered to the PRISMA-protocols (i.e.,  
109 PRISMA-P) guidelines was developed and then registered on Open Science Framework (OSF).

110 Access: <https://osf.io/fjdvg>.<sup>7</sup>

### 112 Search Strategy

113 A comprehensive search of major bibliographic databases, MEDLINE, Embase, Cochrane Library  
114 (Wiley), CINAHL, and medRxiv was performed in August 2021. MEDLINE was searched again  
115 between August 2021 and May 2022 to screen any new articles published after our protocol was  
116 registered. The search strategy was developed by a medical librarian at Queen's University  
117 (Kingston, ON). Please see the supplementary appendix for additional information on the search  
118 strategy.

119  
120 No restrictions were placed on the language or status of the publications. Search results were  
121 limited to studies published between January 2010 and May 2022 due to the novelty of  
122 incorporating smartphones in teledermatology remote consultations.<sup>8</sup> The International  
123 Prospective Register of Systematic Reviews (PROSPERO) and OSF were searched up to May  
124 2022 for relevant ongoing systematic reviews using the terms 'telemedicine,' 'teledermatology,'



1  
2  
3 125 'dermatology,' 'diagnostic accuracy,' and 'diagnostic concordance.' Reference lists of included  
4  
5 126 studies were screened to identify additional studies not captured in the search.  
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9  
10 128 Eligibility Criteria

11  
12 129 Studies evaluating the diagnostic reliability of teledermatology that reported on patients with  
13  
14 130 dermatological conditions assessed by a clinician using asynchronous or synchronous telemedicine  
15  
16 131 systems were included. All articles were required to compare tele- to F2F diagnoses conducted by  
17  
18 132 a physician. Exclusion criteria encompassed survey articles, feasibility studies, non-  
19  
20 133 dermatological telemedicine studies, cost-effectiveness studies, editorials, review articles, studies  
21  
22 134 using teledermatology as the reference standard, studies comparing only dermatoscopic images  
23  
24 135 without clinical images, and studies where patients captured their own photographs. The latter was  
25  
26 136 excluded to ensure consistent image quality, enabling a more accurate comparison of diagnostic  
27  
28 137 reliability between tele- and F2F methods. Included articles are summarized in **eTable 1** in the  
29  
30 138 supplementary appendix. Inclusion and exclusion criteria are summarized in **eTable 2**, available  
31  
32 139 in the supplementary appendix.  
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39  
40 141 Data Selection & Extraction

41  
42 142 Following the removal of duplicated citations, the titles and abstracts were screened. Following  
43  
44 143 this step, a full-text assessment was conducted. At both stages, two reviewers performed screening  
45  
46 144 independently [AB and NB]. Any disagreements were resolved through consensus by the two  
47  
48 145 reviewers and when necessary, through discussion with a third reviewer [JLRG].  
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3 147 A data collection form was created on the *Covidence* website and piloted by two reviewers [AB,  
4  
5 148 NB]. Three additional reviewers assisted with data extraction [JLRG, MB, MM]. Two reviewers  
6  
7 149 were assigned to each paper. One reviewer extracted all characteristics of the included literature,  
8  
9 150 and the second reviewer validated the characteristics for accuracy. Any disagreements were  
10  
11 151 resolved by consensus. In the supplementary appendix, **eTable 3** summarizes the information  
12  
13 152 extracted from full-text articles.  
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### 19 154 Data Synthesis

21 155 This meta-analysis assessed the effectiveness of SFTD technologies and live video conferencing  
22  
23 156 in diagnosing skin conditions. Outcomes regarding complete diagnostic percentage agreement  
24  
25 157 rates and Cohen's kappa concordance were evaluated separately, with some studies being part of  
26  
27 158 both analyses if they reported both variables. The patient, intervention type, lesion, and geographic  
28  
29 159 characteristics were summarized qualitatively. Please see the supplementary appendix and **eTable**  
30  
31 160 **4** for more details on data synthesis and nomenclature for each study grouping.  
32  
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### 162 Risk of Bias

40 163 Three reviewers [AB, NB, MB] completed the risk of bias assessment; all studies were  
41  
42 164 independently reviewed. Version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB  
43  
44 165 2) was used to assess the risk of bias in three randomized trials.<sup>9-11</sup> RoB 2 is structured into a fixed  
45  
46 166 set of domains of bias, focusing on different aspects of trial design, conduct, and reporting.<sup>12</sup> The  
47  
48 167 Quality Assessment of Diagnostic Assessment of Diagnostic Accuracy (2<sup>nd</sup> Edition, QUADAS-2)  
49  
50 168 was used to assess the risk of bias. Uncertain risk of bias was assigned to studies with insufficient  
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3 169 information except for studies that were likely to be biased due to missing data. In the latter case,  
4  
5 170 a high risk of bias was assigned.  
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10 172 Synthesis of Results

11  
12 173 Statistical analysis was performed using the dmetar package in R v.4.0.1 (R Foundation for  
13  
14 174 Statistical Computing, 2022). Agreement rates and Cohen's kappa concordances for unique study  
15  
16 175 groupings were treated as individual and independent values. For the percentage of agreement,  
17  
18 176 meta-analyses were conducted using the aggregated data, and proportions were calculated with the  
19  
20 177 corresponding 95 percent confidence intervals (CI). Point-biserial correlations were utilized to  
21  
22 178 calculate pooled kappa values. Statistical heterogeneity was investigated using the  $I^2$  index and the  
23  
24 179  $\tau^2$  statistic, leading to the use of a random-effects model for overall complications with a logit  
25  
26 180 transformation due to the high degree of heterogeneity. Possible sources of heterogeneity were  
27  
28 181 explored through sub-group analysis, and confounding factors were controlled using meta-  
29  
30 182 regression. A random-effects model, as proposed by DerSimonian and Laird, was chosen as the  
31  
32 183 primary method to estimate all pooled estimates. Further details on the statistical analysis can be  
33  
34 184 found in the supplementary appendix.  
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42 186 Patient and Public Involvement

43  
44 187 Patients or the public were not involved in our research's design, conduct, reporting, or  
45  
46 188 dissemination plans.  
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## 189 **Results**

190 A total of 7,173 studies were screened for eligibility of which 44 were included in this study. Of  
191 these, 40 studies reported diagnostic agreement rates <sup>4 5 9-11 13-47</sup> and 21 studies reported kappa  
192 concordance. <sup>5 9 13 14 19 22 25 28-33 35-37 48-52</sup> Further details are provided in the PRISMA diagram in  
193 **Figure 1**. The complete list of excluded studies can be found in the supplementary appendix,  
194 **eTable 5**.

### 196 Study and patient characteristics

197 **eTable 1** summarizes the study and participant characteristics for the 44 included papers. Forty of  
198 the included studies were observational, of which 31 were prospective, nine were retrospective.  
199 One study was ambispective. Three studies were randomized controlled trials and one study was  
200 a quasi-randomized trial. Studies selected for the review included a total of 52,075 patients (Range:  
201 26 to 24,210 patients). Some patients had multiple lesions and the total number of lesions included  
202 in the study was 57,222 (Range: 26 to 27,519 lesions).

203  
204 The mean age reported in 27 (61%) studies was  $54.78 \pm 15.69$  years (Range: 0 to 100 years old).  
205 Thirty-four (77%) studies reported participant gender, with a mean of 57% females (Range: 3.2%  
206 to 74%). Only 13 (29%) studies reported information on Fitzpatrick skin types, ethnicity, or race.  
207 Twenty-eight studies (64%) included in this analysis were inclusive of all types of dermatoses, 13  
208 (29%) studies looked specifically at suspicious lesions, and three (7%) studies excluded skin  
209 cancers completely.

210  
211 Diagnostic reliability of teledermatology when compared to F2F (specialist and non-specialist)  
212 evaluation

213 We assessed the diagnostic reliability of teledermatology compared to F2F evaluations by  
214 analyzing diagnostic agreement rates and concordance. The overall diagnostic agreement rate  
215 ranged from 13.9% to 98.0% (mean 68.9%, CI 64.4% to 73.1%), with a concordance that ranged  
216 from 0.21 to 0.96 (mean 0.67, CI 0.60 to 0.74). See **eFigure 1** and the supplementary appendix  
217 for further details.

218  
219 **Sub-group analyses**

220  
221 Diagnostic agreement between teledermatologist and teledermatologist, F2F and F2F physicians,  
222 and teledermatology and histopathology

223 See supplementary appendix and **eFigure 2** for further details.

224  
225 Diagnostic reliability of teledermatologist vs F2F specialist and non-specialist

226 See supplementary appendix and **eFigure 3** for further details.

227  
228 Diagnostic reliability of teledermatology vs F2F by training provided for image acquisition

229 Twenty studies with 37 unique comparisons explicitly provided training to those in charge of  
230 image acquisition shown in **Figure 2**.<sup>9-11 14-16 19 20 23 26 29 32 35-41 43 44</sup> The mean agreement rate  
231 between teledermatology and F2F physicians in these studies was 75.9% (CI 74.4% to 77.27%),  
232 significantly higher than the 62.1% (CI 60.5% to 63.7%) observed when no training was provided

233 (p = 0.033, heterogeneity: I<sup>2</sup> = 98%). Concordance values were also higher when training was  
234 provided (mean 0.77, CI 0.66-0.84) compared to when no training was provided (mean 0.60, CI  
235 0.49-0.69) (p = 0.01, I<sup>2</sup>=98%).

### 237 Diagnostic reliability of teledermatology vs F2F by type of technology used for image acquisition

238 Approximately half of the studies with 41 unique comparisons that compared Teledermatologists  
239 with F2F physicians used digital cameras for image acquisition. Eighteen studies comparing F2F  
240 and teledermatology agreement rates with 26 unique comparisons reported the use of smartphones  
241 and tablets for image acquisition. **Figure 3** shows that the mean percentage agreement rate for  
242 digital cameras was 71.7% (CI 70.3% to 73.1% compared to 59.8% (CI 57.2% to 62.3%) for  
243 smartphones or tablets. The higher agreement rate with digital photography was statistically  
244 significant (p = 0.029, heterogeneity: I<sup>2</sup>=98%). The concordance values for digital photography  
245 were reported for twelve studies with a mean of 0.70 (CI 0.61 to 0.76). Concordance values for  
246 smartphone or tablet technologies were reported for eight studies with a mean of 0.62 (CI 0.38 to  
247 0.78). The higher concordance with digital photography was statistically significant (p = 0.003,  
248 heterogeneity: I<sup>2</sup>=100%).

### 250 Other sub-group analyses

251 No statistically significant patterns could be identified with the inclusion of teledermoscopy in  
252 addition to clinical images (**eFigure 4**), lesion type (**eFigure 5**), grouping studies as pre- or post-  
253 pandemic (figure not shown), or risk of bias (figure not shown). Please see the supplementary  
254 appendix for further details.

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5 256 **Quality assessment**6  
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8 257 The quality assessment results for risk of bias and applicability in individual studies are displayed  
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10 258 in the supplementary appendix and **eTable 6**.11  
12 25913  
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15 260 **Discussion:**16  
17 261 To our knowledge, this study constitutes the most extensive systematic review and meta-analysis  
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19 262 on tele dermatology, including 44 studies across four languages.20  
21 26322  
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24 264 Our sub-group analyses revealed that agreement rates between tele dermatology consultations and  
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26 265 F2F physicians were significantly higher when dermatologists conducted in-person assessments  
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28 266 compared to non-specialists. This finding suggests that tele dermatology may be more beneficial  
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30 267 in supplementing primary care than specialist care, as lower concordance with non-specialists  
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32 268 indicates reduced reference test accuracy. Although we did not directly assess the impact of  
33  
34 269 consulting tele dermatologists on non-specialist accuracy, the included studies report high levels of  
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36 270 non-specialist satisfaction with the teleconsultation process. In fact, 96% of non-specialists agreed  
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38 271 that they learned about the dermatologic diagnosis, and 100% agreed that it helped patient care.<sup>23</sup>  
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40 272 These results are consistent with prior research attributing high provider satisfaction to streamlined  
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42 273 workflows, effective communication, and fast turnaround times in tele dermatology.<sup>2 53</sup>43  
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49 275 The study emphasizes the importance of standardized training on image acquisition in improving  
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51 276 agreement rates between in-person and remote care. Additionally, digital photography was linked  
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53 277 to increased agreement rates, potentially due to enhanced image resolution and experienced staff  
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3 278 conducting virtual consultations using standardized procedures. This suggests a crucial need for  
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5 279 comprehensive training in image acquisition, highlighting the importance of equipping primary  
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7 280 care providers supporting telehealth delivery with high-quality cameras and the latest smartphone  
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10 281 models.<sup>24 54 55</sup>

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12 282  
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14 283 Assessing agreement on the management plan is crucial in teledermatology as it serves as a triage  
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16 284 tool for distinguishing mild/benign cases from severe/malignant/uncertain cases. Ensuring  
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18 285 concordance in the management plan between telemedicine and face-to-face consultations is vital  
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20 286 for optimizing patient care. Future research should explore the consistency of treatment  
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22 287 recommendations and interventions between telemedicine and in-person consultations to further  
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24 288 enhance the evaluation of telemedicine's effectiveness in guiding appropriate patient management.  
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31 290 Pathological assessment of skin lesions is the cornerstone of skin cancer diagnosis. This meta-  
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33 291 analysis found a 55.7% (CI 53.0% to 58.4%) agreement rate between teledermatology and  
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35 292 histopathology. This low agreement rate reflects all skin biopsies and specific diagnostic accuracy  
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37 293 rates could not be calculated by lesion type due to the small number of studies that reported this  
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39 294 value. Through sub-group analyses, we were able to compare cancerous and non-cancerous  
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41 295 lesions; slightly higher concordance was seen with skin cancers compared to studies that also  
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43 296 included non-suspicious lesions like dermatitis and psoriasis. However, the data was too  
44  
45 297 heterogeneous for any significant conclusions. We also looked at the use of teledermoscopy,  
46  
47 298 another technique that could help improve the diagnostic accuracy of teledermatology for  
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49 299 suspicious lesions, but no significant trends could be identified. These findings reflected the results  
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52 300 of a 2016 systematic review on teledermatology.<sup>6</sup>  
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3 301  
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5 302 Many teledermoscopy studies grouped statistics from lesions analyzed with and without  
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7 303 dermoscopy, preventing the assessment of the dermatoscope's incremental contributions without  
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9 304 the influence of potentially less accurate, dermatoscope-free analysis. Supporting this explanation,  
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11 305 the three teledermoscopy studies focused on cancer lesions demonstrated greater concordance rates  
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13 306 than the teledermoscopy studies targeting broader lesions. One study identified agreement rates  
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15 307 between teledermatology and F2F dermatology of 92.3% (24/26) and between teledermatology  
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17 308 and histopathology of 66.7% (17/26), both above our identified median.<sup>45</sup> Another study found an  
18  
19 309 agreement rate of 90% (37/41) when targeting pigmented lesions, although the rate may have been  
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21 310 inflated due to recall bias introduced by having the same dermatologist perform teledermatology  
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23 311 and F2F consults.<sup>16</sup> Finally, one study diagnosed keratotic lesions in sun-exposed areas, finding a  
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25 312 high agreement rate of 92% (915/1000).<sup>37</sup> However, this study also risked bias from its  
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27 313 experimental design, which excluded lesions with poor image quality. This fails to recapitulate the  
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29 314 complexities of practical teledermatology, which must contend with potentially difficult image  
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31 315 acquisition.

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35 317 The 68.9% (CI 64.4% to 73.05%) combined agreement rate between teledermatology and F2F is  
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37 318 lower than the agreement rates outlined in a recent review.<sup>56</sup> This suggests our greater sample size  
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39 319 introduces more studies with poor agreement, which may better reflect the reality of adopting  
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41 320 teledermatology at a larger scale and signal risk from a lack of standardization.<sup>55</sup> Our date cut-off  
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43 321 of 2010 means our dataset has little overlap with existing reviews, and more heavily features new  
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45 322 relevant technologies like smartphone apps for image acquisition.<sup>6 57</sup> The most recent MA<sup>57</sup> on  
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3 323 teledermatology limited its dataset to studies with multiple teledermatology and F2F consults and  
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5 324 variably choosing to filter low-frequency diagnoses from certain studies.<sup>46</sup>  
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10 326 We acknowledge several potential limitations. The heterogeneity of the data, though at first glance  
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12 327 might limit generalizability, enhances the adaptability and applicability of teledermatology across  
13  
14 328 diverse real-world contexts. Challenges exist due to the absence of stratification by study design  
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16 329 and a limited number of randomized controlled trials. Nevertheless, our findings emphasize the  
17  
18 330 critical importance of standardized processes for effective teledermatology, such as training in  
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20 331 image acquisition, reporting guidelines, and addressing privacy concerns. Our study reveals a  
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22 332 greater degree of heterogeneity compared to previous meta-analyses, reflecting real-world  
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24 333 application and clinical practice, bolstering the robustness of our conclusions. We advocate for a  
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26 334 nuanced interpretation when generalizing these findings across all settings, recognizing the  
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28 335 demographic and technological diversity in our sample as an asset. While our attempts to filter  
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30 336 biased studies didn't yield significant improvements to our meta-analysis model, we are mindful  
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32 337 of the potential risk of publication bias in our review.  
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40 339 Furthermore, our study only included a limited number of live video conferencing studies,<sup>11 24 46</sup>  
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42 340 and our ability to draw meaningful conclusions regarding the differences between live video  
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44 341 conferencing and SFTD methods is therefore limited. A recent study by Duong et al. demonstrated  
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46 342 that live video conferencing can significantly contribute to diagnosis in teledermatology by  
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48 343 improving the quality of collected information and accuracy of the patient's status evaluation.<sup>24</sup>  
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50 344 The study found that videoconferencing significantly improved the diagnostic performance in  
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3 345 68.7% of cases. While these results are promising, further research is needed to explore the  
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5 346 potential differences between clinical images and live video conferencing.  
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10 348 In addition, our search was limited to published literature and may have missed relevant studies in  
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12 349 the grey literature and reports from low- and middle-income countries. Nonetheless, the variability  
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14 350 across providers and settings underlines the need for a standardized framework to employ and  
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16 351 assess teledermatologists. Future research is needed to explore the differences between these  
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18 352 methods and other potential factors that may impact the efficacy of teledermatology, particularly  
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20 353 in low- and middle-income countries. We acknowledge these limitations and encourage further  
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22 354 research to address these gaps in the literature.  
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28 356 Current trends suggest that teledermatology will continue to expand, there have been many recent  
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30 357 studies examining its accuracy without the design considerations necessary to allow comparisons  
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32 358 beyond siloed investigations.<sup>1</sup> The implementation of evidence-informed processes is critical to  
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34 359 the success of teledermatology services, and the accurate assessment of teledermatology will be  
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36 360 required to assess which contexts it should be employed in, e.g., suspected malignancy vs.  
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38 361 erythema.  
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44 363 While acknowledging the significant potential of artificial intelligence (AI) in enhancing  
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46 364 teledermatology, particularly in areas like image recognition and diagnosis, it is crucial to note that  
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48 365 our current study does not incorporate these aspects. The impact of AI on teledermatology, while  
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50 366 promising, introduces an additional layer of complexity, necessitating a dedicated, separate  
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52 367 investigation beyond the scope of our current study.  
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5 369 The factors targeted by our sub-analysis are undoubtedly important to standardize with best  
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8 370 practices requiring the inclusion of primary care provider training in image acquisition, explicitly  
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10 371 outlined conditions where dermatoscope attachments are required, and standardized reporting with  
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12 372 a lesion's anatomical site, size, distribution, morphology, and colour. Additional guidelines for  
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14 373 data reporting could be designed with a mind to future research goals, e.g., the inclusion of  
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16 374 Fitzpatrick grading to identify gaps in medical care. Finally, both clinical and research guidelines  
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18 375 must address privacy concerns, as integrating EMR and sharing of patient images or videos  
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21 376 presents potential vulnerabilities.  
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3 377 **Conclusion:**  
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5 378 This meta-analysis indicates that diagnostic agreement between remote and in-person  
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7 379 dermatologists is acceptable in select conditions (i.e., when training for image acquisition is  
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9 provided and technologies for high-quality images are used). Telemedicine adoption rates are  
10 380 accelerating globally, and teledermatology must be considered for enhanced accessibility,  
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12 381 flexibility, reduced costs, and safer environments it can provide patients.  
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17 383 The results of this meta-analysis represent significant evidence to indicate the suitability of  
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19 384 teledermatology for remote care, particularly as a complement to primary care, where it can serve  
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21 385 as an intermediate step before F2F specialist consultations. Furthermore, the categorization of  
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23 386 diagnostic concordance highlights important factors to further improve diagnostic accuracy.  
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25 387 Additionally, it highlights the lack of standardization in teledermatology studies, calling for greater  
26  
27 388 structure in clinical practice and conducting primary research.  
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47 396 **Author Contributions:**  
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49 397 JLRG is the guarantor of the review and supervised study design. JLRG also contributed to data  
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51 398 analysis and provided statistical expertise. AB and NB oversaw study design, data collection,  
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53 399 data analysis, and original draft preparation. AB designed the search strategy with the guidance  
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3 400 of the medical librarian, AKP. AB, NB, MB, and MM participated in the abstract and full-text  
4  
5 401 screen, data extraction, and risk of bias assessment. RDJF, AL, and SCW contributed to the draft  
6  
7 402 review and editing. All authors read, provided feedback and approved the final manuscript.  
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17  
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19 407

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21 408 **Competing interests:**

22  
23 409 RDJF is an employee, and SCW is a co-founder, chief medical officer, and shareholder of Swift  
24  
25 410 Medical. JRGL and AL were formerly employees of Swift. No funding bodies have any role in  
26  
27 411 study design, data collection and analysis, decision to publish, or preparation of the manuscript.  
28  
29 412 All other authors declare no conflict of interest.  
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34 414 **Data availability statement:**

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36 415 Data are available in a public, open access repository. All data relevant to the study are included  
37  
38 416 in the article, uploaded as supplementary information, or deposited on Open Science Framework:  
39  
40 417 <https://osf.io/fjdvg>. Data are available under the terms of the Creative Commons Zero “No rights  
41  
42 418 reserved” data waiver (CC0 1.0 Public domain dedication). Our systematic review produced a  
43  
44 419 large amount of information, and the arising database is available for future collaboration on  
45  
46 420 additional analyses. Please contact the corresponding author with any inquiries.  
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51 422 **Patient consent for publication:**

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423 Not required.

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425 **Ethics and dissemination**

426 Ethics approval is not applicable for this study since no original data will be collected.

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3 627 **Figure Legends**  
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5 628 **Figure 1. PRISMA Flow diagram of study selection.**  
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9 631 **Figure 2. Forest plot representing F2F and teledermatology primary diagnostic agreement by whether imaging acquisition training was indicated by the study.**

10 632  
11 633 Forest plot representing F2F and teledermatology primary diagnostic agreement when image  
12 634 acquisition training is involved. Studies were sorted into two groups, a) Did not conduct or did not  
13 635 report training personnel on image acquisition; b) Stated that person in charge of image acquisition  
14 636 was trained. **(Left)** Forest plot representing percentage agreement and 95% C.I. for overall  
15 637 concordance across 40 studies with a total of 72 unique number of comparisons, N of events and total  
16 638 included participants. **(Right)** Forest plot representing kappa concordance and 95% C.I. for overall  
17 639 concordance across 21 studies with a total of 45 unique number of comparisons, N of total included  
18 640 participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology  
19 641 or Teledermatologist).  
20 642

21 643  
22 644 **Figure 3. Forest plot representing F2F and teledermatology primary diagnostic agreement by device type used to capture clinical photographs.**

23 645  
24 646 Forest plot representing F2F and teledermatology primary diagnostic agreement by imaging  
25 647 technology used. Studies were sorted into three groups, i) Digital photography ii) Imaging technology  
26 648 not mentioned iii) Smartphone or tablet. **(Left)** Forest plot representing percentage agreement and  
27 649 95% C.I. for overall concordance across 40 studies with a total of 72 unique number of comparisons,  
28 650 N of events and total included participants. **(Right)** Forest plot representing kappa concordance and  
29 651 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons,  
30 652 N of total included participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD  
31 653 (Teledermatology or Teledermatologist)  
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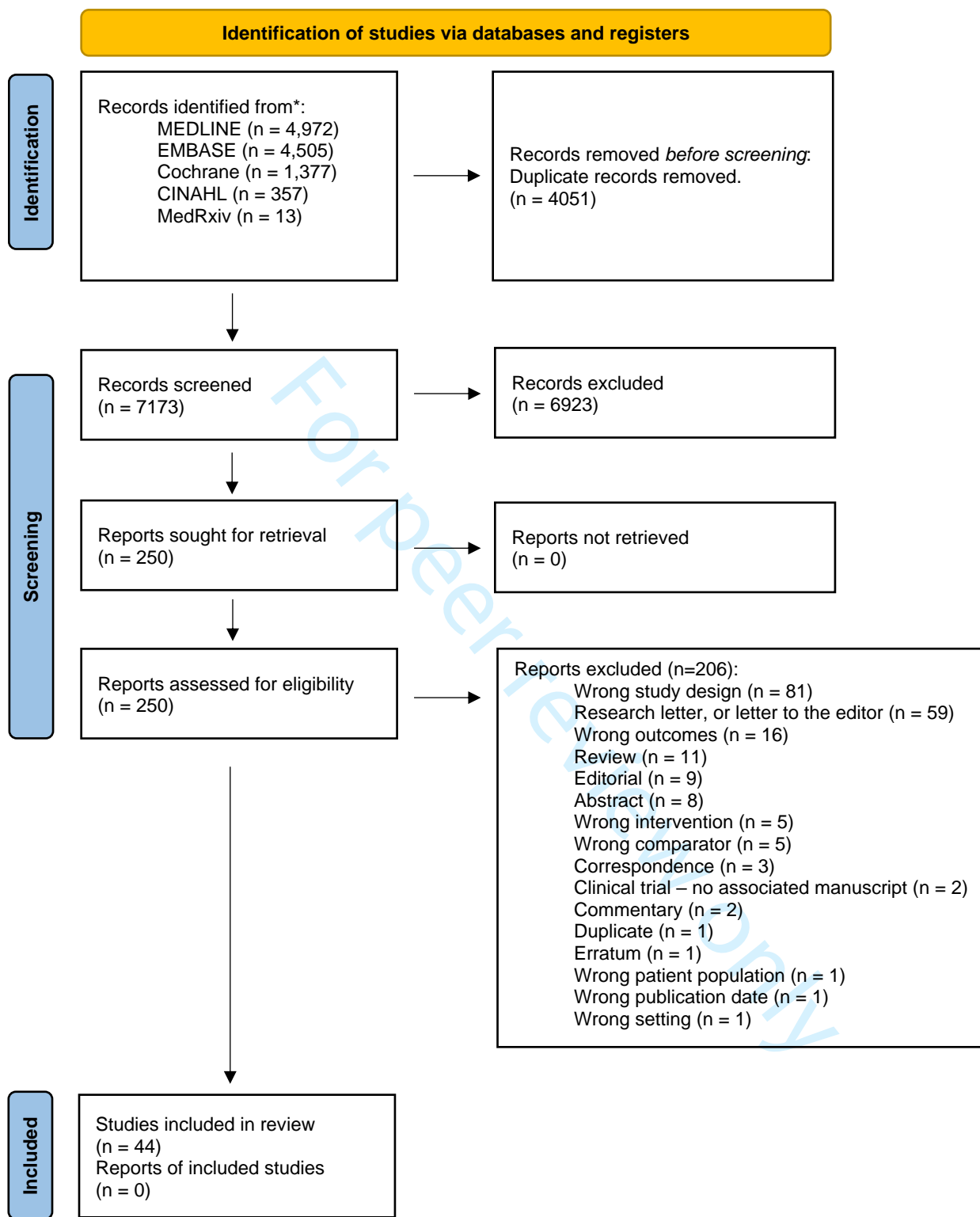
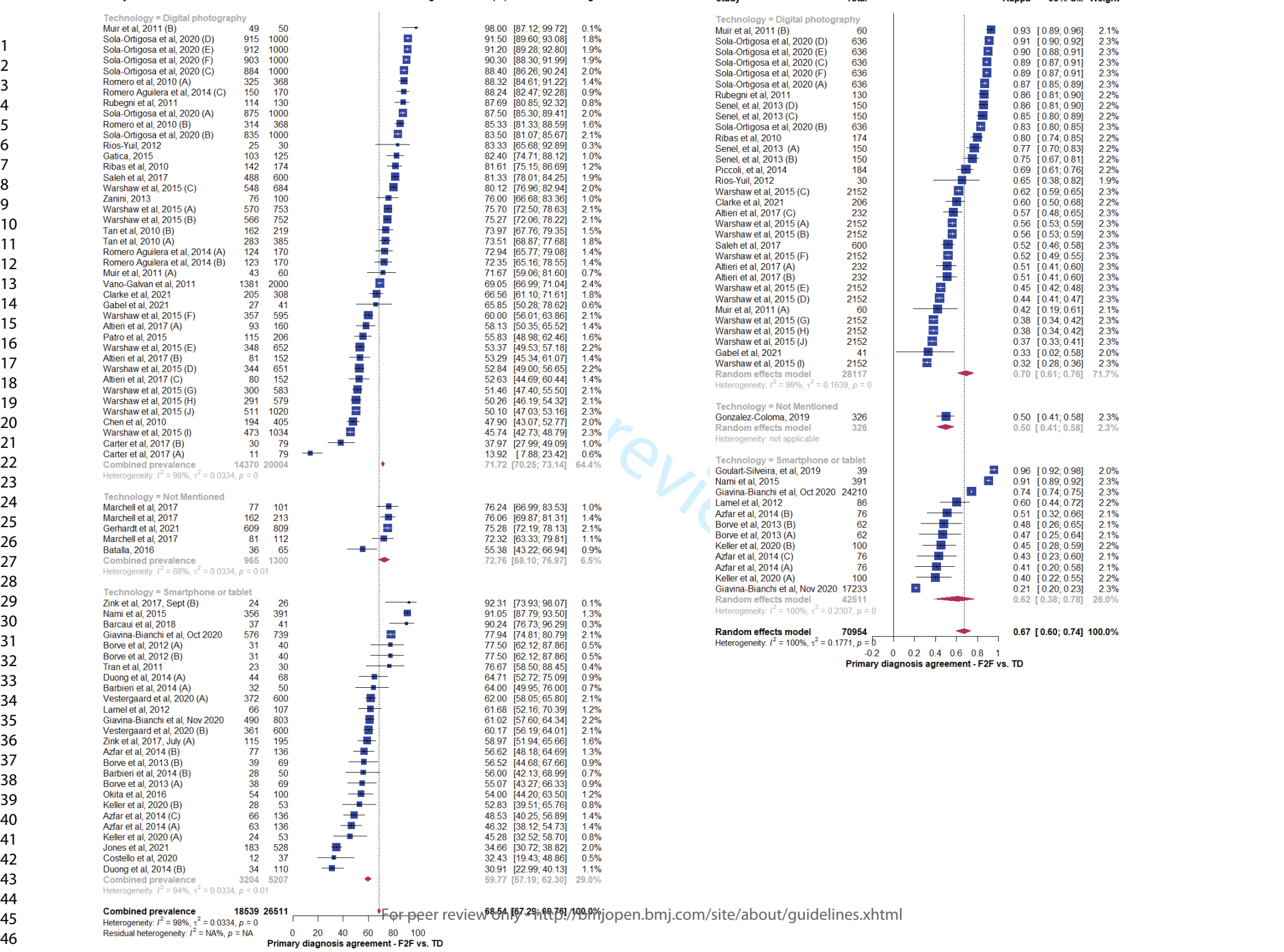
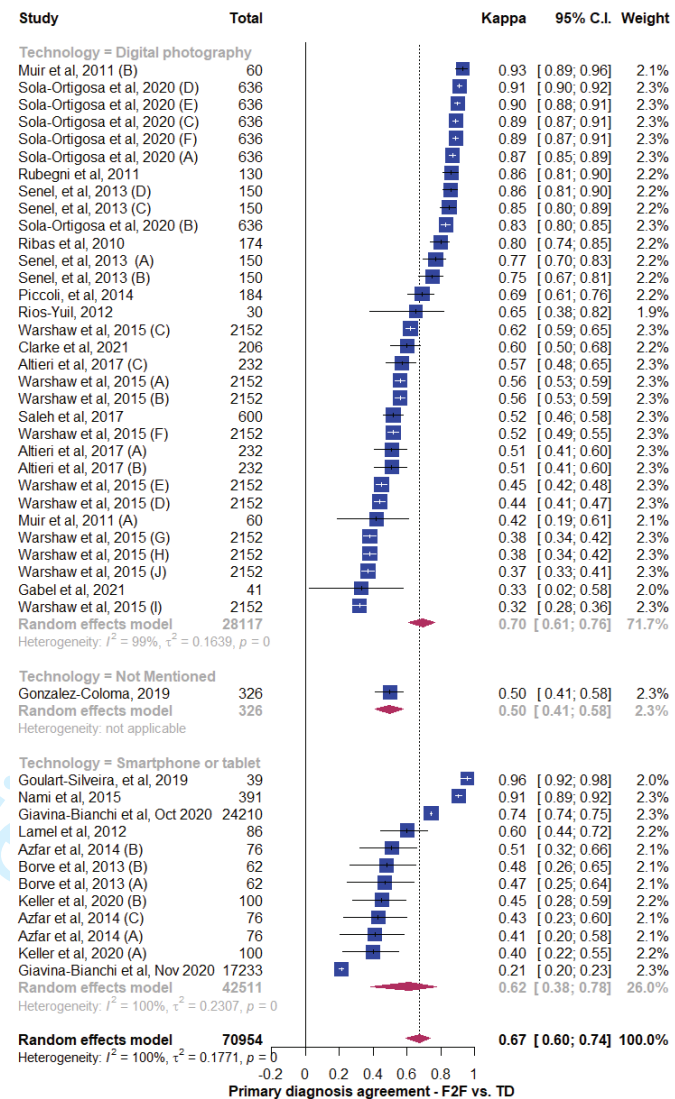
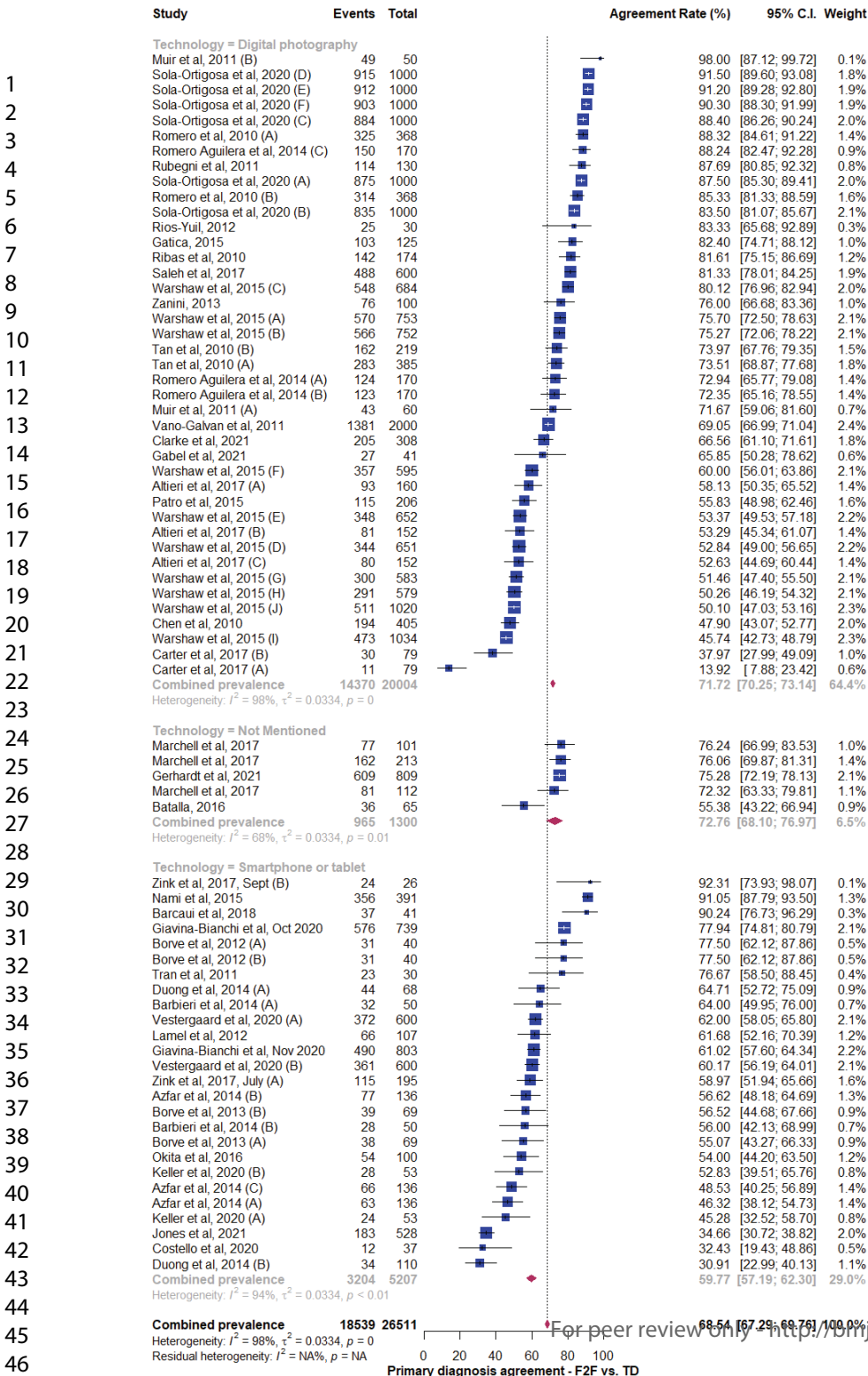


Figure 1. PRISMA Flow diagram of study selection.





For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>



Primary diagnosis agreement - F2F vs. TD

Primary diagnosis agreement - F2F vs. TD

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>



## Supplementary Online Content

**Title:** Diagnostic Reliability in Teledermatology: A Systematic Review and Meta-Analysis

### Authors

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## Supplementary eMethods

### Search Strategy

The search strategy was written for Ovid Medline and translated using each database's syntax, controlled vocabulary, and search fields. MeSH terms, Emtree terms, and free text words were used for teledermatology and skin conditions such as melanoma and related synonyms. To identify additional articles not captured through the aforementioned search, a manual search was conducted via reference search of the included studies.

All database records were downloaded to EndNote X9 (Clarivate) and uploaded to web-based software for deduplication, screening, and full-text evaluation (Covidence; Veritas Health Innovation). We contacted three study authors to gain access to their published work.<sup>1-3</sup> The search strategy is available below.

### Ovid MEDLINE Search

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations and Daily <1946 to 2022 May 02>

1	e consult*.mp.	322
2	econsult*.mp.	218
3	electronic consult*.mp.	366
4	e health.mp.	4095
5	ehealth.mp.	6823
6	e visit*.mp.	88
7	evisit*.mp.	26
8	home video visit*.mp.	4
9	internet/ or internet-based intervention/	82046
10	internet.mp.	128675
11	offsite care.mp.	4
12	off site care.mp.	9
13	ontario telemedicine network.mp.	19
14	Remote Consultation/	5689
15	remote consultation*.mp.	6406
16	remote visit*.mp.	95
17	tele care.mp.	40
18	telecare.mp.	945
19	tele consult*.mp.	208
20	teleconsult*.mp.	2208
21	tele diagnos*.mp.	46
22	telehealth.mp.	13222
23	tele health.mp.	287
24	telemedicine/	36763
25	telemedicine.mp.	47751
26	tele medicine.mp.	197
27	telemonitor*.mp.	2380
28	tele monitor*.mp.	209
29	Telepathology/	918
30	telepatholog*.mp.	1223
31	tele patholog*.mp.	25
32	telepractice*.mp.	276
33	tele practice*.mp.	16
34	Therapy, Computer-Assisted/	6969
35	video consult*.mp.	827
36	videoconsult*.mp.	41
37	virtual care.mp.	1177
38	web based.mp.	42402
39	Telepathology/	918

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3 77 40 or/1-39 216985  
4 78 41 Dermatology/21077  
5 79 42 dermatolog\*.mp. 110593  
6 80 43 dermatopatholog\*.mp. 2990  
7 81 44 exp Skin Diseases/di [Diagnosis] 196739  
8 82 45 exp Skin Neoplasms/ 142454  
9 83 46 skin.mp. 880457  
10 84 47 exp Skin Abnormalities/ 34228  
11 85 48 burns/ or burns, chemical/ or burns, electric/ or sunburn/ 59533  
12 86 49 burn\*.mp. 141877  
13 87 50 wound healing/ or cicatrix/ 127484  
14 88 51 wound\*.mp. 446154  
15 89 52 or/41-51 1580012  
16 90 53 40 and 52 7160  
17 91 54 teledermatolog\*.mp. 1273  
18 92 55 tele dermatolog\*.mp. 35  
19 93 56 54 or 55 1298  
20 94 57 53 or 56 7448  
21 95 58 limit 57 to dt=20100101-20220501 [January 1st, 2010 to May 1st, 2022] 4972  
22 96  
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### Embase Search

24 99 Embase Classic+Embase <1947 to 2021 July 15>  
25 100 1 computer assisted therapy/ 4772  
26 101 2 e consult\*.mp. 411  
27 102 3 econsult\*.mp. 283  
28 103 4 electronic consult\*.mp. 461  
29 104 5 e health.mp. 4440  
30 105 6 ehealth.mp. 5099  
31 106 7 e visit\*.mp. 83  
32 107 8 evisit\*.mp. 30  
33 108 9 home video visit\*.mp. 10  
34 109 10 internet/ or web-based intervention/ 114861  
35 110 11 internet.mp. 143810  
36 111 12 offsite care.mp. 5  
37 112 13 off site care.mp. 12  
38 113 14 ontario telemedicine network.mp. 36  
39 114 15 remote consultation\*.mp. 808  
40 115 16 remote visit\*.mp. 79  
41 116 17 tele care.mp. 55  
42 117 18 telecare.mp. 983  
43 118 19 teleconsultation/ 11686  
44 119 20 tele consult\*.mp. 243  
45 120 21 teleconsult\*.mp. 12352  
46 121 22 tele diagnos\*.mp. 53  
47 122 23 telehealth.mp. 15276  
48 123 24 tele health.mp. 389  
49 124 25 telemedicine/ 31867  
50 125 26 telemedicine.mp. 38951  
51 126 27 tele medicine.mp. 333  
52 127 28 telemonitor\*.mp. 4838  
53 128 29 tele monitor\*.mp. 344  
54 129 30 Telepathology/ 869  
55 130 31 telepatholog\*.mp. 1265  
56 131 32 tele patholog\*.mp. 41  
57 132 33 telepractice\*.mp. 162

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3 133 34 tele practice\*.mp. 9  
4 134 35 video consult\*.mp. 751  
5 135 36 videoconsult\*.mp. 54  
6 136 37 virtual care.mp. 496  
7 137 38 web based.mp. 49157  
8 138 39 or/1-38 240118  
9 139 40 dermatology/ or cosmetic dermatology/ or pediatric dermatology/ or psychodermatology/ 51419  
10 140 41 dermatolog\*.mp. 161210  
11 141 42 dermatopatholog\*.mp. 3737  
12 142 43 burn/ or burn contracture/ or electric burn/ or face burn/ or hand burn/ or ionizing radiation burn/ or scald/ or  
13 143 sunburn/ 74890  
14 144 44 burn\*.mp. 189010  
15 145 45 exp skin disease/di [Diagnosis] 209136  
16 146 46 exp skin tumor/ 213775  
17 147 47 skin\*.mp. 1294867  
18 148 48 or/40-47 1665263  
19 149 49 39 and 48 7063  
20 150 50 teledermatology/ 1295  
21 151 51 tele dermatolog\*.mp. 42  
22 152 52 teledermatolog\*.mp. 1798  
23 153 53 50 or 51 or 52 1812  
24 154 54 49 or 53 8004  
25 155 55 limit 54 to (books or chapter or conference abstract or conference paper or "conference review") 1828  
26 156 56 54 not 55 6176  
27 157 57 limit 56 to yr="2010 -Current" 4505  
28 158

### 28 159 Cochrane Search

29 160 EBM Reviews - Cochrane Database of Systematic Reviews <2005 to July 14, 2021> EBM Reviews - ACP Journal  
30 161 Club <1991 to June 2021> EBM Reviews - Database of Abstracts of Reviews of Effects <1st Quarter 2016> EBM  
31 162 Reviews - Cochrane Clinical Answers <June 2021> EBM Reviews - Cochrane Central Register of Controlled Trials  
32 163 <June 2021> EBM Reviews - Cochrane Methodology Register <3rd Quarter 2012> EBM Reviews - Health  
33 164 Technology Assessment <4th Quarter 2016> EBM Reviews - NHS Economic Evaluation Database <1st Quarter  
34 165 2016>  
35 166 1 e consult\*.mp. 44  
36 167 2 econsult\*.mp. 22  
37 168 3 electronic consult\*.mp. 29  
38 169 4 e health.mp. 617  
39 170 5 ehealth.mp. 766  
40 171 6 e visit\*.mp. 14  
41 172 7 evisit\*.mp. 1  
42 173 8 home video visit\*.mp. 3  
43 174 9 internet/ or internet-based intervention/ 4,275  
44 175 10 internet.mp. 15,059  
45 176 11 offsite care.mp. 2  
46 177 12 off site care.mp. 2  
47 178 13 ontario telemedicine network.mp. 7  
48 179 14 Remote Consultation/ 460  
49 180 15 remote consultation\*.mp. 551  
50 181 16 remote visit\*.mp. 17  
51 182 17 tele care.mp. 34  
52 183 18 telecare.mp. 249  
53 184 19 tele consult\*.mp. 59  
54 185 20 teleconsult\*.mp. 822  
55 186 21 tele diagnos\*.mp. 4  
56 187 22 telehealth.mp. 2,308  
57 188 23 tele health.mp. 128

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3	189	24 telemedicine/	2,617
4	190	25 telemedicine.mp.	4,819
5	191	26 tele medicine.mp.	57
6	192	27 telemonitor*.mp.	1,236
7	193	28 tele monitor*.mp.	115
8	194	29 Telepathology/	8
9	195	30 telepatholog*.mp.	22
10	196	31 tele patholog*.mp.	2
11	197	32 telepractice*.mp.	37
12	198	33 tele practice*.mp.	0
13	199	34 Therapy, Computer-Assisted/	1,391
14	200	35 video consult*.mp.	117
15	201	36 videoconsult*.mp.	8
16	202	37 virtual care.mp.	31
17	203	38 web based.mp.	9,110
18	204	39 Telepathology/	8
19	205	40 or/1-39	29,268
20	206	41 Dermatology/	124
21	207	42 dermatolog*.mp.	10,838
22	208	43 dermatopatholog*.mp.	80
23	209	44 exp Skin Diseases/di [Diagnosis]	630
24	210	45 exp Skin Neoplasms/	1,738
25	211	46 skin.mp.	67,534
26	212	47 exp Skin Abnormalities/	269
27	213	48 burns/ or burns, chemical/ or burns, electric/ or sunburn/	1,779
28	214	49 burn*.mp.	12,780
29	215	50 wound healing/ or cicatrix/	5,677
30	216	51 wound*.mp.	35,982
31	217	52 or/41-51	110,390
32	218	53 40 and 52	1,622
33	219	54 teledermatolog*.mp.	149
34	220	55 tele dermatolog*.mp.	20
35	221	56 54 or 55	151
36	222	57 53 or 56	1,684
37	223	58 limit 57 to yr="2010 -Current"	1,377
38	224		

### 225 CINAHL Search

226 Searched keyword teledermatology and set limit to yr="2010-Current" 357

### 228 MedRxiv Search

229 Searched keyword teledermatology and set limit to yr="2010-Current" 13

### 231 Eligibility Criteria

232 Inclusion and exclusion criteria are summarized in **eTable 2**.

### 234 Data Selection and Extraction

235 Information extracted from full-text articles is summarized in **eTable 3**.

### 237 Data Analysis and Synthesis

238 In this study, a letter was assigned to each unique study grouping as explained in **eTable 4**. For both the percentage  
239 of agreement and kappa values, forest plots, the  $I^2$  index, and the  $\tau^2$  statistic were used in combination to investigate  
240 statistical heterogeneity.

241  
242 Cohen's kappa values for diagnostic concordance between teledermatology and F2F physicians were interpreted based  
243 on the following criteria.<sup>4</sup> Values between 0–.20 indicate no agreement, .21–.39 minimal agreement, .40–.59 weak  
244 agreement, .60–.79 moderate agreement, .80–.90 strong agreement, and above .90 almost perfect agreement.

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4 246 Sub-group analysis included different skin conditions, specialization of the F2F physician, whether staff were trained  
5 247 on image acquisition, the technology used for image acquisition, the use of teledermoscopy, studies conducted pre- or  
6 248 post-pandemic, and the risk of bias. Confounding factors, such as technology type, year of publication, and training  
7 249 of study raters, were controlled using meta-regression.

8 250  
9 251 Proportions meta-analysis looked at weighted averages, and 95% confidence intervals were reported. Publication bias  
10 252 was not statistically pursued due to the substantial heterogeneity observed, in addition to the authors' decision to pursue  
11 253 a meta-analysis of proportions.

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For peer review only

## 254 Supplementary eResults

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256 Our analysis incorporated forty-four relevant studies. Key study and participant details are summarized in **eTable 1**,  
257 with a concise overview provided in the main text. Articles excluded based on our criteria are listed in **eTable 5**.

258

### 259 Diagnostic reliability of teledermatology when compared to F2F (specialist and non-specialists) evaluation

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261 Of the 40 studies that reported diagnostic agreement rates there were 72 unique comparisons made between F2F and  
262 teledermatology.<sup>5-44</sup> **eFigure 1A** shows that the mean percentage agreement of 68.9% (CI 64.4%-73.1%) ranged from  
263 14% to 98%, where 35/72 had percentage agreement above 70% and 7 studies had over 90% agreement. The studies  
264 were heterogeneous ( $I^2=98%$ ,  $p < 0$ ).

265

266 Of the 21 studies that reported concordance values, there were 45 unique comparisons made.<sup>5 6 11 14 17 20-25 28 29 32-34 45-</sup>

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268 <sup>49</sup> **eFigure 1B** shows that the mean diagnostic concordance of 0.67 (CI 0.60 to 0.74) ranged from 0.213 (CI 0.20 to  
269 0.23) to 0.96 (CI 0.92 to 0.98), with 21 studies (47%) having moderate agreement ( $k=0.6$  and above), and 13 (29%)  
270 studies having strong agreement. The studies were heterogeneous ( $I^2=100%$ ,  $p < 0.001$ ).

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### 272 Diagnostic agreement between teledermatologist and teledermatologist, F2F and F2F, and teledermatology 273 and histopathology

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275 Of the ten studies that reported diagnostic agreement rates between teledermatologists, there were 17 unique comparisons  
276 made between F2F and teledermatology consults. **eFigure 2A** shows the mean percentage agreement of 76.4% (CI  
277 69% to 82.5%) ranged from 37% to 91.5%, with 10/17 having percentage agreement above 70% and two studies  
278 having over 90% agreement. The studies were heterogeneous ( $I^2=97%$ ,  $p < 0.001$ ).

279

280 From four studies that reported diagnostic agreement rates between F2F dermatologists there were 6 unique  
281 comparisons. **eFigure 2B** shows that the mean percentage agreement 82.4% (CI 76.7%-87.0%) ranged from 75.5% to  
282 91%. The studies were heterogeneous ( $I^2=68%$ ,  $p < 0.001$ ).

283

284 Five studies compared teledermatology to histopathology data, and there were six unique comparisons. **eFigure 2C**  
285 shows that the mean percentage agreement of 55.7% (CI 53% to 58.4%) ranged from 53.8% to 65.4%. The mean  
286 agreement rate between histopathology and teledermatology was 55.7% (CI 53.0 to 58.4). The studies were  
287 homogeneous ( $I^2=0%$ ,  $p = 0.49$ ).

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## 289 Subgroup analyses

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### 291 Diagnostic reliability of teledermatology vs F2F specialist and non-specialist

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293 Within the same modality, **eFigure 3A** shows that teledermatologists had a diagnostic agreement rate of 70.96% (CI  
294 69.8% to 72.1%) with F2F dermatologists, while the agreement rate with F2F non-specialists was 44.1% (CI 39.9%  
295 to 48.4%). Comparing teledermatologists to non-specialists showed significantly lower agreement among non-specialists  
296 ( $p < 0.001$ , heterogeneity:  $I^2 = 98%$ ). Among 35 studies reporting diagnostic agreement rates, 44 out of 64  
297 comparisons between teledermatology and F2F dermatologists had a percentage agreement above 60%, with seven  
298 studies reporting over 90% agreement. The mean kappa concordance value for diagnostic agreement between  
299 teledermatology and F2F dermatologists shown in **eFigure 3B** was 0.69 (CI 0.60 to 0.75). Additionally,  
300 teledermatologists had a mean concordance value of 0.52 (CI 0.25 to 0.71) when compared to non-specialists. Non-  
301 specialists showed significantly lower diagnostic concordance compared to dermatologists for F2F vs.  
302 teledermatology ( $p = 0.031$ , heterogeneity:  $I^2 = 100%$ ). Moreover, studies comparing teledermatologists to F2F and  
303 teledermatology to histopathology showed a range of agreement rates, with heterogeneity observed in the former ( $I^2$   
304  $= 97%$ ,  $p < 0.001$ ) and homogeneity in the latter ( $I^2 = 0%$ ,  $p = 0.49$ ).

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### 306 Diagnostic reliability of teledermatology vs F2F by the inclusion of teledermoscopy in both teledermatology 307 and F2F assessments

308

309 Overall, twelve studies with 22 unique comparisons used teledermoscopy for diagnosing suspicious lesions.<sup>8 11 15 29 32</sup>  
310 <sup>34 38 39 42 44</sup> **eFigure 4A** shows that with teledermoscopy, the mean diagnostic agreement rates was 69.1% (CI 66.8% to  
311 71.4%), and this percentage ranged between from 31.6% to 92.3%. Without the use of teledermoscopy, the mean  
312 agreement rate was 68.3% (CI 66.8% to 69.8%). The means were not significantly different between the two groups  
313 and the studies were heterogeneous ( $I^2=97%$ ,  $p < 0.001$ ). **eFigure 4B** shows concordance values of seven studies that

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3 310 adapted teledermoscopy had a mean of 0.71 (CI 0.58 to 0.80).<sup>11 29 32 34 39 47 48</sup> Without teledermoscopy, the mean was  
4 311 0.65 (CI 0.54 to 0.74). This difference was not statistically significant, and the studies were heterogeneous ( $I^2=100\%$ ,  
5 312  $p<0.001$ ).

### 6 313 7 314 **Diagnostic reliability of teledermatology vs F2F by the inclusion of lesion category**

8 315 Twenty-six studies with 39 unique comparisons reporting percentage agreement rates that were inclusive to all lesion  
9 316 types as shown in **eFigure 5A**.<sup>5-10 15-19 22 24-26 28-33 36 37 40 41 43</sup> The mean percentage agreement was 69.9% (CI 67.9% to  
10 317 71.7%) and ranged from 30.9% to 98%, with the majority (26/39) having percentage agreement above 60% and 4  
11 318 studies having over 90%. Eleven studies only looked at suspicious lesions,<sup>11 12 14 20 23 34 35 38 39 42 44</sup> and the mean  
12 319 percentage agreement was 68.1% (CI 66.3% to 69.8%). Three studies excluded skin cancers<sup>13 21 27</sup> and the mean  
13 320 percentage agreement was 62.2% (CI 56.2% to 67.8%). No statistical significance could be identified between the  
14 321 three lesion groups and the studies were heterogeneous ( $I^2=98\%$ ,  $p<0.001$ ).

15 322  
16 323 Concordance values for studies inclusive to all lesions seen in **eFigure 5B** were reported in ten studies with a mean  
17 324 of 0.62 (CI 0.48 to 0.74).<sup>5 6 17 22 24 25 28 29 32 33</sup> Six studies that looked at cancerous skin lesions only reported a mean of  
18 325 0.70 (CI 0.59 to 0.78).<sup>11 14 20 23 34 39</sup> Only one study that looked at all lesions except cancerous ones reported a  
19 326 concordance value.<sup>22</sup> No statistical significance could be identified between the three lesion groups and the studies  
20 327 were heterogeneous ( $I^2=100\%$ ,  $p<0.001$ ).

### 21 328 22 329 23 330 **Diagnostic reliability of teledermatology vs F2F by pre- and post-pandemic timelines**

24 331 When comparing teledermatologists to all F2F physicians, the average agreement rate was 65.5% (CI 64.0-66.9) for pre-  
25 332 pandemic studies, and 75.3% (CI 73.4% to 77.2%) for studies published after January 2020. When the percentage  
26 333 agreements were compared between the two groups, they were not statistically significant ( $p = 0.421$ ) and also  
27 334 heterogeneous ( $I^2=98\%$ ,  $p<0.001$ ). eTable not included.

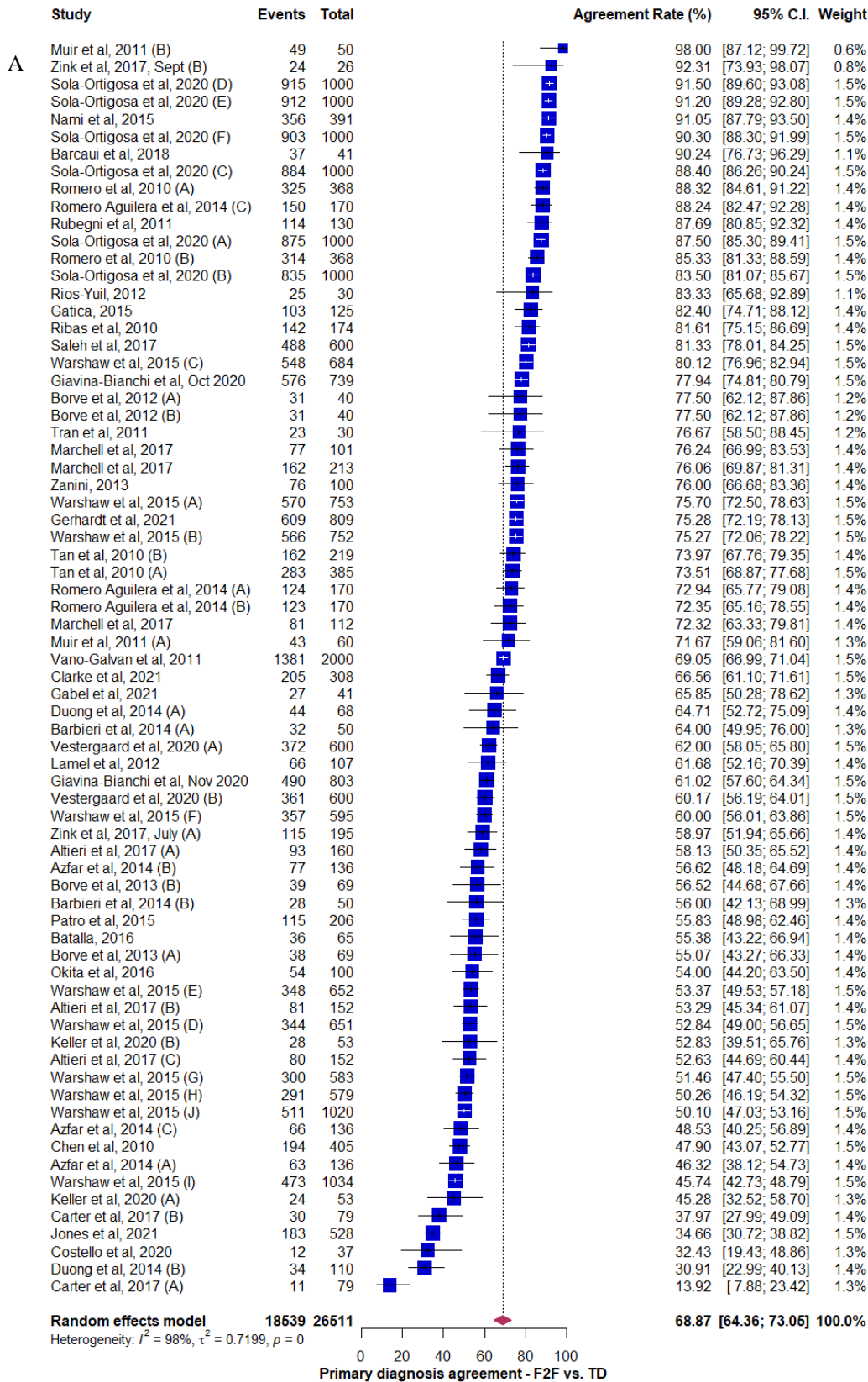
### 28 335 29 336 30 337 **Risk of bias and quality assessment**

31 338 The QUADAS-2 framework was utilized to evaluate bias and applicability across four essential domains, ensuring  
32 339 that our conclusions are both accurate and applicable to real-life clinical situations. **eTable 6A** summarizes the  
33 340 QUADAS-2 criteria tailored to this study.

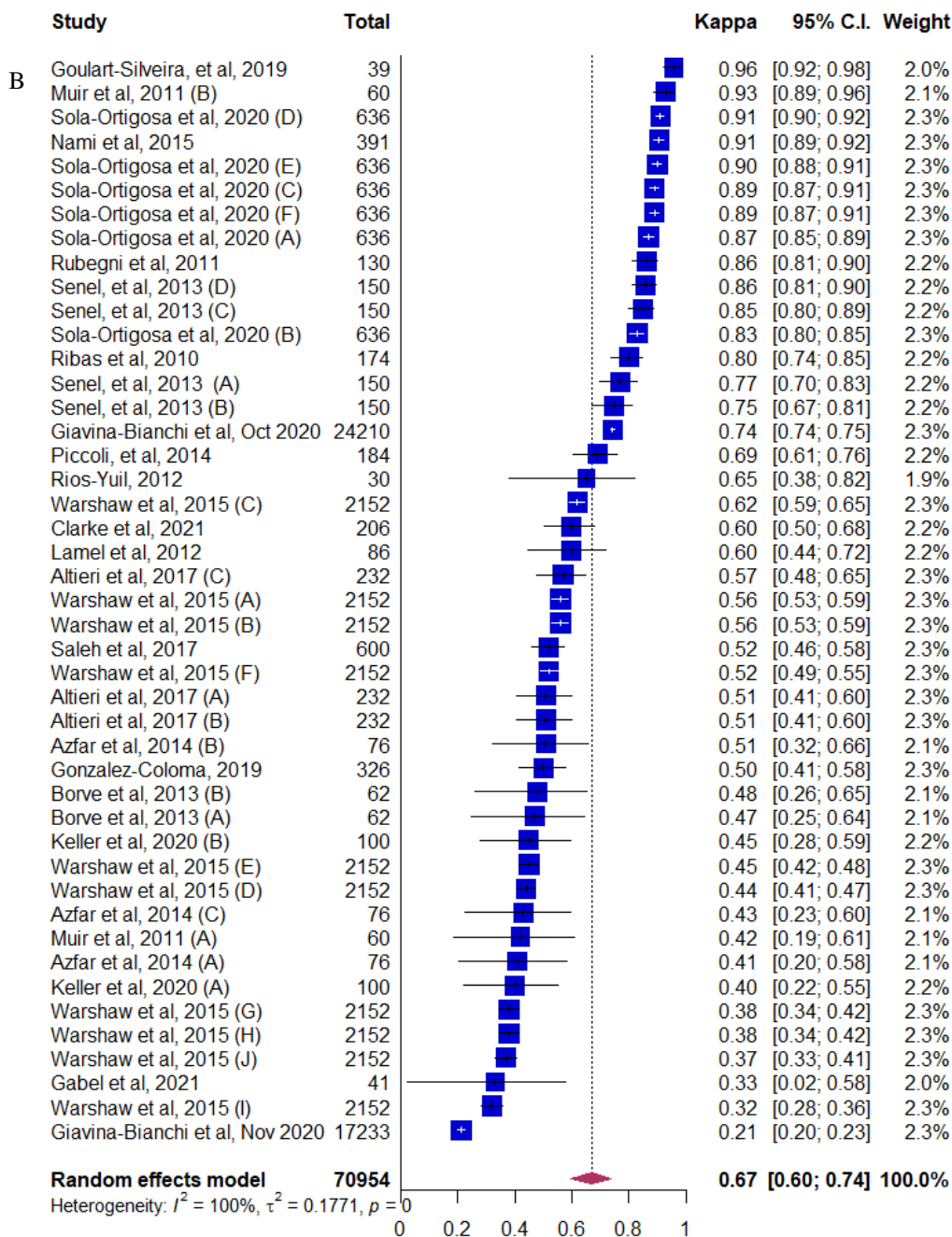
34 341  
35 342 The results of quality assessment for risk of bias and applicability in individual studies are displayed in **eTable 6B-**  
36 343 **E**. Six of the studies had low risk of bias, nine had moderate risk, and 29 had high-risk of bias. There were no  
37 344 systematic differences between the results of studies that attempted to reduce risk of bias, compared with those with  
38 345 higher risk of bias. The mean diagnostic agreement rate between F2F and teledermatology was 66.4% (CI 62.4% to  
39 346 70.1%) for low risk, and 69.1% (CI 67.6% to 70.6%) for high risk ( $p = 0.932$ ). When the percentage agreements were  
40 347 compared between groups, they were heterogeneous ( $I^2=98\%$ ,  $p<0.001$ ). eTable not included.



348 **Supplementary eFigures and Legends**



349



**eFigure 1. Forest plot representing F2F and teledermatology primary diagnostic agreement.** (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 40 studies with a total of 72 unique number of comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology or Teledermatologist).

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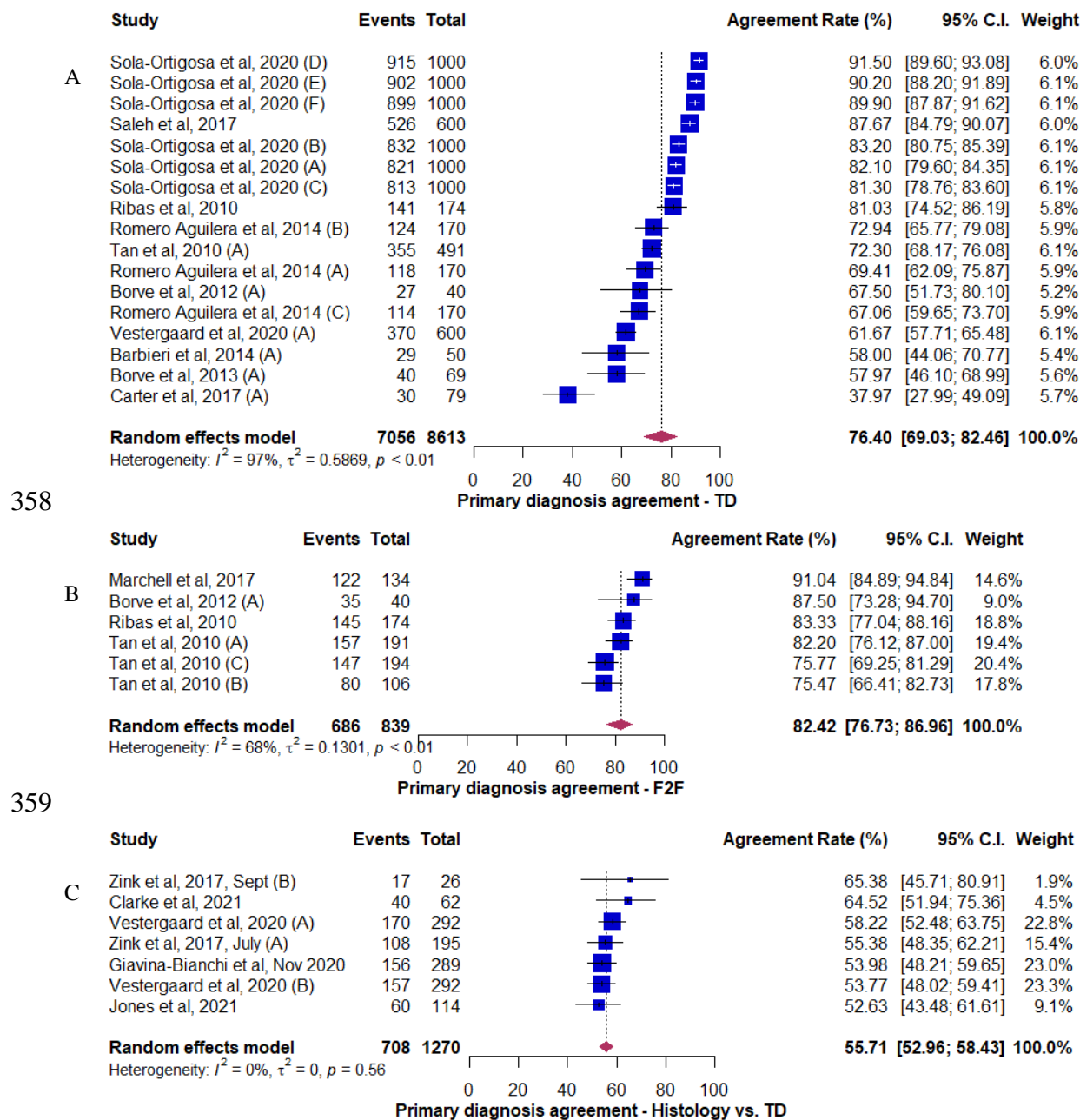
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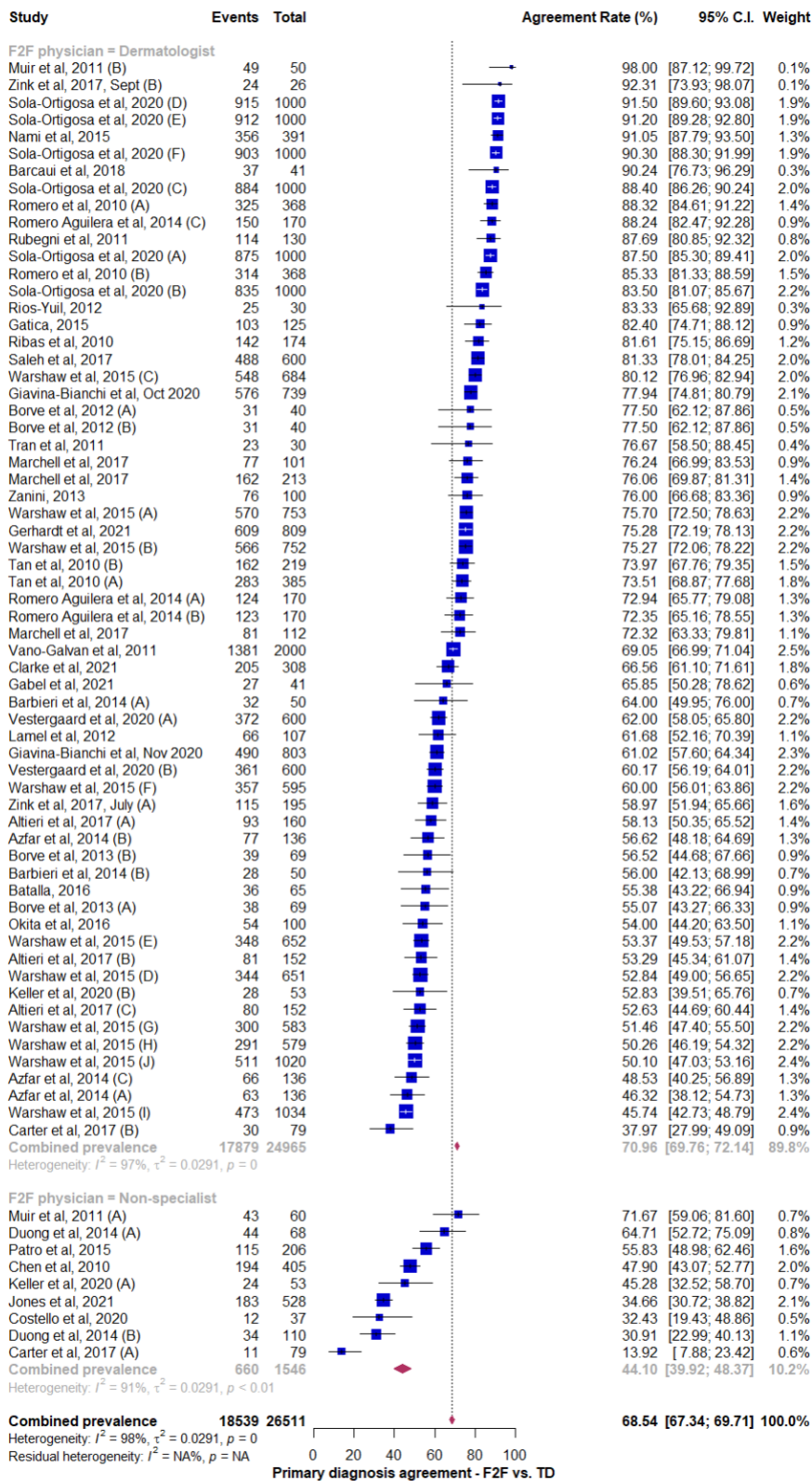
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**360**  
**361** **eFigure 2. Forest plot representing teledermatologists, F2F physicians, and histopathology primary diagnostic**  
**362** **agreements.** (A) Forest plot representing percentage agreement between teledermatologist and teledermatologist and  
**363** 95% C.I. for overall concordance across ten studies with a total of 17 unique number of comparisons, N of events and  
**364** total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance  
**365** between two F2F physician diagnoses across four studies with a total of six unique number of comparisons, N of total  
**366** included participants. (C) Forest plot representing percentage agreement between teledermatologists and  
**367** histopathology with 95% C.I. for overall concordance across six studies, N of events and total included participants.  
**368** Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology or Teledermatologist).  
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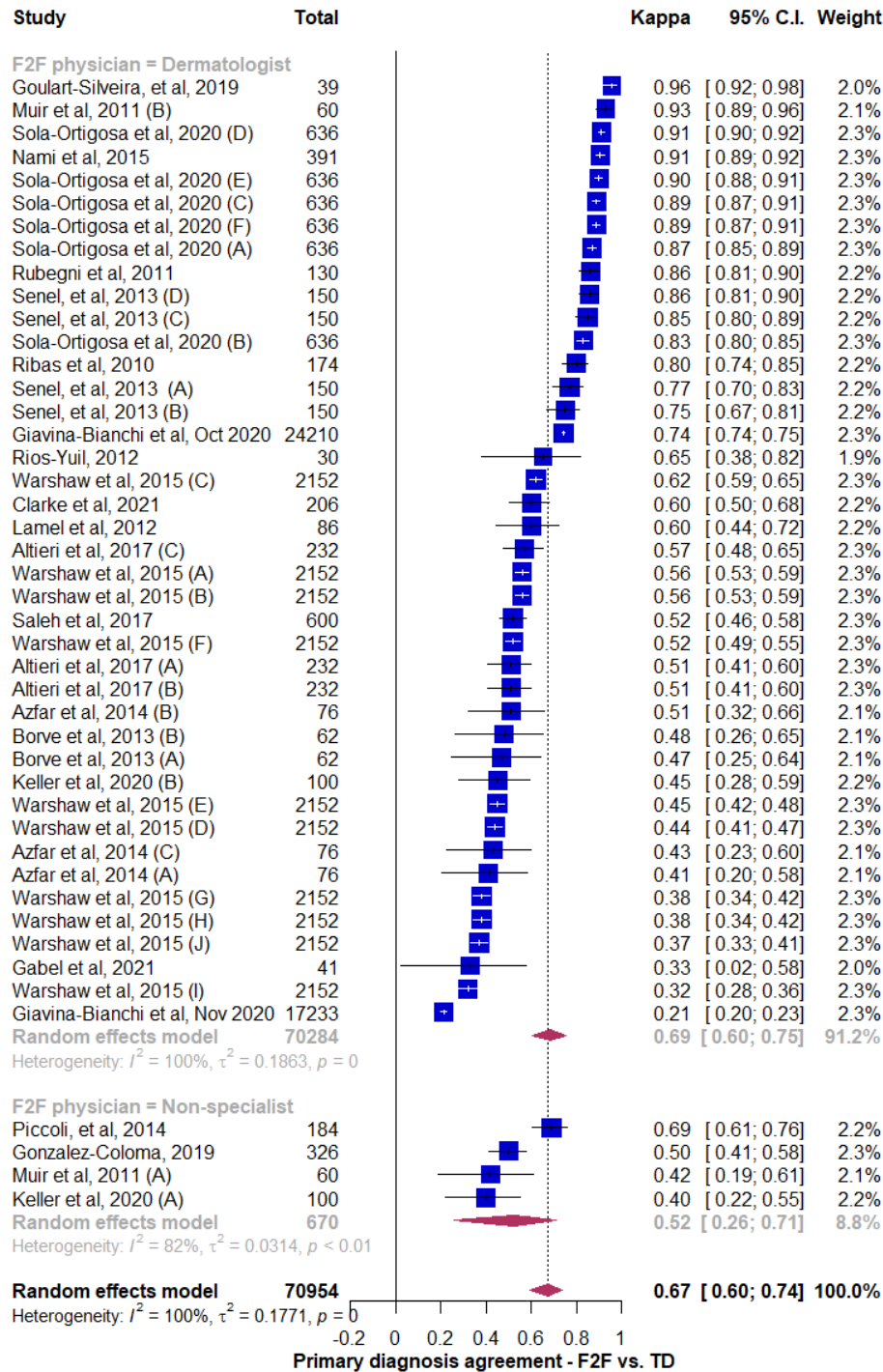


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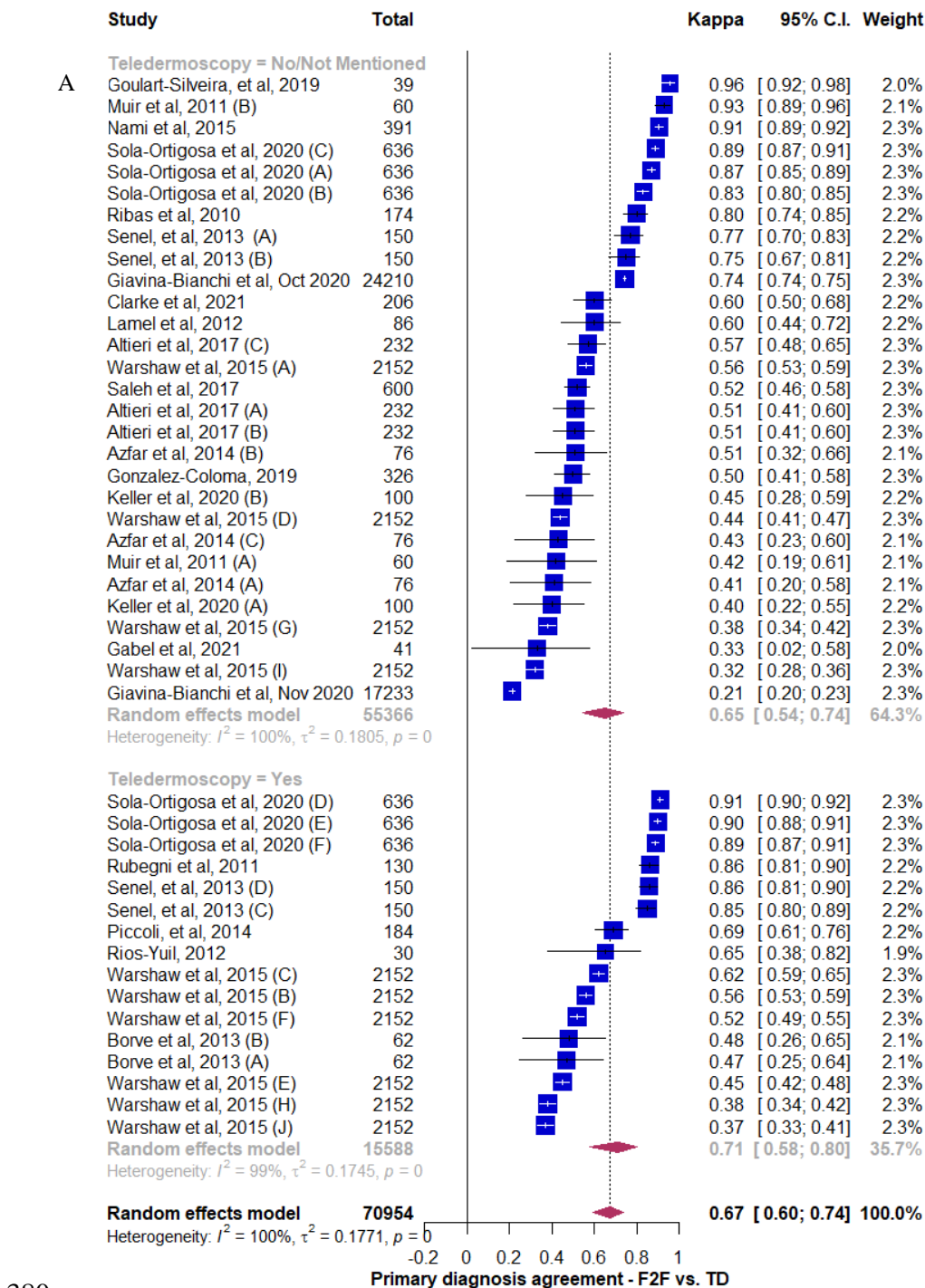


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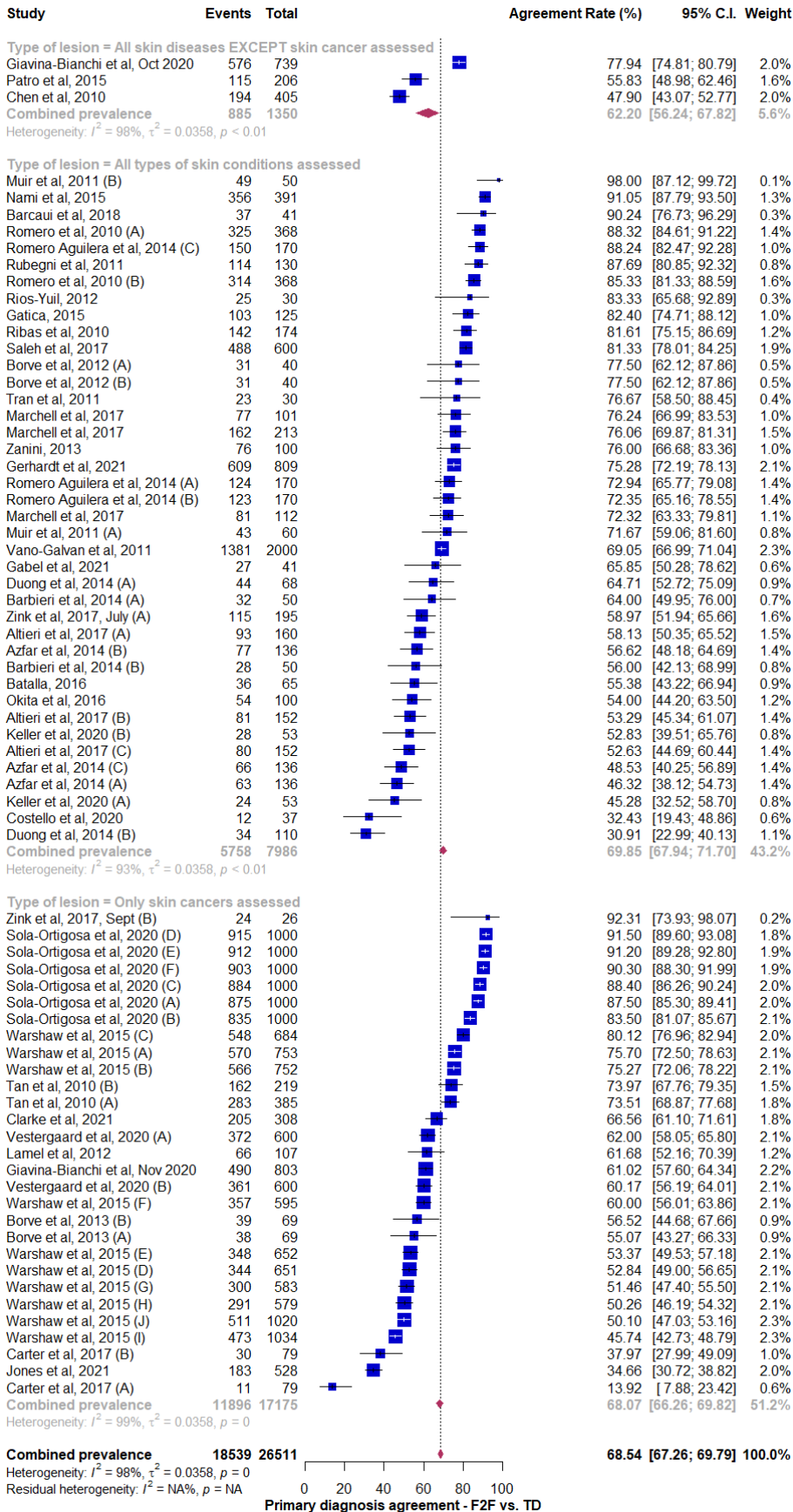


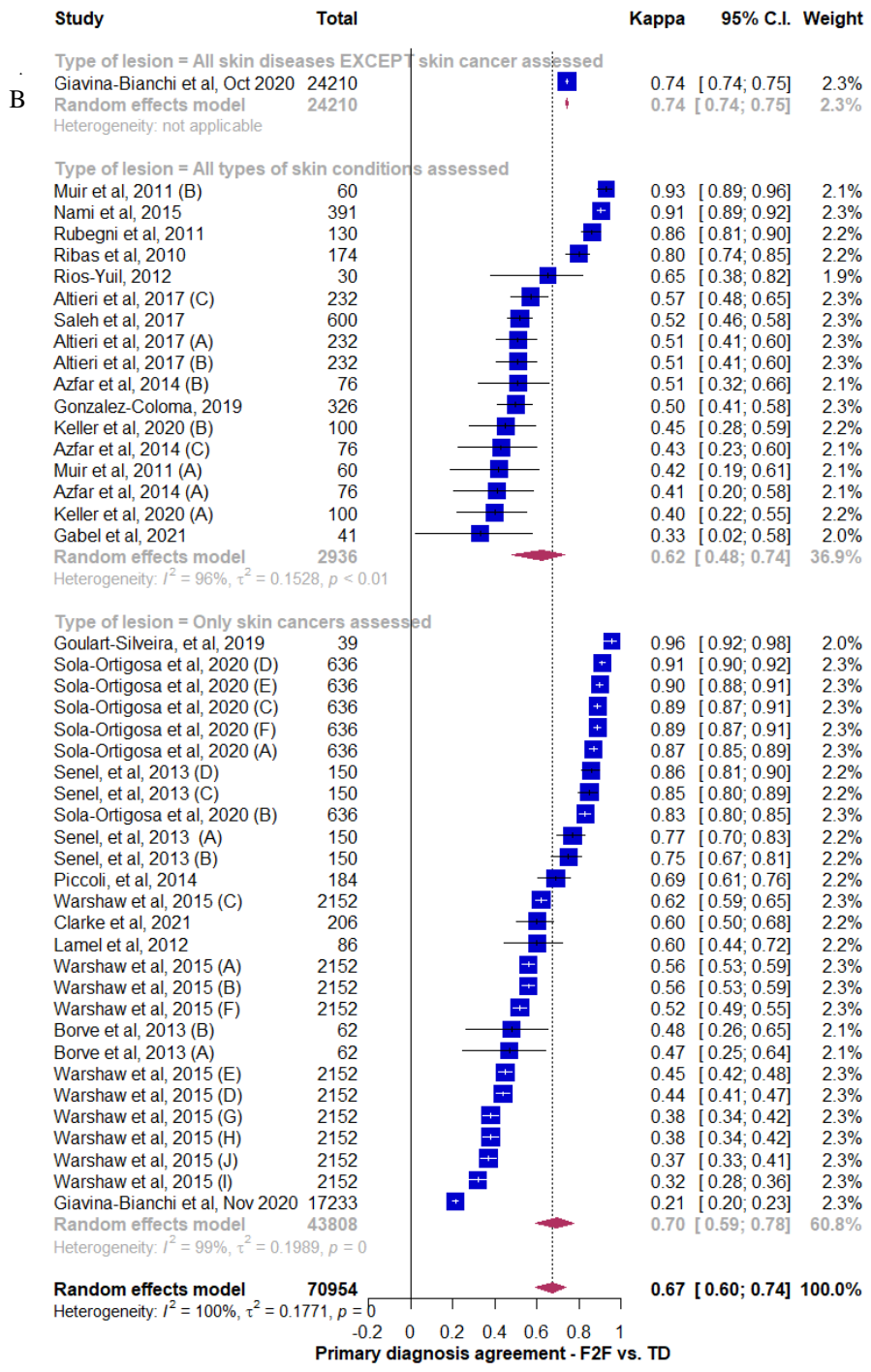
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 372 **eFigure 3. Forest plot representing F2F and teledermatology primary diagnostic agreement by specialization**  
 373 **status of the F2F physician.** Studies were sorted into two groups, a) F2F diagnosis completed by a board-certified  
 374 dermatologist; b) F2F diagnosis completed by a non-specialist (e.g., general practitioner). (A) Forest plot representing  
 375 percentage agreement and 95% C.I. for overall concordance across 40 studies with a total of 72 unique number of  
 376 comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95%  
 377 C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included

378 participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology or  
 379 Teledermatologist).



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 381 **eFigure 4. Forest plot representing F2F and teledermatology primary diagnostic agreement by utilization of**  
 382 **teledermoscopy.** Studies were sorted into two groups, i) Did not use or did not report the use of teledermoscopy; ii)  
 383 Used teledermoscopy. (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across  
 384 12 studies with a total of 22 unique number of comparisons, N of events and total included participants. (B) Forest  
 385 plot representing kappa concordance and 95% C.I. for overall concordance across seven studies with a total of 16  
 386 unique number of comparisons, N of total included participants. Abbreviations: F2F (Face-to-Face), PCP (Primary  
 387 Care Provider), TD (Teledermatology or Teledermatologist).





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**eFigure 5. Forest plot representing F2F and teledermatology primary diagnostic agreement by skin lesion category.** Studies were sorted into three groups according to the type of lesions included, i) All skin conditions except likely malignant lesions; ii) All skin conditions; iii) Likely malignant lesions only. (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 26 studies with a total of 39 unique number of comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across ten studies with a total of 27 unique number of comparisons, N of total included participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology or Teledermatologist).



Author, Year	Study design	Country	Funding reported	Intervention	*Outcome	Patients (n)	Female (%)	Mean Age (y)	Lesions (N)	
<b>TD vs F2F Dermatologist</b>										
Altieri, et al, 2017	Prospective Cohort	USA	Y	TD and F2F dermatologists via clinical images taken by digital photography	Diagnostic agreement rate, Concordance	232	N/A	NA	232	
Azfar, et al, 2014	Prospective Cohort	USA, Botswana	N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate, Concordance	76	57	39	159	
Barbieri, et al, 2014	Prospective Cohort	USA	N	TD and F2F dermatologists via smartphone images using the AccessDerm smartphone platform	Diagnostic agreement rate	50	64	55.2	50	
Barcaui, et al, 2018	Prospective Cohort	Brazil	N	TD and F2F consult by the same dermatologist via digital photography and dermoscopy images stored in WhatsApp	Diagnostic agreement rate	31	71	56.5	41	
Batalla, 2015	Retrospective Cohort	Spain	N	TD and F2F dermatologists by via clinical images	Diagnostic agreement rate	183	66	9	65	
Borve, et al, 2012	Prospective Cohort	Sweden	Y	TD and F2F consults by the same dermatologist via smartphone images stored in Tele-Dermis	Diagnostic agreement rate	40	57.5	49	40	
Gabel, et al, 2021	Prospective Cohort	USA	Y	TD and F2F dermatologists via clinical images taken by digital photography and tablets	Diagnostic agreement rate, Concordance	41	N/A	N/A	41	
Gatica, et al, 2015	Prospective Cohort	Chile	N	TD and F2F dermatologists via clinical images taken by digital photography	Diagnostic agreement rate	125	57.6	37.7	125	
Gerhardt, et al, 2021	Observational	USA	Y	TD and F2F dermatologists via clinical images	Diagnostic agreement rate	809	N/A	N/A	809	
Keller, et al, 2020	Prospective Cohort	USA	Y	TD and F2F dermatologists or hospitalists on clinical images taken by smartphones and tablets	Diagnostic agreement rate, Concordance	100	43.2	N/A	100	
Marchell, et al., 2017	Quasi RCT	USA	Y	TD and F2F dermatologists via digital photography, compressed and uncompressed video	Diagnostic agreement rate (SFTD, video)	216	N/A	N/A	216	
Muir, et al, 2011	Prospective Cohort	Australia	N	TD and F2F emergency derms and non-specialists via clinical images taken by digital photography	Diagnostic agreement rate, Concordance	50	65	47	50	
Nami, et al, 2015	Prospective Cohort	Italy and Austria	Y	TD and F2F dermatologists via smartphone images stored in MugDerma	Diagnostic agreement rate, Concordance	391	52.2	54	391	
Okita, et al, 2016	Prospective Cohort	Brazil	N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate	100	N/A	N/A	100	
Ribas, et al, 2010	Prospective Cohort	Brazil	Y	TD and F2F dermatologists via digital photography	Diagnostic agreement rate, Concordance	174	53.4	34.7	174	
Rios-Yuil, 2011	RCT	Panama	N	TD and F2F dermatologists via clinical images taken by digital photography for case conferences	Diagnostic agreement rate, Concordance	30	63.3	N/A	30	
Romero Aguilera, et al, 2014	Prospective Cohort	Spain	Y	TD and F2F dermatologists via clinical images taken by digital photography stored in DERMARED. Some patients were seen by the same derm for F2F and TD.	Diagnostic agreement rate	457	56%	36	170	
Romero, et al, 2010	RCT	Spain	Y	TD and F2F consults by the same dermatologist via digital photography and videoconferences via DERMARED software	Diagnostic agreement rate	328	56%	36	510	
Rubegni, et al, 2011	Prospective Cohort	Italy	N	TD and F2F dermatologists via digital photography and dermoscopy images stored in Dermo-image.	Diagnostic agreement rate, Concordance	130	53.9	80.6	130	
Saleh, et al, 2017	Prospective Cohort	Egypt	Y	TD and F2F dermatologists via clinical images taken by digital photography stored in Dropbox	Diagnostic agreement rate, Concordance	600	50.7	N/A	600	
Tran, et al, 2011	Prospective Cohort	Egypt	Y	TD and F2F dermatologists via smartphone images stored in ClickDoc	Diagnostic agreement rate	30	N/A	N/A	30	
Vano-Galvan, et al, 2010	Retrospective, Cross-sectional	Spain	N	TD and F2F dermatologists via clinical images taken by digital photography for case conferences	Diagnostic agreement rate, 100 patients each analyzed by 20 observers	100	N/A	N/A	100	
Zanini, 2013	Prospective Cohort	Brazil	N	TD and F2F dermatologists via clinical images taken by digital photography	Diagnostic agreement rate	100	N/A	N/A	100	
Zink, et al, 2017, July	Prospective Cohort	Germany	Y	TD and F2F dermatologists via smartphone images stored in the KLARA app	Diagnostic agreement rate	195	20.5	N/A	195	

All lesions

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Borve, et al, 2013	Prospective Cohort	Sweden	Y	TD and F2F consults by the same dermatologist via smartphone and dermoscopy images stored in iDoc 24 app	Diagnostic agreement rate, Concordance	62	38.7	64	64	Skin cancers only																																				
Carter, et al, 2017	Prospective, retrospective cohort	USA	Y	TD and F2F dermatologists, as well as F2F PCP via clinical images stored using Epic EHR software	Diagnostic agreement rate	79	74	47	79																																					
Clarke, et al, 2021	Prospective Cohort	USA	Y	TD and F2F dermatologists via clinical images taken by digital photography stored in Research Electronic Data Capture	Diagnostic agreement rate, Concordance	206	49.5	56.9	308																																					
Giavina-Bianchi, et al, 2020 Nov	Retrospective Cohort	Brazil	N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate, Concordance	17,233	71.4	N/A	803																																					
Goulart-Silveira et al, 2019	Prospective Cohort	Brazil	N	TD and F2F dermatologists via smartphone images acquired and stored via Telederma app	Concordance	39	69	68	39																																					
Lamel, et al, 2012	Prospective Cohort	USA	N	TD and F2F dermatologists via smartphone images stored in ClickDerm	Diagnostic agreement rate, Concordance	86	58.1	45.2	107																																					
Senel, et al, 2013	Prospective Cohort	Turkey	N	TD and F2F dermatologists via digital photography and dermoscopy images	Concordance with and without dermoscopy	150	49	55	150																																					
Sola-Ortigosa, et al, 2020	Prospective Cohort	Spain	N	TD and F2F consults by the same dermatologist via dermoscopy and clinical images taken by digital photography and tablets	Diagnostic agreement rate, Concordance	636	43.2	72.8	1,000																																					
Tan, et al, 2010	Prospective Cohort	New Zealand	Y	TD and F2F consults by the same dermatologist via digital photography	Diagnostic agreement rate	200	63	N/A	491																																					
Vestergaard, et al, 2020	Prospective Cohort	Denmark	N	TD and F2F dermatologists via smartphone and dermoscopy images using FotoFinder Systems	Diagnostic agreement rate, Concordance	519	57	55	600																																					
Warshaw, et al, 2015	Prospective, Cross-sectional	USA	N	TD and F2F dermatologists via digital photography and dermoscopy images	Diagnostic agreement rate, Concordance	2,152	3.2	68	3,021																																					
Zink, et al, 2017, Sept	Prospective Cohort	Germany	Y	TD and F2F dermatologists via smartphone and dermoscopy images using Handyfotos	Diagnostic agreement rate	26	N/A	N/A	26																																					
Giavina-Bianchi, et al, 2020 Oct	Retrospective Cohort	Brazil	N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate, Concordance	24,210	70	N/A	739		B.																																			
Author, Year	Study design	Country	Funding reported	Intervention	*Outcome	Patients (n)	Female (%)	Mean Age (y)	Lesions (N)																																					
<b>TD vs F2F Non-specialist</b>																																														
Costello, et al, 2019	Prospective Cross-sectional	USA	Y	TD and F2F PCP via smartphone and dermoscopy images using the Photo Exam app	Diagnostic agreement rate	37	65	47.9	37		All skin lesions																																			
Duong, et al, 2014	Observational	France	Y	TD and F2F emergency physicians via smartphone images and videoconferences	Diagnostic agreement rate (SFTD, video)	194	N/A	N/A	178																																					
Gonzalez-Coloma, et al, 2019	Prospective, Cross-sectional	Chile	N	TD and F2F PCP via clinical images	Diagnostic concordance	326	59	35.8	326																																					
Keller, et al, 2020	Prospective Cohort	USA	Y	TD and F2F dermatologists or hospitalists on clinical images taken by smartphones and tablets	Diagnostic agreement rate, Concordance	100	43.2	N/A	100																																					
Muir, et al, 2011	Prospective Cohort	Australia	N	TD and F2F emergency physicians via clinical images taken by digital photography	Diagnostic agreement rate, Concordance	60	65	47	60																																					
Carter, et al, 2017	Prospective, retrospective cohort	USA	Y	TD and F2F dermatologists, as well as F2F PCP via clinical images stored using Epic EHR software	Diagnostic agreement rate	79	74	47	79	Skin cancers only																																				
Jones, et al, 2021	Retrospective Cohort	New Zealand	Y	TD and F2F PCP via digital photography and dermoscopy images	SSC matched for age, sex, and ethnicity. Diagnostic agreement rate	481	64	N/A	528																																					
Piccoli, et al, 2015	Retrospective Cross-sectional	Brazil	Y	TD and F2F PCP via digital photography and dermoscopy images	Diagnostic concordance	184	73.4	54.7	184																																					
Chen, et al, 2010	Retrospective Cohort	USA	Y	TD and F2F PCP via clinical images stored in Second Opinion Software	Diagnostic agreement rate	405	50.6	5.9	405	B.																																				
Patro, et al 2015	Prospective Cohort	India	Y	TD and F2F PCP via digital photography	Diagnostic agreement rate	206	58.7	N/A	206																																					

**eTable 1. Study and patient characteristics for all included studies.** The table is divided into two sections: one comparing teledermatology with Face-to-Face (F2F) dermatologists, and another comparing teledermatologists with F2F non-specialists. The studies are listed alphabetically and grouped by lesion type. \*See supplementary **eTable 4** for agreement rates and

Page 51 of 72  
confidence values. Abbreviations used in the table include B (Benign lesions only), ED (Emergency Department), EHR (Electronic Health Record), F2F (Face-to-Face), Histo (Histopathology), ICD10 (International Classification of Diseases, 10th Edition), N (No), N/A (Not available), PCP (Primary Care Provider), PLD (Polarized Light Dermoscopy), RCT (Randomized Controlled Trial), SFTD (Store-and-Forward Teledermatology), SSC (Specialized Skin Clinic), TD (Teledermatology or Teledermatologist), and Y (Yes). Patient characteristics for all 44 included studies are also provided, grouped by lesion type, with a column describing special inclusion and exclusion criteria.

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For peer review only

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Inclusion criteria	Exclusion criteria
Primary articles assessing diagnostic agreement where store-and-forward technology or live video conference consults were compared with a control group who attend in-person visits.	Survey articles, feasibility studies, studies regarding other forms of telemedicine unrelated to dermatology, cost-effectiveness studies, editorials, and review articles.
Primarily comparing teledermatology to F2F, sometimes using histopathology as the reference standard.	Studies that clearly stated they used telematologists as the gold- or reference standard.  Studies that only compared dermatoscopic images in the absence of clinical images.  Studies where patients captured their own photographs.

399 **eTable 2. Inclusion and exclusion criteria for screening of literature search results.**

400 F2F: Face-to-Face.

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### Study characteristics

Author, year, title, study type, objective, country of publication. Patient characteristics: total number of participants included declaration of funding source, number of participants per study, mean age +/- SD, age range, gender, mean BMI and range, race/ethnicity, type of lesions evaluated, type of patients evaluated.

### Methodology - teledermatology and F2F consults

Method of correspondence, platform used for the teledermatology consult, training on teledermatology platform, length of teledermatology and F2F consult, experience of the teledermatologist and F2F physician, location of the teledermatologist, number of teledermatologists and F2F physicians who made a diagnosis for each patient, total number of telematologists and F2F physicians in study, order of visits, wait time between teledermatology and F2F consult, whether same specialist conducted teledermatology and F2F visit, specialization of the F2F physician, number of reviews; qualifications of the individual who acquired the clinical photographs and whether they received additional training on taking clinical photographs.

### Metrics and results

Technology used for image acquisition and for viewing images with, distance between camera and lesion, number of images taken, use of teledermoscopy & dermoscopy, brand of dermatoscope, use of histopathology, referral content provided to teledermatologist, primary and differential diagnoses agreement and concordance rates, diagnostic accuracy values (if available) such as sensitivity, specificity, PPV and NPV.

404 **eTable 3. Data extraction form with details of domains record.**

405 F2F: Face-to-Face, PPV: Positive Predictive Value, NPV: Negative Predictive Value.

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Author and Year	Unique Study Grouping	Participants (n)	Lesions (N)	Primary Diagnosis Agreement F2F vs F2F (n/n)	Diagnosis Agreement (N) / Total Diagnoses (N)	Primary Diagnosis Agreement TD vs TD (n/n)	Diagnosis Agreement (N) / Total Diagnoses (N)	Primary Diagnosis Agreement TD vs F2F (n/n)	Diagnosis Agreement (N) / Total Diagnoses (N)	Primary Diagnosis Agreement TD vs F2F (n/n)	Diagnosis Agreement (N) / Total Diagnoses (N)	Primary Diagnosis Kappa Value TD vs F2F	Primary Diagnosis Kappa Value TD vs Histo
Altieri et al, 2017 (A)	F2F Derm vs TD1	232	232					58	93/160			0.51	
Altieri et al, 2017 (B)	F2F Derm vs TD2	232	232					53	81/152			0.51	
Altieri et al, 2017 (C)	F2F Derm vs TD3	232	232					53	80/152			0.57	
Azfar et al, 2014 (A)	F2F Derm vs TD1	76	159					47	63/136			0.41	
Azfar et al, 2014 (B)	F2F Derm vs TD2	76	159					57	77/136			0.51	
Azfar et al, 2014 (C)	F2F Derm vs TD3	76	159					49	66/136			0.43	
Barbieri et al, 2014 (A)	F2F Derm vs TD1	50	50			58	29/50	64	32/50				
Barbieri et al, 2014 (B)	F2F Derm vs TD2	50	50					56	28/50				
Barcaui et al, 2018	F2F Derm vs TD	31	41					90	37/41				
Batalla, 2016	F2F Derm vs TD	183	183					55	36/65				
Borve et al, 2012 (A)	F2F Derm vs TD1	40	40	88	35/40	68	27/40	78	31/40				
Borve et al, 2012 (B)	F2F Derm vs TD2	40	40					78	31/40				

Borve et al, 2013 (A)	F2F Derm vs TD1	62	69	58	40/69	55	38/69	0.47	0.51
Borve et al, 2013 (B)	F2F Derm vs TD2	62	69			57	39/69	0.48	
Carter et al, 2017 (A)	F2F nonspecialist vs TD	79	79	38	30/79	14	11/79		
Carter et al, 2017 (B)	F2F Derm vs TD	79	79			38	30/79		
Chen et al, 2010	F2F nonspecialist vs TD	405	405			48	194/405		
Clarke et al, 2021	F2F Derm vs TD	206	308			67	205/308	65	40/62
Costello et al, 2020	F2F nonspecialist vs TD	37	37			32	12/37		
Duong et al, 2014 (A)	F2F nonspecialist vs TD (Videoconference)	111	110			65	44/68		
Duong et al, 2014 (B)	F2F nonspecialist vs TD (SFTD)	111	110			31	34/110		
Gabel et al, 2021	F2F Derm vs TD	41	41			67	27/41	0.33	
Gatica, 2015	F2F Derm vs TD	125	125			82	103/125		
Gerhardt et al, 2021	F2F Derm vs TD	809	809			75	609809		
Giavina-Bianchi et al, Nov 2020	F2F Derm vs TD	17233	17233			61	490/803	54	156/289
Giavina-Bianchi et al, Oct 2020	F2F Derm vs TD	24210	27519			78	576/739	0.21	0.09
Gonzalez-Coloma, 2019	F2F nonspecialist vs TD	326	326					0.5	
Goulart-Silveira, et al, 2019	F2F Derm vs TD	39	39					0.96	0.56
Jones et al, 2021	F2F nonspecialist vs TD (Suspicious Skin Cancer pathway)	NA	528			35	183/528	53	60/114
Keller et al, 2020 (A)	F2F nonspecialist vs TD	100	100			45	24/53	0.4	
Keller et al, 2020 (B)	F2F Derm vs TD	100	100			53	28/53	0.45	
Lamel et al, 2012	F2F Derm vs TD	86	107			62	66/107	0.6	

Marchell et al, 2017	F2F Derm vs TD (SFTD)	216	216	91	122/134			76	162/213		
Marchell et al, 2017	F2F Derm vs TD (Uncompressed video)	216	216					76	77/101		
Marchell et al, 2017	F2F Derm vs TD (Compressed video)	216	216					72	81/112		
Muir et al, 2011 (A)	F2F nonspecialist vs TD	60	60					72	43/60		0.42
Muir et al, 2011 (B)	F2F Derm vs TD	60	60					98	49/50		0.93
Nami et al, 2015	F2F Derm vs TD	391	391					91	356/391		0.91
Okita et al, 2016	F2F Derm vs TD	100	100					54	54/100		
Patro et al, 2015	F2F nonspecialist vs TD	206	206					56	115/206		
Piccoli, et al, 2014	F2F nonspecialist vs TD	184	184								0.69
Ribas et al, 2010	F2F Derm vs TD	174	174	83	145/174	81	141/174	82	142/174		0.8
Rios-Yuil, 2012	F2F Derm vs TD	30	30					83	25/30	67	0.65
Romero Aguilera et al, 2014 (A)	F2F Derm vs TD1	457	192			69	118/170	73	124/170		
Romero Aguilera et al, 2014 (B)	F2F Derm vs TD2	457	192			73	124/170	72	123/170		
Romero Aguilera et al, 2014 (C)	F2F Derm vs TD3	457	192			67	114/170	88	150/170		
Romero et al, 2010 (A)	F2F Derm vs TD (SFTD)	457	192					88	325/368		
Romero et al, 2010 (B)	F2F Derm vs TD (SFTD and videoconferencing)	457	176					85	314/368		
Rubegni et al, 2011	F2F Derm vs TD	130	130					88	114/130		0.86
Saleh et al, 2017	F2F Derm vs TD	600	600			88	526/600	81	488/600		0.46-0.52
Senel, et al, 2013	F2F Derm vs TD1 (no dermoscopy)	150	150								0.77
Senel, et al, 2013	F2F Derm vs TD2 (no dermoscopy)	150	150								0.75



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Senel, et al, 2013	F2F Derm vs TD1 (dermoscopy)	150	150							0.85
Senel, et al, 2013	F2F Derm vs TD2 (dermoscopy)	150	150							0.86
Sola-Ortigosa et al, 2020 (A)	F2F Derm vs TD1 (no dermoscopy)	636	1000	82	821/1000	88	875/1000			0.87
Sola-Ortigosa et al, 2020 (B)	F2F Derm vs TD2 (no dermoscopy)	636	1000	83	832/1000	84	835/1000			0.83
Sola-Ortigosa et al, 2020 (C)	F2F Derm vs TD3 (no dermoscopy)	636	1000	81	813/1000	88	884/1000			0.89
Sola-Ortigosa et al, 2020 (D)	F2F Derm vs TD1 (dermoscopy)	636	1000	92	915/1000	92	915/1000			0.91
Sola-Ortigosa et al, 2020 (E)	F2F Derm vs TD2 (dermoscopy)	636	1000	90	902/1000	91	912/1000			0.9
Sola-Ortigosa et al, 2020 (F)	F2F Derm vs TD3 (dermoscopy)	636	1000	90	899/1000	90	903/1000			0.89
Tan et al, 2010 (A)	F2F Derm vs TD1, F2F Derm 1 vs F2F Derm 2	200	491	82	157/191	72	355/491	74	283/385	
Tan et al, 2010 (B)	F2F Derm vs TD2, F2F Derm 2 vs F2F Derm 3	200	491	76	80/106			74	162/219	
Tan et al, 2010 (C)	F2F Derm 1 vs F2F Derm 3	200	491	76	147/194					
Tran et al, 2011	F2F Derm vs TD	30	30					75	23/30	
Vano-Galvan et al, 2011	F2F Derm vs TD	100	100					69	1381/2000	
Vestergaard et al, 2020 (A)	A F2F Derm vs TD1	519	600	62	370/600	62	372/600	58	170/292	
Vestergaard et al, 2020 (B)	F2F Derm vs TD2	519	600					60	361/600	54 157/292
Warshaw et al, 2015 (A)	F2F Derm vs TD (non biopsied pigmented lesions, Macro)	2152	3021					76	570/753	0.56
Warshaw et al, 2015 (B)	F2F Derm vs TD (non biopsied pigmented lesions, Macro+PLD)	2152	3021					75	566/752	0.56
Warshaw et al, 2015 (C)	F2F Derm vs TD (non biopsied pigmented lesions, Macro+PLD)	2152	3021					80	548/684	0.62

Warshaw et al, 2015 (D)	F2F Derm vs TD (biopsied pigmented lesions, Macro)	2152	3021	53	344/651		0.44
Warshaw et al, 2015 (E)	F2F Derm vs TD (biopsied pigmented lesions, Macro+PLD)	2152	3021	53	348/652		0.45
Warshaw et al, 2015 (F)	F2F Derm vs TD (biopsied pigmented lesions, Macro+PLD)	2152	3021	60	357/595		0.52
Warshaw et al, 2015 (G)	F2F Derm vs TD (NONbiopsied NONpigmented lesions, Macro)	2152	3021	52	300/583		0.38
Warshaw et al, 2015 (H)	F2F Derm vs TD (NONbiopsied NONpigmented lesions, Macro+PLD)	2152	3021	50	291/579		0.38
Warshaw et al, 2015 (I)	F2F Derm vs TD (biopsied NONpigmented lesions, Macro)	2152	3021	46	473/1034		0.32
Warshaw et al, 2015 (J)	F2F Derm vs TD (biopsied NONpigmented lesions, Macro+PLD)	2152	3021	50	511/1020		0.37
Zanini, 2013	F2F Derm vs TD	100	100	76	76/100		
Zink et al, 2017, July (A)	F2F Derm vs TD	195	195	59	115/195	56	108/195
Zink et al, 2017, Sept (B)	F2F Derm vs TD	26	26	92	24/26	67	17/26

**eTable 4. Included unique study groupings and letter codes for individual agreement rates and kappa concordance values.** The abbreviations used in the text are as follows: TD (Teledermatology or Teledermatologist), Derm (Dermatologist), F2F (Face-to-Face), SFTD (Store and Forward Technology), PLD (Polarized Light Dermoscopy), and Macro (Macroscopic clinical images).

Study ID	Journal	Reason For Exclusion
NCT03034694, 2016	<a href="http://ClinicalTrials.gov">ClinicalTrials.gov</a>	Wrong study design
Andersson et al, 2017	Lakartidningen	Wrong study design
Romero et al, 2018	Actas dermo-sifiliograficas	Wrong study design
Orruno et al, 2016	Health Technology Assessment Database	Wrong study design
Batalla et al, 2016	Piel	Wrong study design
Kroemer et al, 2011	British Journal of Dermatology	Wrong study design
Ernstberger et al, 2014	Zentralblatt fur Chirurgie	Wrong study design
Totty et al, 2018	Journal of wound care	Wrong study design
Wurm et al, 2013	Journal of Telemedicine and Telecare	Wrong study design
Wang et al, 2017	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
Singh et al, 2011	Australasian Journal of Dermatology	Wrong study design
Grey et al, 2017	Dermatitis	Wrong study design
Crompton et al, 2010	Journal of Visual Communication in Medicine	Wrong study design
Ali et al, 2021	JMIR formative research	Wrong study design
Boyce et al, 2011	Dermatology	Wrong study design
Berg et al, 2017	Sarcoidosis Vasculitis and Diffuse Lung Diseases	Wrong study design
Shin et al, 2014	Journal of telemedicine and telecare	Wrong study design
Gacto-Sanchez et al, 2020	Burns : journal of the International Society for Burn Injuries	Wrong study design
Tian et al, 2017	Journal of Cosmetic Dermatology	Wrong study design
Thind et al, 2011	Clinical and Experimental Dermatology	Wrong study design
Silveira et al, 2014	BMC Dermatology	Wrong study design
O'Connor et al, 2017	JAMA Dermatology	Wrong study design
Janda et al, 2020	The Lancet. Digital health	Wrong study design
Day et al, 2020	Military medicine	Wrong study design
Karlsson et al, 2015	Acta Dermato-Venereologica	Wrong study design
Seghers et al, 2015	Australasian Journal of Dermatology	Wrong study design
Hazenberget al, 2010	Journal of Medical Engineering and Technology	Wrong study design
Borve et al, 2015	Acta Dermato-Venereologica	Wrong study design
Boissin et al, 2015	Burns	Wrong study design
Da Silva et al, 2018	Dermatology online journal	Wrong study design
Devrim et al, 2019	BMC pediatrics	Wrong study design
Danielsson et al, 2016	Health Technology Assessment Database	Wrong study design
Berglund et al, 2020	Journal of the European Academy of Dermatology and Venereology : JEADV	Wrong study design
Forsblom et al, 2013	Clinical Infectious Diseases	Wrong study design
G Bianchi et al, 2020	Journal of medical Internet research	Wrong study design
Congalton et al, 2015	Journal of the European Academy of Dermatology and Venereology	Wrong study design
Ferrandiz et al, 2012	Archives of Dermatology	Wrong study design
Ismail et al, 2018	International Journal of Women's Dermatology	Wrong study design
Gamus et al, 2019	International journal of medical informatics	Wrong study design
Paudel et al, 2020	Case reports in dermatological medicine	Wrong study design
Georgesesen et al, 2020	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
Gagnon et al, 2015	Dermatology Times	Wrong study design
Philp et al, 2013	Pediatric Dermatology	Wrong study design
Mooney et al, 2011	Skin Research and Technology	Wrong study design
Do Khac et al, 2021	JMIR mHealth and uHealth	Wrong study design
Chambers et al, 2012	Journal of the American Academy of Dermatology	Wrong study design
Garcia-Romero et al, 2011	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
Ahmed et al, 2020	Annals of internal medicine	Wrong study design
Marwaha et al, 2019	Journal of the American Academy of Dermatology	Wrong study design
NCT02122432, 2014	<a href="http://ClinicalTrials.gov">ClinicalTrials.gov</a>	Wrong study design
Lowe et al, 2021	Clinical and experimental dermatology	Wrong study design

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Bowling et al, 2011	Wound Repair and Regeneration	Wrong study design
Marin-Gomez et al, 2020	Journal of primary care & community health	Wrong study design
Veronese et al, 2021	Diagnostics (Basel, Switzerland)	Wrong study design
Ismail et al, 2018	International journal of dermatology	Wrong study design
NCT02905851, 2016	<a href="http://ClinicalTrials.gov">ClinicalTrials.gov</a>	Wrong study design
Trinidad et al, 2020	Journal of the American Academy of Dermatology	Wrong study design
Tensen et al, 2019	Studies in health technology and informatics	Wrong study design
Karavan et al, 2014	Journal of telemedicine and telecare	Wrong study design
Viola et al, 2011	Archives of Dermatology	Wrong study design
van Netten et al, 2017	Scientific reports	Wrong study design
Cai et al, 2016	Burns : journal of the International Society for Burn Injuries	Wrong study design
Hazenberget al, 2010	Diabetes Technology and Therapeutics	Wrong study design
Jacoby et al, 2021	Journal of drugs in dermatology : JDD	Wrong study design
Pak et al, 2018	Wound repair and regeneration : official publication of the Wound Healing Society [and] the European Tissue Repair Society	Wrong study design
Kummerow Broman et al, 2019	JAMA surgery	Wrong study design
Munoz-Lopez et al, 2021	Journal of the European Academy of Dermatology and Venereology : JEADV	Wrong study design
Markun et al, 2017	Medicine	Wrong study design
Piette et al, 2017	Journal of telemedicine and telecare	Wrong study design
Tan et al, 2010	British Journal of Dermatology	Wrong study design
Watson et al, 2010	Archives of Dermatology	Wrong study design
Wiseman et al, 2016	Journal of vascular surgery. Venous and lymphatic disorders	Wrong study design
Wolf et al, 2013	JAMA dermatology	Wrong study design
Laggis et al, 2020	The American Journal of dermatopathology	Wrong study design
Kazi et al, 2021	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
Kanthraj et al, 2013	Indian Journal of Dermatology, Venereology and Leprology	Wrong study design
Shah et al, 2016	Journal of the American Academy of Dermatology	Wrong study design
Kim et al, 2018	Skin research and technology	Wrong study design
Nguyen et al, 2017	Journal of Clinical and Aesthetic Dermatology	Wrong study design
Rizvi et al, 2020	PloS one	Wrong study design
Mehrtens et al, 2019	Clinical and experimental dermatology	Wrong study design
Knudsen et al, 2012	Lakartidningen	Research letter or letter to the editor
Korman et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Mercer et al, 2014	Journal of Cutaneous Medicine and Surgery	Research letter or letter to the editor
Grunig et al, 2015	JAMA Dermatology	Research letter or letter to the editor
Cartron et al, 2020	Dermatologic therapy	Research letter or letter to the editor
McAfee et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Wong et al, 2021	JAMA dermatology	Research letter or letter to the editor
Baranowski et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Micheletti et al, 2014	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Osei-Tutu et al, 2013	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Nair et al, 2015	International Journal of Dermatology	Research letter or letter to the editor
Miller et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Keleshian et al, 2017	Journal of the American Academy of Dermatology	Research letter or letter to the editor
HAYES; Inc et al, 2016	Health Technology Assessment Database	Research letter or letter to the editor
Jacob et al, 2017	Journal of telemedicine and telecare	Research letter or letter to the editor
Perkins et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Halpern et al, 2010	British Journal of Dermatology	Research letter or letter to the editor
Newman et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Hunt et al, 2020	Clinical and experimental dermatology	Research letter or letter to the editor
2018	Nursing	Research letter or letter to the editor
Taneja et al, 2021	Indian journal of dermatology, venereology and leprology	Research letter or letter to the editor
Echeverria-Garcia et al, 2019	Actas dermo-sifiliograficas	Research letter or letter to the editor
Henning et al, 2010	Archives of Dermatology	Research letter or letter to the editor

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3	Demo et al, 2019	Clinical and experimental dermatology	Research letter or letter to the editor
4	Byamba et al, 2015	British Journal of Dermatology	Research letter or letter to the editor
5	Gupta et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
6	De Giorgi et al, 2017	Journal of the European Academy of Dermatology and Venereology	Research letter or letter to the editor
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8	Duong et al, 2016	Annales de Dermatologie et de Venereologie	Research letter or letter to the editor
9	Mortimer et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
10	Gravelly et al, 2010	Journal of the American Academy of Dermatology	Research letter or letter to the editor
11	Choi et al, 2021	International journal of dermatology	Research letter or letter to the editor
12	Motley et al, 2012	BMJ: British Medical Journal (Clinical Research Edition)	Research letter or letter to the editor
13	Leavitt et al, 2016	Journal of the American Academy of Dermatology	Research letter or letter to the editor
14	Cheng et al, 2020	Dermatitis : contact, atopic, occupational, drug	Research letter or letter to the editor
15	Clark et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
16	Fuesl et al, 2010	MMW-Fortschritte der Medizin	Research letter or letter to the editor
17	English III et al, 2013	Journal of the American Academy of Dermatology	Research letter or letter to the editor
18	Cotes et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
19	Abi Rafeh et al, 2021	Journal of cutaneous medicine and surgery	Research letter or letter to the editor
20	Okeke et al, 2020	The Journal of dermatological treatment	Research letter or letter to the editor
21	Splete et al, 2014	Emergency Medicine (00136654)	Research letter or letter to the editor
22	Khosravi et al, 2021	Clinical and experimental dermatology	Research letter or letter to the editor
23	Sivesind et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
24	Stoecker et al, 2013	JAMA dermatology	Research letter or letter to the editor
25	Skayem et al, 2020	Journal of the European Academy of Dermatology and Venereology : JEADV	Research letter or letter to the editor
26	Su et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
27	Massone et al, 2021	Anais brasileiros de dermatologia	Research letter or letter to the editor
28	Li et al, 2021	The Journal of infection	Research letter or letter to the editor
29	Afanasiev et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
30	Varma et al, 2011	British Journal of Dermatology	Research letter or letter to the editor
31	Van Der Heijden et al, 2010	Journal of the European Academy of Dermatology and Venereology	Research letter or letter to the editor
32	Motley et al, 2012	BMJ (Online)	Research letter or letter to the editor
33	Villani et al, 2020	Dermatologic therapy	Research letter or letter to the editor
34	Portnoy et al, 2018	The journal of allergy and clinical immunology. In practice	Research letter or letter to the editor
35			
36	Tschandl et al, 2018	British Journal of Dermatology	Research letter or letter to the editor
37	Poolworarluk et al, 2020	Future healthcare journal	Research letter or letter to the editor
38	Anonymous et al, 2020	Journal of drugs in dermatology : JDD	Research letter or letter to the editor
39			
40	Tan et al, 2021	Annals of the Academy of Medicine, Singapore	Research letter or letter to the editor
41	Silva et al, 2021	Anais brasileiros de dermatologia	Research letter or letter to the editor
42	de Giorgi et al, 2016	International Journal of Dermatology	Wrong outcomes
43	Senel et al, 2014	Journal of telemedicine and telecare	Wrong outcomes
44	Goodier et al, 2021	Contact dermatitis	Wrong outcomes
45	Foolad et al, 2017	International Journal of Dermatology	Wrong outcomes
46	Wells et al, 2020	The Journal of clinical and aesthetic dermatology	Wrong outcomes
47	Arzberger et al, 2016	Acta Dermato-Venereologica	Wrong outcomes
48	Creighton-Smith et al, 2017	International Journal of Dermatology	Wrong outcomes
49			
50	Marwaha et al, 2019	Journal of the American Academy of Dermatology	Wrong outcomes
51	Pasquali et al, 2021	Actas dermo-sifiliograficas	Wrong outcomes
52	Vestergaard et al, 2020	Family practice	Wrong outcomes
53	Kravets et al, 2018	Acta dermatovenerologica Alpina, Pannonica, et Adriatica	Wrong outcomes
54	Speiser et al, 2014	American Journal of Dermatopathology	Wrong outcomes
55	N/A	Journal of the American Academy of Dermatology	Wrong outcomes
56	Whited et al, 2013	Journal of Telemedicine and Telecare	Wrong outcomes

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Abhishek et al, 2021	medRxiv	Wrong outcomes
Villa et al, 2020	Internal and emergency medicine	Wrong outcomes
Lubeek et al, 2016	Tijdschrift voor gerontologie en geriatrie	review
Ndegwa et al, 2016	Health Technology Assessment Database	review
Moreno-Ramirez et al, 2017	Acta dermato-venereologica	review
Moreno-Ramirez et al, 2017	Acta Dermato-Venereologica	review
Van Der Heijden et al, 2010	Huisarts en Wetenschap	review
Walocko et al, 2017	Dermatologic Clinics	review
Roman et al, 2014	Journal of the Dermatology Nurses' Association	review
Hart et al, 2011	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	review
Elsner et al, 2020	Journal der Deutschen Dermatologischen Gesellschaft = Journal of the German Society of Dermatology : JDDG	review
Kaliyadan et al, 2020	Indian journal of dermatology	review
Burch et al,		review
Evans et al, 2017	Pharmazeutische Zeitung	Editorial
Anonymous. et al, 2016	Journal of AHIMA / American Health Information Management Association	Editorial
Luk et al, 2018	Hong Kong Journal of Dermatology and Venereology	Editorial
Queen et al, 2018	International wound journal	Editorial
Anguita et al, 2014	Nurse Prescribing	Editorial
Haworth et al, 2020	Clinical and experimental dermatology	Editorial
Romero-Aguilera et al, 2019	Actas dermo-sifiliograficas	Editorial
Barrio Garde et al, 2016	Piel	Editorial
Morand et al, 2010	Annales de dermatologie et de venereologie	Editorial
N/A	Journal of the American Academy of Dermatology	Abstract
N/A	Journal of the American Academy of Dermatology	Abstract
Bianchi et al, 2020	Journal of the American Academy of Dermatology	Abstract
Creadore et al, 2020	Journal of the American Academy of Dermatology	Abstract
N/A	Journal of the American Academy of Dermatology	Abstract
Tognetti L et al, 2020		Abstract
SPLATE et al, 2014	Emergency Medicine (00136654)	Abstract
N/A	Journal of the American Academy of Dermatology	Abstract
Dahlen Gyllencreutz et al, 2017	Journal of the European Academy of Dermatology and Venereology	Wrong intervention
Tandjung et al, 2015	Journal of Evaluation in Clinical Practice	Wrong intervention
Paradela-De-La-Morena et al, 2015	European Journal of Dermatology	Wrong intervention
Horsham et al, 2015	British Journal of Dermatology	Wrong intervention
Saenz et al, 2018	International Journal of Telemedicine and Applications	Wrong intervention
Kochmann et al, 2016	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong comparator
Markun et al, 2017	Medicine (United States)	Wrong comparator
Feigenbaum et al, 2017	Pediatric Dermatology	Wrong comparator
Massone et al, 2014	Journal of the European Academy of Dermatology and Venereology	Wrong comparator
MacLellan et al, 2021	Journal of the American Academy of Dermatology	Wrong comparator
Koysombat et al, 2021	Journal of plastic, reconstructive & aesthetic surgery : JPRAS	Correspondence
Jakhar et al, 2020	Clinical and experimental dermatology	Correspondence
Alkmim et al, 2013	Journal of Telemedicine and Telecare	Correspondence
NCT02836665, 2016	<a href="http://ClinicalTrials.gov">ClinicalTrials.gov</a>	Clinical trial - no associated manuscript
JPRN-UMIN000020873 et al, 2016		Clinical trial - no associated manuscript
Fogel et al, 2016	Journal of the American Academy of Dermatology	Commentary
Hoyer et al, 2020	Cutis	Commentary
Pasadyn et al, 2020	Journal of the American Academy of Dermatology	Duplicate

Moreno-Ramirez et al, 2017	American Journal of Clinical Dermatology	Erratum
Trovato et al, 2011	Eplasty	Wrong patient population
Bowns et al, 2016	Health Technology Assessment Database	Wrong publication date
Gemelas et al, 2019	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong setting

**eTable 5. List of studies excluded at the full-text screening stage.**

For peer review only



A

Domain 1: SAMPLE SELECTION		
Signalling Q1	<p>Was a consecutive or random sample of patients enrolled?</p> <ul style="list-style-type: none"> <li>- In the study by Giavina-Bianchi et al., a consecutive sample of patients was enrolled, introducing less bias.</li> </ul> <p>Skewed patient demographics: e.g., over 70% female, select age groups, studies.</p> <p>that do not disclose age range and or sex/gender of the patients.</p> <ul style="list-style-type: none"> <li>- In the study by Carter et al., over 70% of the patients were female, which may introduce bias and reduce applicability.</li> </ul>	Yes/No/Unclear
Signalling Q2	<p>Was a case-control design avoided?</p> <ul style="list-style-type: none"> <li>- Gabel et al. avoided a case-control design, which reduces the risk of bias.</li> </ul>	Yes/No/Unclear
Signalling Q3	<p>Did the study avoid inappropriate exclusions?</p> <ul style="list-style-type: none"> <li>- In the study by Giavina-Bianchi et al., complex, and severe cases were excluded, which may introduce bias and affect applicability.</li> </ul>	Yes/No/Unclear
Risk of bias	<p><b>Could the selection of patients have introduced bias?</b></p> <ul style="list-style-type: none"> <li>- For example, Giavina-Bianchi removed the most complex/severe cases and then excluded any non-skin neoplasms, and then they further filtered to only include the 10 most common skin neoplasms.</li> </ul>	RISK: LOW/HIGH/UNCLEAR
Concerns regarding applicability	<p><b>Is there concern that the included patients do not match the review question?</b></p> <ul style="list-style-type: none"> <li>- 'High' if the study only looked at a specific lesion category such as skin cancers only, or pigmented lesions only, or if they had a skewed patient demographics (e.g., 70% female, or geriatric population only). Our study is focuses on generalizability of teledermatology in all skin conditions.</li> </ul>	RISK: LOW/HIGH/UNCLEAR
Domain 2: INDEX TEST (Teledermatology consult)		
Signalling Q1	<p>Were the derms/physicians making the index diagnoses unaware of the reference diagnosis?</p> <ul style="list-style-type: none"> <li>- Same dermatologist doing F2F and teledermatology consults? Is there blinding of dermatologists to each other's diagnoses? In the study by Tan et al., the same dermatologist performed both the F2F and teledermatology consultations, which may introduce bias if they were not blinded to each other's diagnoses.</li> </ul>	Yes/No/Unclear
Signalling Q2	<p>Did the study require physicians to provide a specific primary diagnosis, or were they only required to provide a general grouping, e.g., inflammatory vs. skin neoplasm. Was analysis only performed for categories instead of complete primary diagnoses (such as skin neoplasm vs basal cell carcinoma)? Did physicians use standardized referral/consult sheet with set diagnoses? Did they group similar / synonymous diagnoses (e.g dermatitis / eczema together)? Was a non-specialist in charge of comparing diagnoses and deciding if there was agreement?</p> <ul style="list-style-type: none"> <li>- In the study by Warshaw et al., physicians were required to provide a categorical or pooled diagnosis (e.g., skin neoplasm instead of basal cell carcinoma), which may introduce bias and reduce applicability.</li> </ul>	Yes/No/Unclear
Risk of bias	<p><b>Could the conduct (technology used for taking images/viewing images) or interpretation (what constituted primary diagnosis/ complete agreement) of the index test have introduced bias?</b></p>	RISK: LOW/HIGH/UNCLEAR
Concerns regarding applicability	<p>Is there concern that the index test, its conduct, or interpretation differ from the review question?</p>	RISK: LOW/HIGH/UNCLEAR
Domain 3: REFERENCE TEST (F2F, in some cases histopathology)		
Signalling Q1	<p>Describe the reference standard and how it was conducted and interpreted:</p>	Yes/No/Unclear

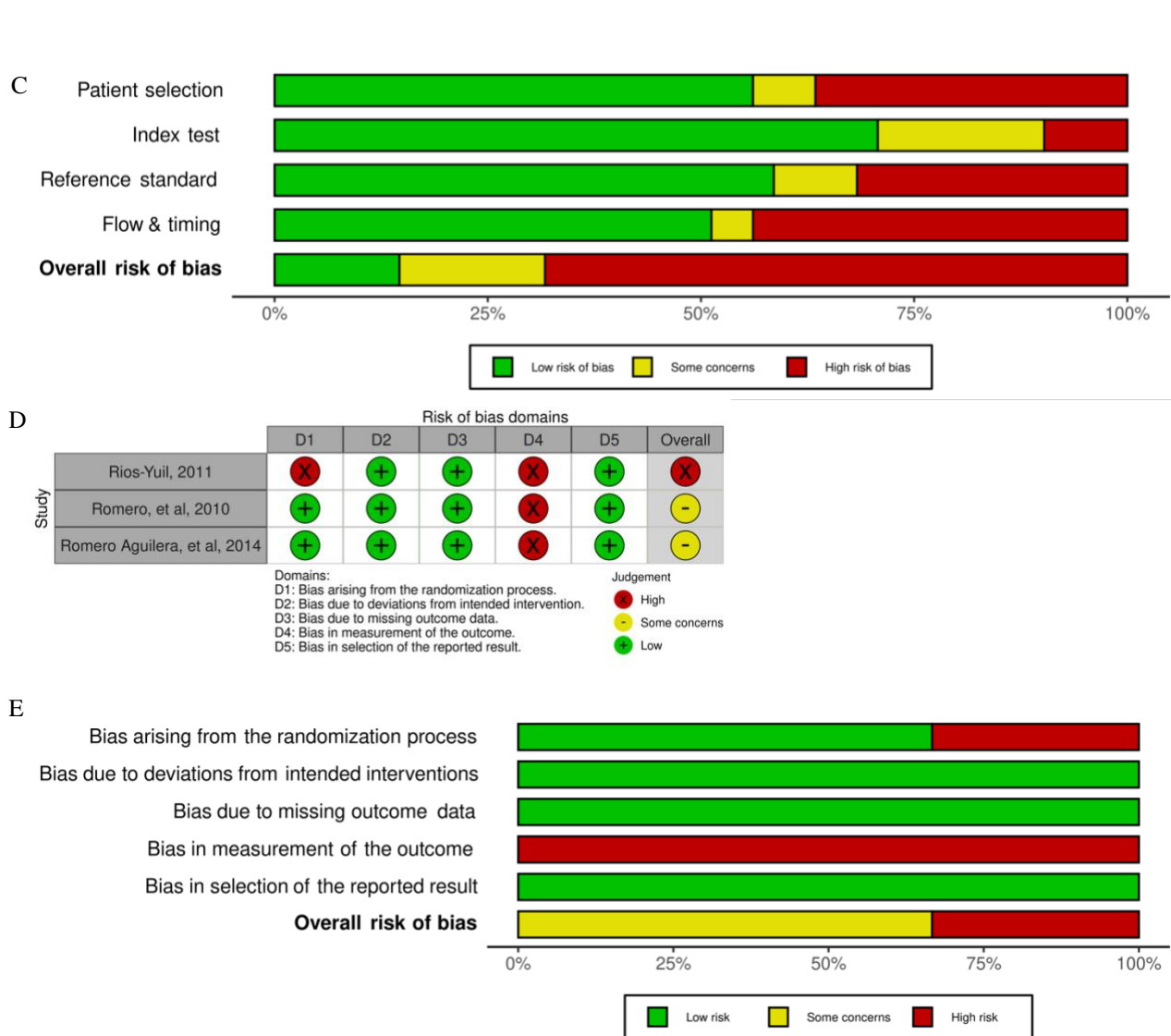
	What was the order of visits? What was the experience level and specialization of the F2F physician? Did the same dermatologist do both teledermatology and F2F consult?	
Signalling Q2	Is the reference standard likely to correctly classify the target condition?	Yes/No/Unclear
<b>Risk of bias</b>	<b>Could the reference standard, its conduct, or its interpretation have introduced bias?</b> - In studies where the reference standard was a consultation with a non-specialist, such as Costello et al., there is a risk of introducing bias.	RISK: LOW/HIGH/UNCLEAR
<b>Concerns regarding applicability</b>	<b>Could the reference standard, its conduct, or its interpretation have introduced bias?</b> - Applicability was impacted by physician specialization.	RISK: LOW/HIGH/UNCLEAR
<b>Domain 4: FLOW AND TIMING</b>		
Signalling Q1	Was there an appropriate interval between index test(s) and reference standard? - Was the time interval greater than 2 weeks? In studies where the same dermatologist did F2F and teledermatology -> Say 'No' regardless of the time between teledermatology and F2F consult. - In the study by Gerhardt et al., there was a 30-day interval between teledermatology and F2F, which may introduce bias.	Yes/No/Unclear
Signalling Q2	Did all patients receive a reference standard?	
Signalling Q3	Did all patients receive the same reference standard? - In studies like Sola-Ortigosa et al., all patients received a reference standard, either histopathology or F2F consultation. Did a paper use histopathology as the reference standard for cancer lesions but F2F for non-cancer lesions? Were all patients evaluated by physicians with similar level of experience?	Yes/No/Unclear
Signalling Q4	Were all patients included in the analysis? - In studies like Gabel et al., all patients were included in the analysis, reducing the risk of bias.	Yes/No/Unclear
<b>Risk of bias</b>	Could the patient flow have introduced bias?	RISK: LOW/HIGH/UNCLEAR

B

Study	Risk of bias domains				
	D1	D2	D3	D4	Overall
Altieri, et al, 2017	+	+	+	+	+
Azfar, et al, 2014	+	+	+	+	X
Barbieri, et al, 2014	+	+	-	+	-
Barcaui, et al, 2018	+	+	X	X	X
Batalla, et al, 2015	-	+	+	+	-
Borve, et al, 2012	+	+	X	X	X
Borve, et al, 2013	X	-	+	+	X
Carter, et al, 2017	X	-	+	X	X
Chen, et al, 2010	+	X	X	-	X
Clarke, et al, 2021	X	X	+	+	X
Costello, et al, 2019	X	+	X	X	X
Duong, et al, 2014	+	-	X	X	X
Gabel, et al, 2021	X	+	+	X	X
Gatica, 2015	+	+	-	+	-
Gerhardt, et al, 2021	X	-	X	X	X
Giavina-Bianchi, et al, Oct 2020	X	+	-	X	X
Giavina-Bianchi, et al, Nov 2020	X	+	-	X	X
Gonzalez-Coloma, et al, 2019	+	X	X	+	X
Goulart-Silveira, et al, 2019	X	+	+	X	X
Jones, et al, 2021	+	-	+	+	-
Keller, et al, 2020	+	+	+	+	+
Lamel, et al, 2012	-	-	+	+	-
Marchell, et al, 2017	+	+	+	+	+
Muir, et al, 2011	X	+	+	X	X
Nami, et al, 2015	X	+	+	+	X
Okita, et al, 2016	+	+	+	+	X
Patro, et al, 2015	+	+	X	+	X
Piccoli, et al, 2015	X	+	X	X	X
Ribas, et al, 2010	X	+	X	X	X
Rubegni, et al, 2011	+	+	+	+	+
Saleh, et al, 2017	+	+	+	+	+
Senel, et al, 2013	X	+	+	X	X
Sola-Ortigosa, et al, 2020	+	+	X	X	X
Tan, et al, 2010	X	X	+	X	X
Tran, et al, 2011	+	+	X	+	X
Vano-Galvan, et al, 2010	+	+	+	+	X
Vestergaard, et al, 2020	+	+	+	X	X
Warsaw, et al, 2015	+	-	+	+	-
Zanini, 2013	-	+	+	-	-
Zink, et al, 2017, July	+	-	X	X	X
Zink, et al, 2017, Sept	+	+	+	+	+

Domains:  
 D1: Patient selection.  
 D2: Index test.  
 D3: Reference standard.  
 D4: Flow & timing.

Judgement  
 X High  
 - Some concerns  
 + Low



**eTable 6. Risk of Bias (ROB) results.**

(A) QUADAS-2 summary sheet. (B,C) QUADAS-2 RoB analysis of 41 observational studies. (D,E) ROB-2 analysis of three randomized controlled trials.

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55 This supplementary material has been provided by the authors to give readers additional information about their work.

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## MOOSE Checklist for Meta-analyses of Observational Studies

Item No	Recommendation	Reported on Page No
Reporting of background should include		
1	Problem definition	4
2	Hypothesis statement	4
3	Description of study outcome(s)	4-5
4	Type of exposure or intervention used	6-8
5	Type of study designs used	6-8
6	Study population	6-8
Reporting of search strategy should include		
7	Qualifications of searchers (eg, librarians and investigators)	6
8	Search strategy, including time period included in the synthesis and key words	6-8
9	Effort to include all available studies, including contact with authors	6-8
10	Databases and registries searched	6-8
11	Search software used, name and version, including special features used (eg, explosion)	6-8
12	Use of hand searching (eg, reference lists of obtained articles)	6-8
13	List of citations located and those excluded, including justification	Supplement
14	Method of addressing articles published in languages other than English	6-8
15	Method of handling abstracts and unpublished studies	6-8, Supplement
16	Description of any contact with authors	6-8, Supplement
Reporting of methods should include		
17	Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	9-12
18	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	9-12
19	Documentation of how data were classified and coded (eg, multiple raters, blinding and interrater reliability)	9-12
20	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	9-12
21	Assessment of study quality, including blinding of quality assessors, stratification or regression on possible predictors of study results	9-12
22	Assessment of heterogeneity	9-12
23	Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	9-12
24	Provision of appropriate tables and graphics	9-12, Supplement
Reporting of results should include		
25	Graphic summarizing individual study estimates and overall estimate	Fig 1-3, Supplement
26	Table giving descriptive information for each study included	Tables 1, 2, Supplement
27	Results of sensitivity testing (eg, subgroup analysis)	9-12
28	Indication of statistical uncertainty of findings	9-12

Item No	Recommendation	Reported on Page No
Reporting of discussion should include		
29	Quantitative assessment of bias (eg, publication bias)	9-12
30	Justification for exclusion (eg, exclusion of non-English language citations)	9-12
31	Assessment of quality of included studies	9-12
Reporting of conclusions should include		
32	Consideration of alternative explanations for observed results	13-17
33	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	13-17
34	Guidelines for future research	13-17
35	Disclosure of funding source	18

From: Stroup DF, Berlin JA, Morton SC, et al, for the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group. Meta-analysis of Observational Studies in Epidemiology. A Proposal for Reporting. *JAMA*. 2000;283(15):2008-2012. doi: 10.1001/jama.283.15.2008.



## PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
<b>TITLE</b>			
Title	1	Identify the report as a systematic review.	p1
<b>ABSTRACT</b>			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p3-4
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	p5-6
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	p5-6
<b>METHODS</b>			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	p8, Supplementary p15
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	p7
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplementary p2
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	p8
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	p8
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Supplementary p15
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	p8 and Supplementary p15
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	p9
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	p8-9
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	p8-9
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	p 8-9 Supplementary p2
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	p 8-9 Supplementary p2
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	p 8-9 Supplementary p2
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	p 8-9 Supplementary p2
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	p9
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA



## PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
<b>RESULTS</b>			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Figure 1, p10
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Supplementary p23-3
Study characteristics	17	Cite each included study and present its characteristics.	p10-11, Table 1, 2
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	p15, Supplementary eTable 5
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	p15, Supplementary eTable 5
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Figure 2, 3, Supplementary eFigure 1-5
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	p 11-13 Supplementary p3
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	p 11-13 Supplementary p3
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Supplementary eTable 5
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	p 11-13 Supplementary p3
<b>DISCUSSION</b>			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	p14
	23b	Discuss any limitations of the evidence included in the review.	p15-16
	23c	Discuss any limitations of the review processes used.	p16
	23d	Discuss implications of the results for practice, policy, and future research.	p17
<b>OTHER INFORMATION</b>			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	p7
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	p7
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	p18
Competing interests	26	Declare any competing interests of review authors.	p18
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71

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# BMJ Open

## Diagnostic Reliability in Teledermatology: A Systematic Review and a Meta-Analysis

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<b>Primary Subject Heading</b>:	Dermatology
Secondary Subject Heading:	Health informatics, General practice / Family practice
Keywords:	Telemedicine < BIOTECHNOLOGY & BIOINFORMATICS, DERMATOLOGY, PRIMARY CARE, Information technology < BIOTECHNOLOGY & BIOINFORMATICS, STATISTICS & RESEARCH METHODS

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1 **Title:** Diagnostic Reliability in Teledermatology: A Systematic Review and a Meta-Analysis

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For peer review only

## 26 **Abstract**

27 Objectives: To compare teledermatology and face-to-face (F2F) agreement in primary diagnoses  
28 of dermatological conditions.

29 Design: Systematic Review and Meta-Analysis

30 Methods: MEDLINE, Embase, Cochrane Library (Wiley), CINAHL, and medRxiv were  
31 searched between January 2010 and May 2022. Observational studies and randomized clinical  
32 trials that reported percentage agreement or kappa concordance for primary diagnoses between  
33 teledermatology and F2F physicians were included. Titles, abstracts, and full-text articles were  
34 screened in duplicate. From 7,173 citations, 44 articles were included. A random-effects meta-  
35 analysis was conducted to estimate pooled estimates. Primary outcome measures were mean  
36 percentage and kappa concordance for assessing diagnostic matches between teledermatology  
37 and F2F physicians. Secondary outcome measures included the agreement between  
38 teledermatologists, F2F dermatologists, and teledermatology and histopathology results.

39 Results: 44 studies were extracted and reviewed. The pooled agreement rate was 68.9%, and  
40 kappa concordance was 0.67. When dermatologists conducted F2F and teledermatology consults,  
41 the overall diagnostic agreement was significantly higher at 71%, compared to 44% for non-  
42 specialists. Kappa concordance was 0.69 for teledermatologist vs specialist and 0.52 for non-  
43 specialists. Higher diagnostic agreements were also noted with image acquisition training and  
44 digital photography. The agreement rate was 76.4% between teledermatologists, 82.4% between  
45 F2F physicians, and 55.7% between teledermatology and histopathology.

46 Conclusions and Relevance: Teledermatology can be an attractive option particularly in  
47 resource-poor settings. Future efforts should be placed on incorporating image acquisition  
48 training and access to high-quality imaging technologies.

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3 49 Registration number: 10.17605/OSF.IO/FJDVG  
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8 51 **Keywords:** teledermatology, dermatology consultations, store-and-forward, telemedicine,  
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10 52 remote consultation, dermatology hospitalists  
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14 54 **Article Summary:**

15 55 Strengths and limitations of this study:  
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- 19 56 ● This is the most comprehensive systematic review and meta-analysis of the topic to date  
20  
21 57 without language restrictions applied.  
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23 58 ● Inclusion criteria were broad, including all types of dermatological diseases, imaging  
24  
25 59 technologies, in-person physician specializations (GPs, hospitalists, and dermatologists),  
26  
27 60 and the presence or absence of image acquisition training.  
28  
29 61 ● The article search was limited to 2010 and later due to the recent incorporation of  
30  
31 62 smartphones in teledermatology practices.  
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33 63 ● Due to considerable heterogeneity between studies, meta-analysis and synthesis of  
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35 64 predictors for accurate diagnoses remotely were limited even after subgrouping.  
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## 65 Introduction

66 With the emergence of COVID-19, the introduction of virtual consults in healthcare settings,  
67 especially dermatology, has been expanded to allow many patients the opportunity for equitable  
68 access to care when in-person appointments pose a challenge and risk to patients.(1) Different  
69 modalities were introduced to support teledermatology. This involves remote sharing of patient  
70 data, including synchronous video-streaming teledermatology and asynchronous sharing of still  
71 images via emails, or text messages, or store-and-forward teledermatology (SFTD).

72  
73 Although both synchronous and asynchronous approaches have been shown to be cost-effective,  
74 SFTD is particularly popular as it requires fewer resources and less coordination than synchronous  
75 teledermatology.(2, 3) With the advent of higher resolution smartphone cameras, relatively  
76 minimal training is required to capture data for remote dermatologists correctly; multiple SFTD  
77 studies opted to provide no training in image capture and still found value in teledermatology.(4,  
78 5)

79  
80 There is valid concern over the reliability of teledermatology given the significant variability in  
81 diagnostic accuracy predicted across pre-pandemic research.(6) This is expected given the lack of  
82 standardization across studies and the potential for confounders across teledermatology  
83 methodologies and applications, e.g., level of training or skin lesion type. This variability in  
84 approach may benefit from an increased demand, which could provide greater impetus to optimize  
85 and standardize teledermatology.

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3 87 To our knowledge, this is the first and most inclusive meta-analysis (MA) that compares  
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5 88 teledermatology consults to face-to-face (F2F) that looked at all relevant studies without overly  
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8 89 exclusive inclusion criteria. The primary objective of this study was to compare the reliability of  
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10 90 teledermatology diagnoses to F2F consults, as determined by Cohen's kappa interrater agreement  
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12 91 and total agreement rates. Teledermatology can assume important roles as a routine complement  
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14 92 to primary care and an alternate route to the typical in-person referrals. Consequently, we wanted  
15  
16 93 to determine agreement for teledermatology and all F2F consults, teledermatology and F2F  
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18 94 primary care consults, and finally teledermatology and F2F dermatologist consults, which would  
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20 95 arguably best capture the limitations introduced by the change in medium from F2F to  
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22 96 teledermatology.  
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28 98 Additional subset analyses were performed to control for potential confounders (e.g.,  
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30 99 inflammatory vs. malignant, staff training for image acquisition, teledermoscopy, and smartphone  
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32 100 vs digital cameras) introduced by the heterogenous methodology. The secondary objectives sought  
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34 101 to determine the agreement rate within teledermatology diagnoses and F2F consults to provide an  
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36 102 idea of each medium's consistency, and provide the best estimate of accuracy for the agreement  
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38 103 rate between teledermatology and histopathology.  
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## 104 **Methods**

105 This study was reported in accordance with the Preferred Reported Items for Systematic Reviews  
106 and Meta-Analyses (PRISMA) guidelines.

### 108 Protocol Registration

109 Prior to the conduct of this review, a protocol which adhered to the PRISMA-protocols (i.e.,  
110 PRISMA-P) guidelines was developed and then registered on Open Science Framework (OSF).

111 Access: <https://osf.io/fjdvg>.(7)

### 113 Search Strategy

114 A comprehensive search of major bibliographic databases, MEDLINE, Embase, Cochrane Library  
115 (Wiley), CINAHL, and medRxiv was performed in August 2021. MEDLINE was searched again  
116 between August 2021 and May 2022 to screen any new articles published after our protocol was  
117 registered. The search strategy was developed by a medical librarian at Queen's University  
118 (Kingston, ON). Please see the supplementary appendix for additional information on the search  
119 strategy.

121 No restrictions were placed on the language or status of the publications. Search results were  
122 limited to studies published between January 2010 and May 2022 due to the novelty of  
123 incorporating smartphones in tele dermatology remote consultations.(8) The International  
124 Prospective Register of Systematic Reviews (PROSPERO) and OSF were searched up to May  
125 2022 for relevant ongoing systematic reviews using the terms 'telemedicine,' 'tele dermatology,'

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3 126 'dermatology,' 'diagnostic accuracy,' and 'diagnostic concordance.' Reference lists of included  
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5 127 studies were screened to identify additional studies not captured in the search.  
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10 129 Eligibility Criteria

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12 130 Studies evaluating the diagnostic reliability of teledermatology that reported on patients with  
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14 131 dermatological conditions assessed by a clinician using asynchronous or synchronous telemedicine  
15  
16 132 systems were included. All articles were required to compare tele- to F2F diagnoses conducted by  
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18 133 a physician. In this context, an 'F2F physician' refers to healthcare professionals, such as  
19  
20 134 dermatologists, general practitioners, or emergency department physicians, who conducted in-  
21  
22 135 person assessments only. This term is used to represent the comparison group in our analyses, and  
23  
24 136 these assessments may occur concurrently or sequentially with teledermatology consultations,  
25  
26 137 depending on the case. Exclusion criteria encompassed survey articles, feasibility studies, non-  
27  
28 138 dermatological telemedicine studies, cost-effectiveness studies, editorials, review articles, studies  
29  
30 139 using teledermatology as the reference standard, studies comparing only dermatoscopic images  
31  
32 140 without clinical images, and studies where patients captured their own photographs. The latter was  
33  
34 141 excluded to ensure consistent image quality, enabling a more accurate comparison of diagnostic  
35  
36 142 reliability between tele- and F2F methods. Included articles are summarized in **eTable 1** in the  
37  
38 143 supplementary appendix. Inclusion and exclusion criteria are summarized in **eTable 2**, available  
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40 144 in the supplementary appendix.  
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49 146 Data Selection & Extraction

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51 147 Following the removal of duplicated citations, the titles and abstracts were screened. Following  
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53 148 this step, a full-text assessment was conducted. At both stages, two reviewers performed screening  
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3 149 independently [AB and NB]. Any disagreements were resolved through consensus by the two  
4  
5 150 reviewers and when necessary, through discussion with a third reviewer [JLRG].  
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10 152 A data collection form was created on the *Covidence* website and piloted by two reviewers [AB,  
11  
12 153 NB]. Three additional reviewers assisted with data extraction [JLRG, MB, MM]. Two reviewers  
13  
14 154 were assigned to each paper. One reviewer extracted all characteristics of the included literature,  
15  
16 155 and the second reviewer validated the characteristics for accuracy. Any disagreements were  
17  
18 156 resolved by consensus. In the supplementary appendix, **eTable 3** summarizes the information  
19  
20 157 extracted from full-text articles.  
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#### 24 158 25 26 159 Data Synthesis

27  
28 160 This meta-analysis assessed the effectiveness of SFTD technologies and live video conferencing  
29  
30 161 in diagnosing skin conditions. Outcomes regarding complete diagnostic percentage agreement  
31  
32 162 rates and Cohen's kappa concordance were evaluated separately, with some studies being part of  
33  
34 163 both analyses if they reported both variables. The patient, intervention type, lesion, and geographic  
35  
36 164 characteristics were summarized qualitatively. Please see the supplementary appendix and **eTable**  
37  
38 165 **4** for more details on data synthesis and nomenclature for each study grouping.  
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#### 43 44 167 Risk of Bias

45  
46 168 Three reviewers [AB, NB, MB] completed the risk of bias assessment; all studies were  
47  
48 169 independently reviewed. Version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB  
49  
50 170 2) was used to assess the risk of bias in three randomized trials.(9, 10, 11) RoB 2 is structured into  
51  
52 171 a fixed set of domains of bias, focusing on different aspects of trial design, conduct, and  
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3 172 reporting.(12) The Quality Assessment of Diagnostic Assessment of Diagnostic Accuracy (2<sup>nd</sup>  
4  
5 173 Edition, QUADAS-2) was used to assess the risk of bias. Uncertain risk of bias was assigned to  
6  
7 174 studies with insufficient information except for studies that were likely to be biased due to missing  
8  
9 175 data. In the latter case, a high risk of bias was assigned.  
10  
11  
12 176

### 13 14 177 Synthesis of Results

15  
16  
17 178 Statistical analysis was performed using the dmetar package in R v.4.0.1 (R Foundation for  
18  
19 179 Statistical Computing, 2022). Agreement rates and Cohen's kappa concordances for unique study  
20  
21 180 groupings were treated as individual and independent values. For the percentage of agreement,  
22  
23 181 meta-analyses were conducted using the aggregated data, and proportions were calculated with the  
24  
25 182 corresponding 95 percent confidence intervals (CI). Point-biserial correlations were utilized to  
26  
27 183 calculate pooled kappa values. Statistical heterogeneity was investigated using the I<sup>2</sup> index and the  
28  
29 184  $\tau^2$  statistic, leading to the use of a random-effects model for overall complications with a logit  
30  
31 185 transformation due to the high degree of heterogeneity. Possible sources of heterogeneity were  
32  
33 186 explored through sub-group analysis, and confounding factors were controlled using meta-  
34  
35 187 regression. A random-effects model, as proposed by DerSimonian and Laird, was chosen as the  
36  
37 188 primary method to estimate all pooled estimates. Further details on the statistical analysis can be  
38  
39 189 found in the supplementary appendix.  
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### 47 191 Patient and Public Involvement

48  
49 192 Patients or the public were not involved in our research's design, conduct, reporting, or  
50  
51 193 dissemination plans.  
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## 194 **Results**

195 A total of 7,173 studies were screened for eligibility of which 44 were included in this study. Of  
196 these, 40 studies reported diagnostic agreement rates (4, 5, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20,  
197 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46,  
198 47) and 21 studies reported kappa concordance.(5, 9, 13, 14, 19, 22, 25, 28, 29, 30, 31, 32, 33, 35,  
199 36, 37, 48, 49, 50, 51, 52) Further details are provided in the PRISMA diagram in **Figure 1**. The  
200 complete list of excluded studies can be found in the supplementary appendix, **eTable 5**.

201

### 202 Study and patient characteristics

203 **eTable 1** summarizes the study and participant characteristics for the 44 included papers. Forty  
204 one of the included studies were observational, of which 32 were prospective, eight were  
205 retrospective. One study was ambispective. Two studies were randomized controlled trials and one  
206 study was a quasi-randomized trial. Studies selected for the review included a total of 52,075  
207 patients (Range: 26 to 24,210 patients). Some patients had multiple lesions and the total number  
208 of lesions included in the study was 57,222 (Range: 26 to 27,519 lesions).

209

210 The mean age reported in 27 (61%) studies was  $54.78 \pm 15.69$  years (Range: 0 to 100 years old).  
211 Thirty-four (77%) studies reported participant gender, with a mean of 57% females (Range: 3.2%  
212 to 74%). Only 13 (29%) studies reported information on Fitzpatrick skin types, ethnicity, or race.  
213 Twenty-eight studies (64%) included in this analysis were inclusive of all types of dermatoses, 13  
214 (29%) studies looked specifically at suspicious lesions, and three (7%) studies excluded skin  
215 cancers completely.

216

217 Diagnostic reliability of teledermatology when compared to F2F (specialist and non-specialist)  
218 evaluation

219 We assessed the diagnostic reliability of teledermatology compared to F2F evaluations by  
220 analyzing diagnostic agreement rates and concordance. The overall diagnostic agreement rate  
221 ranged from 13.9% to 98.0% (mean 68.9%, CI 64.4% to 73.1%), with a concordance that ranged  
222 from 0.21 to 0.96 (mean 0.67, CI 0.60 to 0.74). See **eFigure 1** and the supplementary appendix  
223 for further details.

224  
225 **Sub-group analyses**

226  
227 Diagnostic agreement between teledermatologist and teledermatologist, F2F and F2F physicians,  
228 and teledermatology and histopathology

229 See supplementary appendix and **eFigure 2** for further details.

230  
231 Diagnostic reliability of teledermatologist vs F2F specialist and non-specialist

232 Teledermatologists' 70.96% agreement rate with F2F dermatologists significantly exceeded the  
233 44.1% rate from non-specialists ( $p < 0.001$ ). Non-specialists consistently showed lower diagnostic  
234 concordance across studies; see supplementary appendix and **eFigure 3** for further details.

235  
236 Diagnostic reliability of teledermatology vs F2F by training provided for image acquisition

237 Twenty studies with 37 unique comparisons explicitly provided training to those in charge of  
238 image acquisition shown in **Figure 2**.(9, 10, 11, 14, 15, 16, 19, 20, 23, 26, 29, 32, 35, 36, 37, 38,

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3 239 39, 40, 41, 43, 44) The mean agreement rate between teledermatology and F2F physicians in these  
4  
5 240 studies was 75.9% (CI 74.4% to 77.27%), significantly higher than the 62.1% (CI 60.5% to 63.7%)  
6  
7 241 observed when no training was provided ( $p = 0.033$ , heterogeneity:  $I^2 = 98\%$ ). Concordance  
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9 242 values were also higher when training was provided (mean 0.77, CI 0.66-0.84) compared to when  
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11 243 no training was provided (mean 0.60, CI 0.49-0.69) ( $p = 0.01$ ,  $I^2=98\%$ ).  
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#### 17 245 Diagnostic reliability of teledermatology vs F2F by type of technology used for image acquisition

18  
19 246 Approximately half of the studies with 41 unique comparisons that compared Teledermatologists  
20  
21 247 with F2F physicians used digital cameras for image acquisition. Eighteen studies comparing F2F  
22  
23 248 and teledermatology agreement rates with 26 unique comparisons reported the use of smartphones  
24  
25 249 and tablets for image acquisition. **Figure 3** shows that the mean percentage agreement rate for  
26  
27 250 digital cameras was 71.7% (CI 70.3% to 73.1% compared to 59.8% (CI 57.2% to 62.3%) for  
28  
29 251 smartphones or tablets. The higher agreement rate with digital photography was statistically  
30  
31 252 significant ( $p = 0.029$ , heterogeneity:  $I^2=98\%$ ). The concordance values for digital photography  
32  
33 253 were reported for twelve studies with a mean of 0.70 (CI 0.61 to 0.76). Concordance values for  
34  
35 254 smartphone or tablet technologies were reported for eight studies with a mean of 0.62 (CI 0.38 to  
36  
37 255 0.78). The higher concordance with digital photography was statistically significant ( $p = 0.003$ ,  
38  
39 256 heterogeneity:  $I^2=100\%$ ).  
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#### 47 258 Other sub-group analyses

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49 259 No statistically significant patterns could be identified with the inclusion of teledermoscopy in  
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51 260 addition to clinical images (**eFigure 4**), lesion type (**eFigure 5**), grouping studies as pre- or post-  
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3 261 pandemic (figure not shown), or risk of bias (figure not shown). Please see the supplementary  
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5 262 appendix for further details.  
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10 264 **Quality assessment**

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12 265 The quality assessment results for risk of bias and applicability in individual studies are displayed  
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14 266 in the supplementary appendix and **eTable 6**.  
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19 268 **Discussion:**

20  
21 269 To our knowledge, this study constitutes the most extensive systematic review and meta-analysis  
22  
23 270 on teledermatology, including 44 studies across four languages.  
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28 272 Our sub-group analyses revealed that agreement rates between teledermatology consultations and  
29  
30 273 F2F physicians were significantly higher when dermatologists conducted in-person assessments  
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32 274 compared to non-specialists. This finding suggests that teledermatology may be more beneficial  
33  
34 275 in supplementing primary care than specialist care, as lower concordance with non-specialists  
35  
36 276 indicates reduced reference test accuracy. Although we did not directly assess the impact of  
37  
38 277 consulting teledermatologists on non-specialist accuracy, the included studies report high levels of  
39  
40 278 non-specialist satisfaction with the teleconsultation process. In fact, 96% of non-specialists agreed  
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42 279 that they learned about the dermatologic diagnosis, and 100% agreed that it helped patient care.(23)  
43  
44 280 These results are consistent with prior research attributing high provider satisfaction to streamlined  
45  
46 281 workflows, effective communication, and fast turnaround times in teledermatology.(2, 53)  
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3 283 The study emphasizes the importance of standardized training on image acquisition in improving  
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5 284 agreement rates between in-person and remote care. Additionally, digital photography was linked  
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8 285 to increased agreement rates, potentially due to enhanced image resolution and experienced staff  
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10 286 conducting virtual consultations using standardized procedures. This suggests a crucial need for  
11  
12 287 comprehensive training in image acquisition, highlighting the importance of equipping primary  
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14 288 care providers supporting telehealth delivery with high-quality cameras and the latest smartphone  
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16  
17 289 models.(24, 54, 55)  
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19 290  
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21 291 Assessing agreement on the management plan is crucial in teledermatology as it serves as a triage  
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23 292 tool for distinguishing mild/benign cases from severe/malignant/uncertain cases. Ensuring  
24  
25 293 concordance in the management plan between telemedicine and face-to-face consultations is vital  
26  
27 294 for optimizing patient care. Future research should explore the consistency of treatment  
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29 295 recommendations and interventions between telemedicine and in-person consultations to further  
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31 296 enhance the evaluation of telemedicine's effectiveness in guiding appropriate patient management.  
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37 298 Pathological assessment of skin lesions is the cornerstone of skin cancer diagnosis. This meta-  
38  
39 299 analysis found a 55.7% (CI 53.0% to 58.4%) agreement rate between teledermatology and  
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41 300 histopathology. This low agreement rate reflects all skin biopsies and specific diagnostic accuracy  
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43 301 rates could not be calculated by lesion type due to the small number of studies that reported this  
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45 302 value. Through sub-group analyses, we were able to compare cancerous and non-cancerous  
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47 303 lesions; slightly higher concordance was seen with skin cancers compared to studies that also  
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49 304 included non-suspicious lesions like dermatitis and psoriasis. However, the data was too  
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51 305 heterogeneous for any significant conclusions. We also looked at the use of teledermoscopy,  
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3 306 another technique that could help improve the diagnostic accuracy of teledermatology for  
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5 307 suspicious lesions, but no significant trends could be identified. These findings reflected the results  
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8 308 of a 2016 systematic review on teledermatology.<sup>(6)</sup>  
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10 309  
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12 310 Many teledermoscopy studies grouped statistics from lesions analyzed with and without  
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14 311 dermoscopy, preventing the assessment of the dermatoscope's incremental contributions without  
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16 312 the influence of potentially less accurate, dermatoscope-free analysis. Supporting this explanation,  
17  
18 313 the three teledermoscopy studies focused on cancer lesions demonstrated greater concordance rates  
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20 314 than the teledermoscopy studies targeting broader lesions. One study identified agreement rates  
21  
22 315 between teledermatology and F2F dermatology of 92.3% (24/26) and between teledermatology  
23  
24 316 and histopathology of 66.7% (17/26), both above our identified median.<sup>(45)</sup> Another study found  
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26 317 an agreement rate of 90% (37/41) when targeting pigmented lesions, although the rate may have  
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28 318 been inflated due to recall bias introduced by having the same dermatologist perform  
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30 319 teledermatology and F2F consults.<sup>(16)</sup> Finally, one study diagnosed keratotic lesions in sun-  
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32 320 exposed areas, finding a high agreement rate of 92% (915/1000).<sup>(37)</sup> However, this study also  
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34 321 risked bias from its experimental design, which excluded lesions with poor image quality. This  
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36 322 fails to recapitulate the complexities of practical teledermatology, which must contend with  
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38 323 potentially difficult image acquisition.  
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47 325 The 68.9% (CI 64.4% to 73.05%) combined agreement rate between teledermatology and F2F is  
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49 326 lower than the agreement rates outlined in a recent review.<sup>(56)</sup> This suggests our greater sample  
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51 327 size introduces more studies with poor agreement, which may better reflect the reality of adopting  
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53 328 teledermatology at a larger scale and signal risk from a lack of standardization.<sup>(55)</sup> Our date cut-  
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3 329 off of 2010 means our dataset has little overlap with existing reviews, and more heavily features  
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5 330 new relevant technologies like smartphone apps for image acquisition.(6, 57) The most recent  
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7 331 MA(57) on teledermatology limited its dataset to studies with multiple teledermatology and F2F  
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9 332 consults and variably choosing to filter low-frequency diagnoses from certain studies.<sup>(46)</sup>  
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12 333  
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14 334 We acknowledge several potential limitations. The heterogeneity of the data, though at first glance  
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16 335 might limit generalizability, enhances the adaptability and applicability of teledermatology across  
17  
18 336 diverse real-world contexts. Challenges exist due to the absence of stratification by study design  
19  
20 337 and a limited number of randomized controlled trials. Nevertheless, our findings emphasize the  
21  
22 338 critical importance of standardized processes for effective teledermatology, such as training in  
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24 339 image acquisition, reporting guidelines, and addressing privacy concerns. Our study reveals a  
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26 340 greater degree of heterogeneity compared to previous meta-analyses, reflecting real-world  
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28 341 application and clinical practice, bolstering the robustness of our conclusions. We advocate for a  
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30 342 nuanced interpretation when generalizing these findings across all settings, recognizing the  
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32 343 demographic and technological diversity in our sample as an asset. While our attempts to filter  
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34 344 biased studies didn't yield significant improvements to our meta-analysis model, we are mindful  
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36 345 of the potential risk of publication bias in our review.  
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44 347 Furthermore, our study only included a limited number of live video conferencing studies,(11, 24,  
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46 348 46) and our ability to draw meaningful conclusions regarding the differences between live video  
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48 349 conferencing and SFTD methods is therefore limited. A recent study by Duong et al. demonstrated  
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50 350 that live video conferencing can significantly contribute to diagnosis in teledermatology by  
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52 351 improving the quality of collected information and accuracy of the patient's status evaluation.(24)  
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3 352 The study found that videoconferencing significantly improved the diagnostic performance in  
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5 353 68.7% of cases. While these results are promising, further research is needed to explore the  
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8 354 potential differences between clinical images and live video conferencing.  
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12 356 In addition, our search was limited to published literature and may have missed relevant studies in  
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14 357 the grey literature and reports from low- and middle-income countries. Nonetheless, the variability  
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16  
17 358 across providers and settings underlines the need for a standardized framework to employ and  
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19 359 assess teledermatologists. Future research is needed to explore the differences between these  
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21 360 methods and other potential factors that may impact the efficacy of teledermatology, particularly  
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24 361 in low- and middle-income countries. We acknowledge these limitations and encourage further  
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26 362 research to address these gaps in the literature.  
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31 364 Current trends suggest that teledermatology will continue to expand, there have been many recent  
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33 365 studies examining its accuracy without the design considerations necessary to allow comparisons  
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35 366 beyond siloed investigations.(1) The implementation of evidence-informed processes is critical to  
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37  
38 367 the success of teledermatology services, and the accurate assessment of teledermatology will be  
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40 368 required to assess which contexts it should be employed in, e.g., suspected malignancy vs.  
41  
42 369 erythema.  
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47 371 While acknowledging the significant potential of artificial intelligence (AI) in enhancing  
48  
49 372 teledermatology, particularly in areas like image recognition and diagnosis, it is crucial to note that  
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51 373 our current study does not incorporate these aspects. The impact of AI on teledermatology, while  
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3 374 promising, introduces an additional layer of complexity, necessitating a dedicated, separate  
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5 375 investigation beyond the scope of our current study.  
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10 377 The factors targeted by our sub-analysis are undoubtedly important to standardize with best  
11  
12 378 practices requiring the inclusion of primary care provider training in image acquisition, explicitly  
13  
14 379 outlined conditions where dermatoscope attachments are required, and standardized reporting with  
15  
16 380 a lesion's anatomical site, size, distribution, morphology, and colour. Additional guidelines for  
17  
18 381 data reporting could be designed with a mind to future research goals, e.g., the inclusion of  
19  
20 382 Fitzpatrick grading to identify gaps in medical care. Finally, both clinical and research guidelines  
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22 383 must address privacy concerns, as integrating EMR and sharing of patient images or videos  
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24 384 presents potential vulnerabilities.  
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3 385 **Conclusion:**  
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5 386 This meta-analysis indicates that diagnostic agreement between remote and in-person  
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7 387 dermatologists is acceptable in select conditions (i.e., when training for image acquisition is  
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9 388 provided and technologies for high-quality images are used). Telemedicine adoption rates are  
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11 389 accelerating globally, and teledermatology must be considered for enhanced accessibility,  
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13 390 flexibility, reduced costs, and safer environments it can provide patients.  
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16  
17 391 The results of this meta-analysis represent significant evidence to indicate the suitability of  
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19 392 teledermatology for remote care, particularly as a complement to primary care, where it can serve  
20  
21 393 as an intermediate step before F2F specialist consultations. Furthermore, the categorization of  
22  
23 394 diagnostic concordance highlights important factors to further improve diagnostic accuracy.  
24  
25 395 Additionally, it highlights the lack of standardization in teledermatology studies, calling for greater  
26  
27 396 structure in clinical practice and conducting primary research.  
28  
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32  
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34

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38  
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42  
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45 403

46  
47 404 **Author Contributions:**  
48

49 405 JLRG is the guarantor of the review and supervised study design. JLRG also contributed to data  
50  
51 406 analysis and provided statistical expertise. AB and NB oversaw study design, data collection,  
52  
53 407 data analysis, and original draft preparation. AB designed the search strategy with the guidance  
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3 408 of the medical librarian, AKP. AB, NB, MB, and MM participated in the abstract and full-text  
4  
5 409 screen, data extraction, and risk of bias assessment. RDJF, AL, and SCW contributed to the draft  
6  
7 410 review and editing. All authors read, provided feedback and approved the final manuscript.  
8  
9

10 411

11  
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17  
18

19 415

20  
21 416 **Competing interests:**

22  
23 417 RDJF is an employee, and SCW is a co-founder, chief medical officer, and shareholder of Swift  
24  
25 418 Medical. JRGL and AL were formerly employees of Swift. No funding bodies have any role in  
26  
27 419 study design, data collection and analysis, decision to publish, or preparation of the manuscript.  
28  
29 420 All other authors declare no conflict of interest.  
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34 422 **Data availability statement:**

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36 423 Data are available in a public, open access repository. All data relevant to the study are included  
37  
38 424 in the article, uploaded as supplementary information, or deposited on Open Science Framework:  
39  
40 425 <https://osf.io/fjdvg>. Data are available under the terms of the Creative Commons Zero “No rights  
41  
42 426 reserved” data waiver (CC0 1.0 Public domain dedication). Our systematic review produced a  
43  
44 427 large amount of information, and the arising database is available for future collaboration on  
45  
46 428 additional analyses. Please contact the corresponding author with any inquiries.  
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51 430 **Patient consent for publication:**

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431 Not required.

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433 **Ethics and dissemination**

434 Ethics approval is not applicable for this study since no original data will be collected.

435

436 **Abstract word count: 230 words; Manuscript word count: 3389 words**

For peer review only



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3 590 **Figure Legends**  
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5 591 **Figure 1. PRISMA Flow diagram of study selection.**  
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9 594 **Figure 2. Forest plot representing F2F and teledermatology primary diagnostic agreement by whether imaging acquisition training was indicated by the study.**

10 595  
11 596 Forest plot representing F2F and teledermatology primary diagnostic agreement when image  
12 597 acquisition training is involved. Studies were sorted into two groups, a) Did not conduct or did not  
13 598 report training personnel on image acquisition; b) Stated that person in charge of image acquisition  
14 599 was trained. **(Left)** Forest plot representing percentage agreement and 95% C.I. for overall  
15 600 concordance across 40 studies with a total of 72 unique number of comparisons, N of events and total  
16 601 included participants. **(Right)** Forest plot representing kappa concordance and 95% C.I. for overall  
17 602 concordance across 21 studies with a total of 45 unique number of comparisons, N of total included  
18 603 participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology  
19 604 or Teledermatologist).  
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22 607 **Figure 3. Forest plot representing F2F and teledermatology primary diagnostic agreement by device type used to capture clinical photographs.**

23 608  
24 609 Forest plot representing F2F and teledermatology primary diagnostic agreement by imaging  
25 610 technology used. Studies were sorted into three groups, i) Digital photography ii) Imaging technology  
26 611 not mentioned iii) Smartphone or tablet. **(Left)** Forest plot representing percentage agreement and  
27 612 95% C.I. for overall concordance across 40 studies with a total of 72 unique number of comparisons,  
28 613 N of events and total included participants. **(Right)** Forest plot representing kappa concordance and  
29 614 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons,  
30 615 N of total included participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD  
31 616 (Teledermatology or Teledermatologist)  
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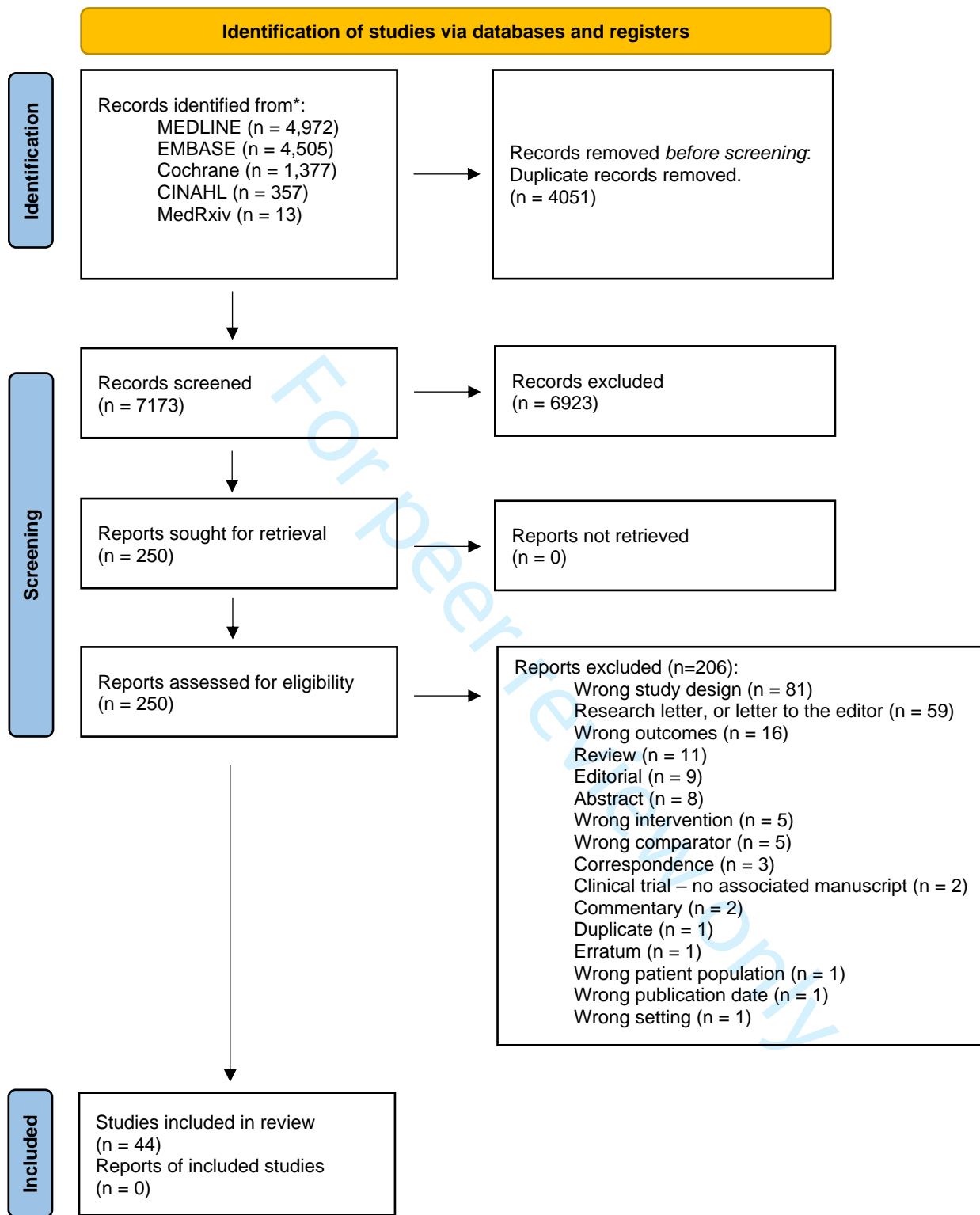
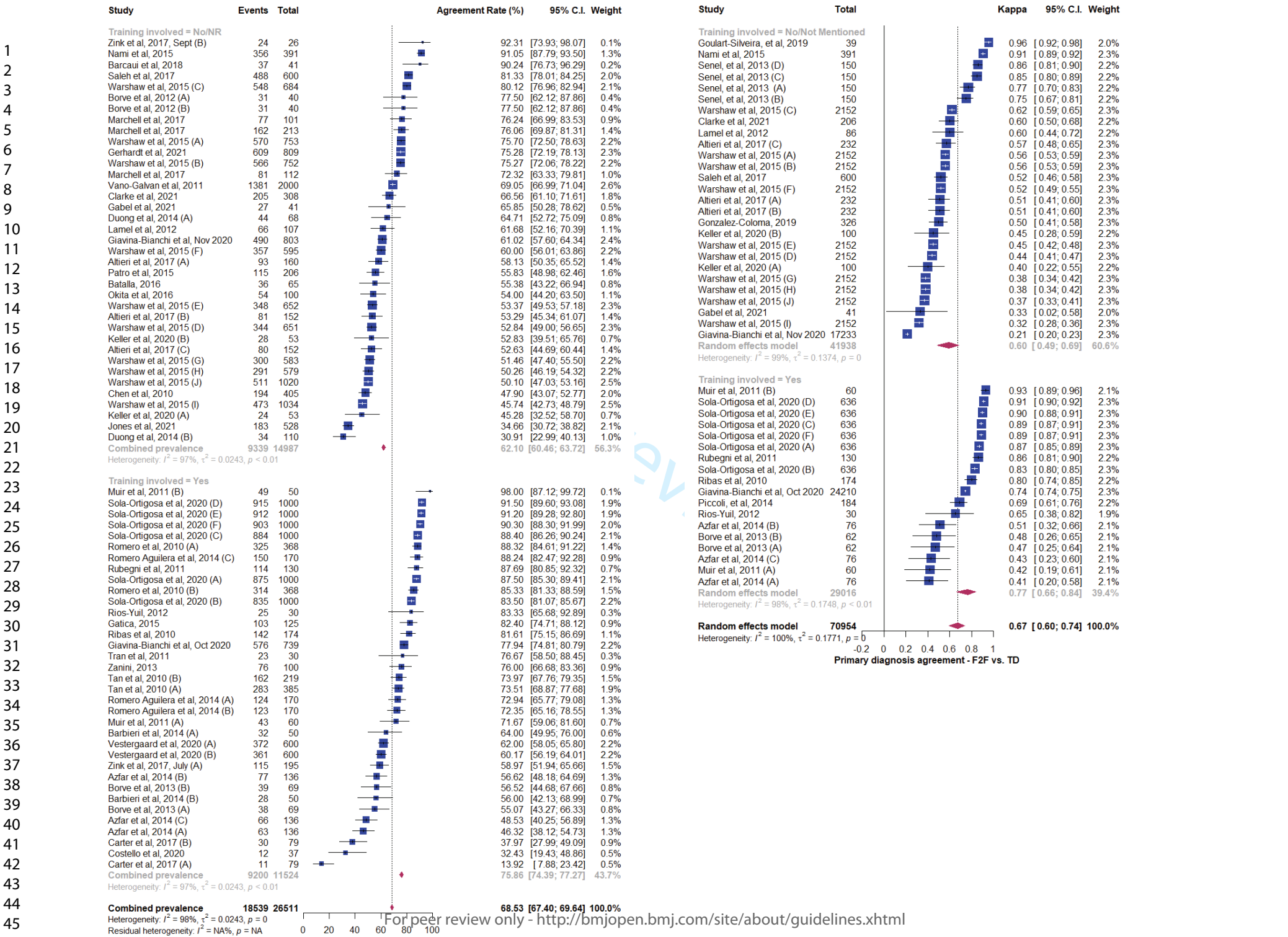
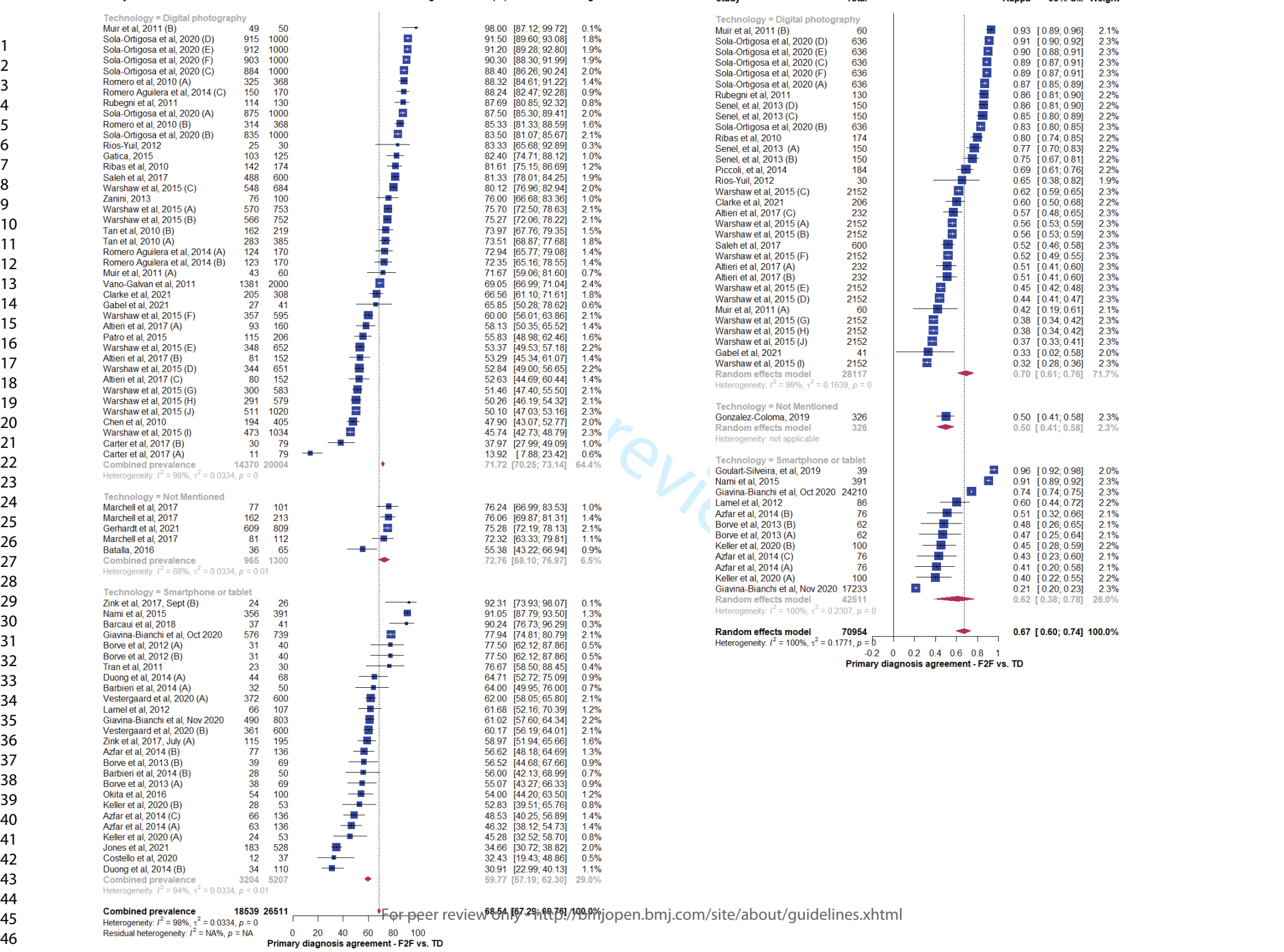


Figure 1. PRISMA Flow diagram of study selection.









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## Supplementary Online Content

**Title:** Diagnostic Reliability in Teledermatology: A Systematic Review and Meta-Analysis

### Authors

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## Supplementary eMethods

### Search Strategy

The search strategy was written for Ovid Medline and translated using each database's syntax, controlled vocabulary, and search fields. MeSH terms, Emtree terms, and free text words were used for teledermatology and skin conditions such as melanoma and related synonyms. To identify additional articles not captured through the aforementioned search, a manual search was conducted via reference search of the included studies.

All database records were downloaded to EndNote X9 (Clarivate) and uploaded to web-based software for deduplication, screening, and full-text evaluation (Covidence; Veritas Health Innovation). We contacted three study authors to gain access to their published work.(1, 2, 3) The search strategy is available below.

### Ovid MEDLINE Search

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations and Daily <1946 to 2022 May 02>

1	e consult*.mp.	322
2	econsult*.mp.	218
3	electronic consult*.mp.	366
4	e health.mp.	4095
5	ehealth.mp.	6823
6	e visit*.mp.	88
7	evisit*.mp.	26
8	home video visit*.mp.	4
9	internet/ or internet-based intervention/	82046
10	internet.mp.	128675
11	offsite care.mp.	4
12	off site care.mp.	9
13	ontario telemedicine network.mp.	19
14	Remote Consultation/	5689
15	remote consultation*.mp.	6406
16	remote visit*.mp.	95
17	tele care.mp.	40
18	telecare.mp.	945
19	tele consult*.mp.	208
20	teleconsult*.mp.	2208
21	tele diagnos*.mp.	46
22	telehealth.mp.	13222
23	tele health.mp.	287
24	telemedicine/	36763
25	telemedicine.mp.	47751
26	tele medicine.mp.	197
27	telemonitor*.mp.	2380
28	tele monitor*.mp.	209
29	Telepathology/	918
30	telepatholog*.mp.	1223
31	tele patholog*.mp.	25
32	telepractice*.mp.	276
33	tele practice*.mp.	16
34	Therapy, Computer-Assisted/	6969
35	video consult*.mp.	827
36	videoconsult*.mp.	41
37	virtual care.mp.	1177
38	web based.mp.	42402
39	Telepathology/	918

1  
2  
3 77 40 or/1-39 216985  
4 78 41 Dermatology/21077  
5 79 42 dermatolog\*.mp. 110593  
6 80 43 dermatopatholog\*.mp. 2990  
7 81 44 exp Skin Diseases/di [Diagnosis] 196739  
8 82 45 exp Skin Neoplasms/ 142454  
9 83 46 skin.mp. 880457  
10 84 47 exp Skin Abnormalities/ 34228  
11 85 48 burns/ or burns, chemical/ or burns, electric/ or sunburn/ 59533  
12 86 49 burn\*.mp. 141877  
13 87 50 wound healing/ or cicatrix/ 127484  
14 88 51 wound\*.mp. 446154  
15 89 52 or/41-51 1580012  
16 90 53 40 and 52 7160  
17 91 54 teledermatolog\*.mp. 1273  
18 92 55 tele dermatolog\*.mp. 35  
19 93 56 54 or 55 1298  
20 94 57 53 or 56 7448  
21 95 58 limit 57 to dt=20100101-20220501 [January 1st, 2010 to May 1st, 2022] 4972  
22 96  
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### Embase Search

24 99 Embase Classic+Embase <1947 to 2021 July 15>  
25 100 1 computer assisted therapy/ 4772  
26 101 2 e consult\*.mp. 411  
27 102 3 econsult\*.mp. 283  
28 103 4 electronic consult\*.mp. 461  
29 104 5 e health.mp. 4440  
30 105 6 ehealth.mp. 5099  
31 106 7 e visit\*.mp. 83  
32 107 8 evisit\*.mp. 30  
33 108 9 home video visit\*.mp. 10  
34 109 10 internet/ or web-based intervention/ 114861  
35 110 11 internet.mp. 143810  
36 111 12 offsite care.mp. 5  
37 112 13 off site care.mp. 12  
38 113 14 ontario telemedicine network.mp. 36  
39 114 15 remote consultation\*.mp. 808  
40 115 16 remote visit\*.mp. 79  
41 116 17 tele care.mp. 55  
42 117 18 telecare.mp. 983  
43 118 19 teleconsultation/ 11686  
44 119 20 tele consult\*.mp. 243  
45 120 21 teleconsult\*.mp. 12352  
46 121 22 tele diagnos\*.mp. 53  
47 122 23 telehealth.mp. 15276  
48 123 24 tele health.mp. 389  
49 124 25 telemedicine/ 31867  
50 125 26 telemedicine.mp. 38951  
51 126 27 tele medicine.mp. 333  
52 127 28 telemonitor\*.mp. 4838  
53 128 29 tele monitor\*.mp. 344  
54 129 30 Telepathology/ 869  
55 130 31 telepatholog\*.mp. 1265  
56 131 32 tele patholog\*.mp. 41  
57 132 33 telepractice\*.mp. 162

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3 133 34 tele practice\*.mp. 9  
4 134 35 video consult\*.mp. 751  
5 135 36 videoconsult\*.mp. 54  
6 136 37 virtual care.mp. 496  
7 137 38 web based.mp. 49157  
8 138 39 or/1-38 240118  
9 139 40 dermatology/ or cosmetic dermatology/ or pediatric dermatology/ or psychodermatology/ 51419  
10 140 41 dermatolog\*.mp. 161210  
11 141 42 dermatopatholog\*.mp. 3737  
12 142 43 burn/ or burn contracture/ or electric burn/ or face burn/ or hand burn/ or ionizing radiation burn/ or scald/ or  
13 143 sunburn/ 74890  
14 144 44 burn\*.mp. 189010  
15 145 45 exp skin disease/di [Diagnosis] 209136  
16 146 46 exp skin tumor/ 213775  
17 147 47 skin\*.mp. 1294867  
18 148 48 or/40-47 1665263  
19 149 49 39 and 48 7063  
20 150 50 teledermatology/ 1295  
21 151 51 tele dermatolog\*.mp. 42  
22 152 52 teledermatolog\*.mp. 1798  
23 153 53 50 or 51 or 52 1812  
24 154 54 49 or 53 8004  
25 155 55 limit 54 to (books or chapter or conference abstract or conference paper or "conference review") 1828  
26 156 56 54 not 55 6176  
27 157 57 limit 56 to yr="2010 -Current" 4505  
28 158

### 28 159 Cochrane Search

29 160 EBM Reviews - Cochrane Database of Systematic Reviews <2005 to July 14, 2021> EBM Reviews - ACP Journal  
30 161 Club <1991 to June 2021> EBM Reviews - Database of Abstracts of Reviews of Effects <1st Quarter 2016> EBM  
31 162 Reviews - Cochrane Clinical Answers <June 2021> EBM Reviews - Cochrane Central Register of Controlled Trials  
32 163 <June 2021> EBM Reviews - Cochrane Methodology Register <3rd Quarter 2012> EBM Reviews - Health  
33 164 Technology Assessment <4th Quarter 2016> EBM Reviews - NHS Economic Evaluation Database <1st Quarter  
34 165 2016>  
35 166 1 e consult\*.mp. 44  
36 167 2 econsult\*.mp. 22  
37 168 3 electronic consult\*.mp. 29  
38 169 4 e health.mp. 617  
39 170 5 ehealth.mp. 766  
40 171 6 e visit\*.mp. 14  
41 172 7 evisit\*.mp. 1  
42 173 8 home video visit\*.mp. 3  
43 174 9 internet/ or internet-based intervention/ 4,275  
44 175 10 internet.mp. 15,059  
45 176 11 offsite care.mp. 2  
46 177 12 off site care.mp. 2  
47 178 13 ontario telemedicine network.mp. 7  
48 179 14 Remote Consultation/ 460  
49 180 15 remote consultation\*.mp. 551  
50 181 16 remote visit\*.mp. 17  
51 182 17 tele care.mp. 34  
52 183 18 telecare.mp. 249  
53 184 19 tele consult\*.mp. 59  
54 185 20 teleconsult\*.mp. 822  
55 186 21 tele diagnos\*.mp. 4  
56 187 22 telehealth.mp. 2,308  
57 188 23 tele health.mp. 128

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3	189	24 telemedicine/	2,617
4	190	25 telemedicine.mp.	4,819
5	191	26 tele medicine.mp.	57
6	192	27 telemonitor*.mp.	1,236
7	193	28 tele monitor*.mp.	115
8	194	29 Telepathology/	8
9	195	30 telepatholog*.mp.	22
10	196	31 tele patholog*.mp.	2
11	197	32 telepractice*.mp.	37
12	198	33 tele practice*.mp.	0
13	199	34 Therapy, Computer-Assisted/	1,391
14	200	35 video consult*.mp.	117
15	201	36 videoconsult*.mp.	8
16	202	37 virtual care.mp.	31
17	203	38 web based.mp.	9,110
18	204	39 Telepathology/	8
19	205	40 or/1-39	29,268
20	206	41 Dermatology/	124
21	207	42 dermatolog*.mp.	10,838
22	208	43 dermatopatholog*.mp.	80
23	209	44 exp Skin Diseases/di [Diagnosis]	630
24	210	45 exp Skin Neoplasms/	1,738
25	211	46 skin.mp.	67,534
26	212	47 exp Skin Abnormalities/	269
27	213	48 burns/ or burns, chemical/ or burns, electric/ or sunburn/	1,779
28	214	49 burn*.mp.	12,780
29	215	50 wound healing/ or cicatrix/	5,677
30	216	51 wound*.mp.	35,982
31	217	52 or/41-51	110,390
32	218	53 40 and 52	1,622
33	219	54 teledermatolog*.mp.	149
34	220	55 tele dermatolog*.mp.	20
35	221	56 54 or 55	151
36	222	57 53 or 56	1,684
37	223	58 limit 57 to yr="2010 -Current"	1,377
38	224		

**CINAHL Search**

Searched keyword teledermatology and set limit to yr="2010-Current" 357

**MedRxiv Search**

Searched keyword teledermatology and set limit to yr="2010-Current" 13

**Eligibility Criteria**

Inclusion and exclusion criteria are summarized in **eTable 2**.

**Data Selection and Extraction**

Information extracted from full-text articles is summarized in **eTable 3**.

**Data Analysis and Synthesis**

In this study, a letter was assigned to each unique study grouping as explained in **eTable 4**. For both the percentage of agreement and kappa values, forest plots, the  $I^2$  index, and the  $\tau^2$  statistic were used in combination to investigate statistical heterogeneity. To evaluate the statistical significance of differences between kappa values, we performed meta-regressions and derived corresponding p-values.



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3 243 Cohen's kappa values for diagnostic concordance between teledermatology and F2F physicians were interpreted based  
4 244 on the following criteria.<sup>(4)</sup> Values between 0–.20 indicate no agreement, .21–.39 minimal agreement, .40–.59 weak  
5 245 agreement, .60–.79 moderate agreement, .80–.90 strong agreement, and above .90 almost perfect agreement.

6 246  
7 247 Sub-group analysis included different skin conditions, specialization of the F2F physician, whether staff were trained  
8 248 on image acquisition, the technology used for image acquisition, the use of teledermoscopy, studies conducted pre- or  
9 249 post-pandemic, and the risk of bias. Confounding factors, such as technology type, year of publication, and training  
10 250 of study raters, were controlled using meta-regression.

11 251  
12 252 Proportions meta-analysis looked at weighted averages, and 95% confidence intervals were reported. Given the unique  
13 253 properties of proportional data and the considerable heterogeneity observed, conventional publication bias tests,  
14 254 specifically designed for comparative data, were not considered applicable. As such, statistical pursuit of publication  
15 255 bias was not undertaken. Instead, a methodologically appropriate qualitative assessment of publication bias was  
16 256 implemented for this type of analysis. This approach was deemed to provide the most accurate and robust outcome.

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## 257 **Supplementary eResults**

258

259 Our analysis incorporated forty-four relevant studies. Key study and participant details are summarized in **eTable 1**,  
260 with a concise overview provided in the main text. Articles excluded based on our criteria are listed in **eTable 5**.

261

### 262 **Diagnostic reliability of teledermatology when compared to F2F (specialist and non-specialists) evaluation**

263 Of the 40 studies that reported diagnostic agreement rates there were 72 unique comparisons made between F2F and  
264 teledermatology.(5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32,  
265 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44) **eFigure 1A** shows that the mean percentage agreement of 68.9% (CI  
266 64.4%-73.1%) ranged from 14% to 98%, where 35/72 had percentage agreement above 70% and 7 studies had over  
267 90% agreement. The studies were heterogeneous ( $I^2=98\%$ ,  $p < 0$ ).

268

269 Of the 21 studies that reported concordance values, there were 45 unique comparisons made.(5, 6, 11, 14, 17, 20, 21,  
270 22, 23, 24, 25, 28, 29, 32, 33, 34, 45, 46, 47, 48, 49) **eFigure 1B** shows that the mean diagnostic concordance of 0.67  
271 (CI 0.60 to 0.74) ranged from 0.213 (CI 0.20 to 0.23) to 0.96 (CI 0.92 to 0.98), with 21 studies (47%) having moderate  
272 agreement ( $k=0.6$  and above), and 13 (29%) studies having strong agreement. The studies were heterogeneous  
273 ( $I^2=100\%$ ,  $p < 0.001$ ).

274

### 275 **Diagnostic agreement between teledermatologist and teledermatologist, F2F and F2F, and teledermatology 276 and histopathology**

277 Of the ten studies that reported diagnostic agreement rates between telermatologists, there were 17 unique comparisons  
278 made between F2F and teledermatology consults. **eFigure 2A** shows the mean percentage agreement of 76.4% (CI  
279 69% to 82.5%) ranged from 37% to 91.5%, with 10/17 having percentage agreement above 70% and two studies  
280 having over 90% agreement. The studies were heterogeneous ( $I^2=97\%$ ,  $p < 0.001$ ).

281

282 From four studies that reported diagnostic agreement rates between F2F dermatologists there were 6 unique  
283 comparisons. **eFigure 2B** shows that the mean percentage agreement 82.4% (CI 76.7% -87.0%) ranged from 75.5% to  
284 91%. The studies were heterogeneous ( $I^2=68\%$ ,  $p < 0.001$ ).

285

286 Five studies compared teledermatology to histopathology data, and there were six unique comparisons. **eFigure 2C**  
287 shows that the mean percentage agreement of 55.7% (CI 53% to 58.4%) ranged from 53.8% to 65.4%. The mean  
288 agreement rate between histopathology and teledermatology was 55.7% (CI 53.0 to 58.4). The studies were  
289 homogeneous ( $I^2=0\%$ ,  $p = 0.49$ ).

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## 291 **Subgroup analyses**

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### 293 **Diagnostic reliability of teledermatology vs F2F specialist and non-specialist**

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295 Within the same modality, **eFigure 3A** shows that teledermatologists had a diagnostic agreement rate of 70.96% (CI  
296 69.8% to 72.1%) with F2F dermatologists, while the agreement rate with F2F non-specialists was 44.1% (CI 39.9%  
297 to 48.4%). Comparing telermatologists to non-specialists showed significantly lower agreement among non-specialists  
298 ( $p < 0.001$ , heterogeneity:  $I^2 = 98\%$ ). Among 35 studies reporting diagnostic agreement rates, 44 out of 64  
299 comparisons between teledermatology and F2F dermatologists had a percentage agreement above 60%, with seven  
300 studies reporting over 90% agreement. The mean kappa concordance value for diagnostic agreement between  
301 teledermatology and F2F dermatologists shown in **eFigure 3B** was 0.69 (CI 0.60 to 0.75). Additionally,  
302 telermatologists had a mean concordance value of 0.52 (CI 0.25 to 0.71) when compared to non-specialists. Non-  
303 specialists showed significantly lower diagnostic concordance compared to dermatologists for F2F vs.  
304 teledermatology ( $p = 0.031$ , heterogeneity:  $I^2 = 100\%$ ). Moreover, studies comparing teledermatologists to F2F and  
305 teledermatology to histopathology showed a range of agreement rates, with heterogeneity observed in the former ( $I^2$   
306  $= 97\%$ ,  $p < 0.001$ ) and homogeneity in the latter ( $I^2 = 0\%$ ,  $p = 0.49$ ).

307

### 308 **Diagnostic reliability of teledermatology vs F2F by the inclusion of teledermoscopy in both teledermatology 309 and F2F assessments**

310 Overall, twelve studies with 22 unique comparisons used teledermoscopy for diagnosing suspicious lesions.(8, 11, 15,  
311 29, 32, 34, 38, 39, 42, 44) **eFigure 4A** shows that with teledermoscopy, the mean diagnostic agreement rates was  
312 69.1% (CI 66.8% to 71.4%), and this percentage ranged between from 31.6% to 92.3%. Without the use of

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3 313 teledermoscopy, the mean agreement rate was 68.3% (CI 66.8% to 69.8%). The means were not significantly different  
4 314 between the two groups and the studies were heterogeneous ( $I^2=97%$ ,  $p<0.001$ ). **eFigure 4B** shows concordance  
5 315 values of seven studies that adapted teledermoscopy had a mean of 0.71 (CI 0.58 to 0.80).(11, 29, 32, 34, 39, 47, 48)  
6 316 Without teledermoscopy, the mean was 0.65 (CI 0.54 to 0.74). This difference was not statistically significant, and  
7 317 the studies were heterogeneous ( $I^2=100%$ ,  $p<0.001$ ).  
8 318

### 9 319 **Diagnostic reliability of teledermatology vs F2F by the inclusion of lesion category**

10 320 Twenty-six studies with 39 unique comparisons reporting percentage agreement rates that were inclusive to all lesion  
11 321 types as shown in **eFigure 5A**.(5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 19, 22, 24, 25, 26, 28, 29, 30, 31, 32, 33, 36, 37, 40,  
12 322 41, 43) The mean percentage agreement was 69.9% (CI 67.9% to 71.7%) and ranged from 30.9% to 98%, with the  
13 323 majority (26/39) having percentage agreement above 60% and 4 studies having over 90%. Eleven studies only looked  
14 324 at suspicious lesions,(11, 12, 14, 20, 23, 34, 35, 38, 39, 42, 44) and the mean percentage agreement was 68.1% (CI  
15 325 66.3% to 69.8%). Three studies excluded skin cancers(13, 21, 27) and the mean percentage agreement was 62.2% (CI  
16 326 56.2% to 67.8%). No statistical significance could be identified between the three lesion groups and the studies were  
17 327 heterogeneous ( $I^2=98%$ ,  $p<0.001$ ).  
18 328

19 329 Concordance values for studies inclusive to all lesions seen in **eFigure 5B** were reported in ten studies with a mean  
20 330 of 0.62 (CI 0.48 to 0.74).(5, 6, 17, 22, 24, 25, 28, 29, 32, 33) Six studies that looked at cancerous skin lesions only  
21 331 reported a mean of 0.70 (CI 0.59 to 0.78).(11, 14, 20, 23, 34, 39) Only one study that looked at all lesions except  
22 332 cancerous ones reported a concordance value.<sup>22</sup> No statistical significance could be identified between the three lesion  
23 333 groups and the studies were heterogeneous ( $I^2=100%$ ,  $p<0.001$ ).  
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### 26 336 **Diagnostic reliability of teledermatology vs F2F by pre- and post-pandemic timelines**

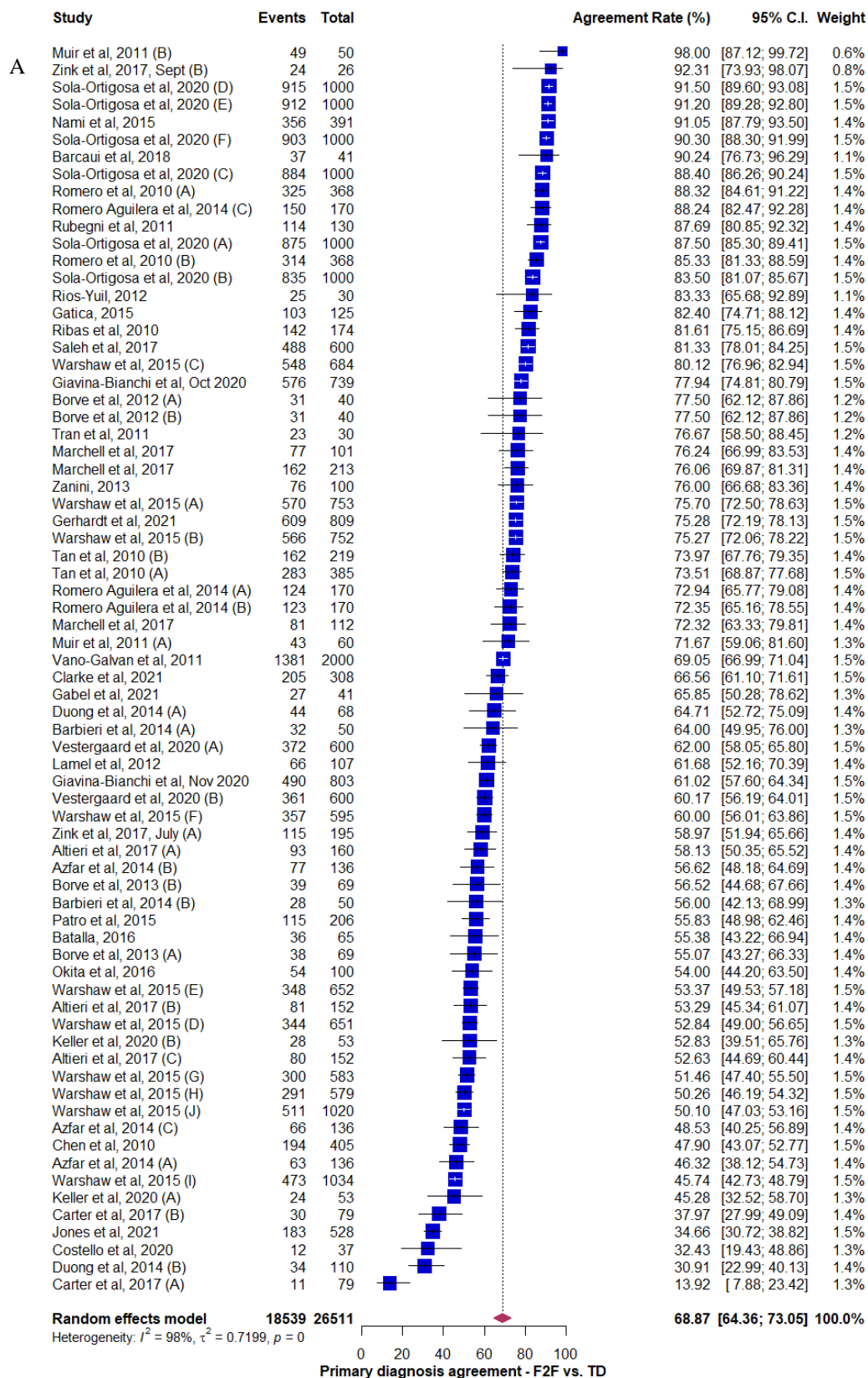
27 337 When comparing telermatologists to all F2F physicians, the average agreement rate was 65.5% (CI 64.0-66.9) for pre-  
28 338 pandemic studies, and 75.3% (CI 73.4% to 77.2%) for studies published after January 2020. When the percentage  
29 339 agreements were compared between the two groups, they were not statistically significant ( $p = 0.421$ ) and also  
30 340 heterogeneous ( $I^2=98%$ ,  $p<0.001$ ). eTable not included.  
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### 33 343 **Risk of bias and quality assessment**

34 344 The QUADAS-2 framework was utilized to evaluate bias and applicability across four essential domains, ensuring  
35 345 that our conclusions are both accurate and applicable to real-life clinical situations. **eTable 6A** summarizes the  
36 346 QUADAS-2 criteria tailored to this study.  
37 347

38 348 The results of quality assessment for risk of bias and applicability in individual studies are displayed in. **eTable 6B-**  
39 349 **E**. Six of the studies had low risk of bias, nine had moderate risk, and 29 had high-risk of bias. There were no  
40 350 systematic differences between the results of studies that attempted to reduce risk of bias, compared with those with  
41 351 higher risk of bias. The mean diagnostic agreement rate between F2F and teledermatology was 66.4% (CI 62.4% to  
42 352 70.1%) for low risk, and 69.1% (CI 67.6% to 70.6%) for high risk ( $p = 0.932$ ). When the percentage agreements were  
43 353 compared between groups, they were heterogeneous ( $I^2=98%$ ,  $p<0.001$ ). eTable not included.  
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354 **Supplementary eFigures and Legends**



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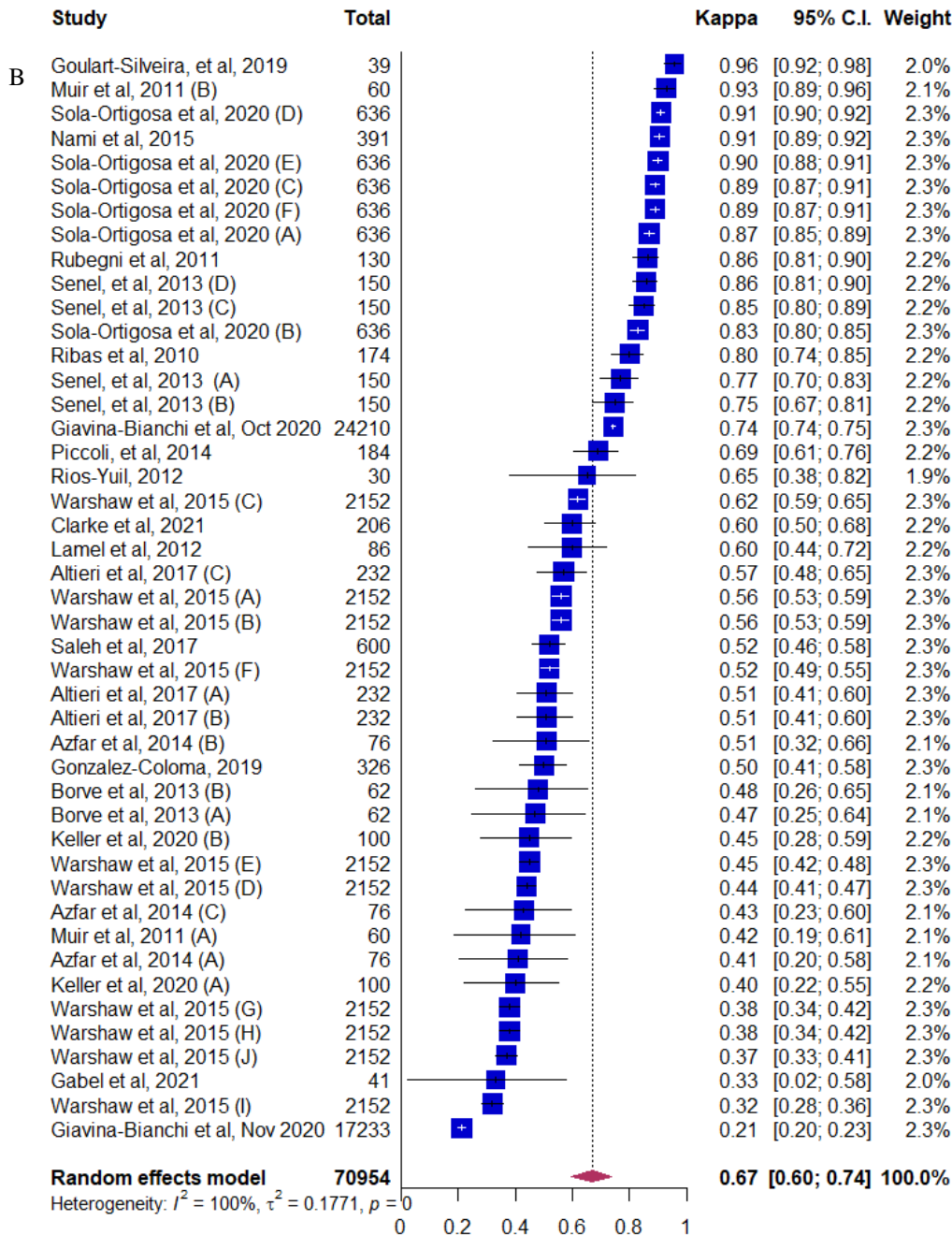
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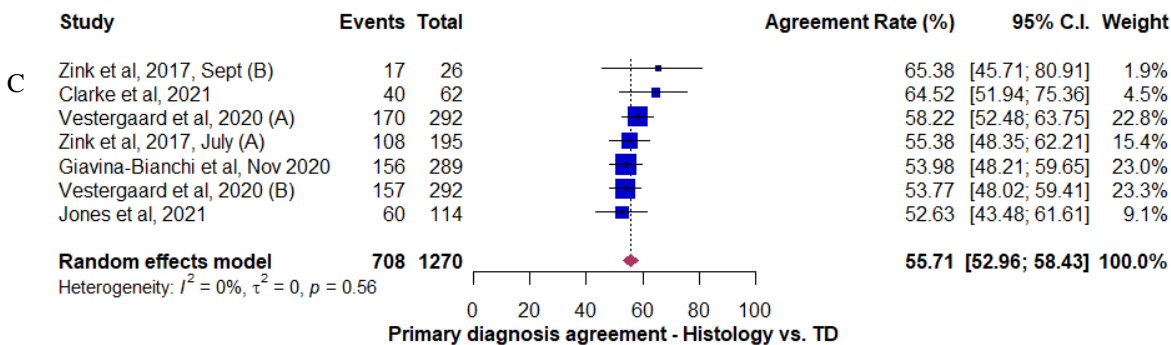
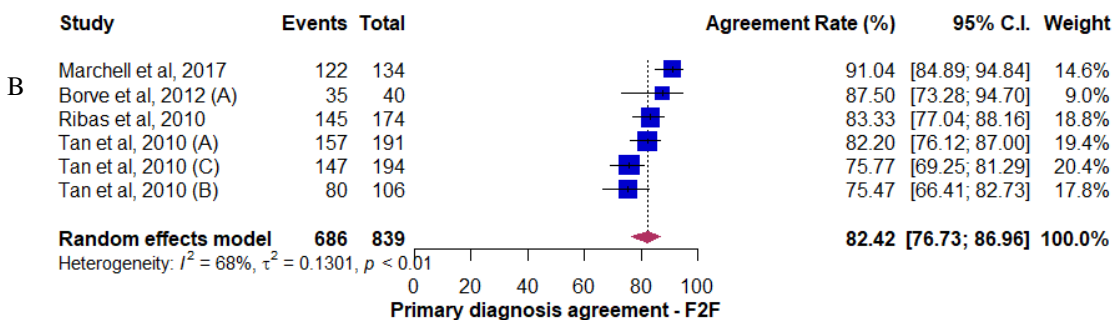
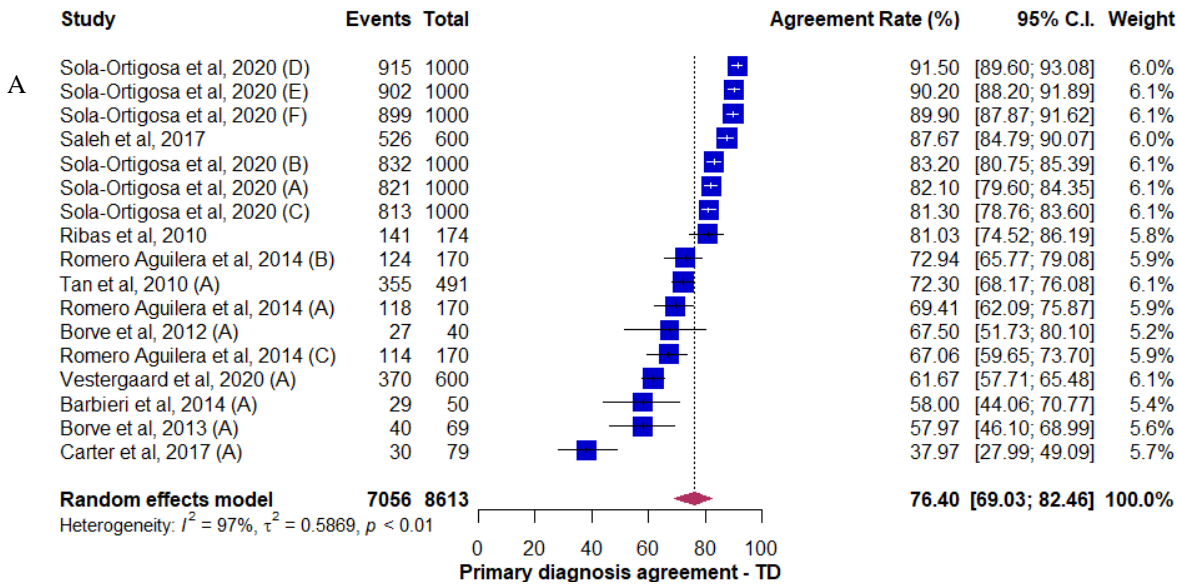
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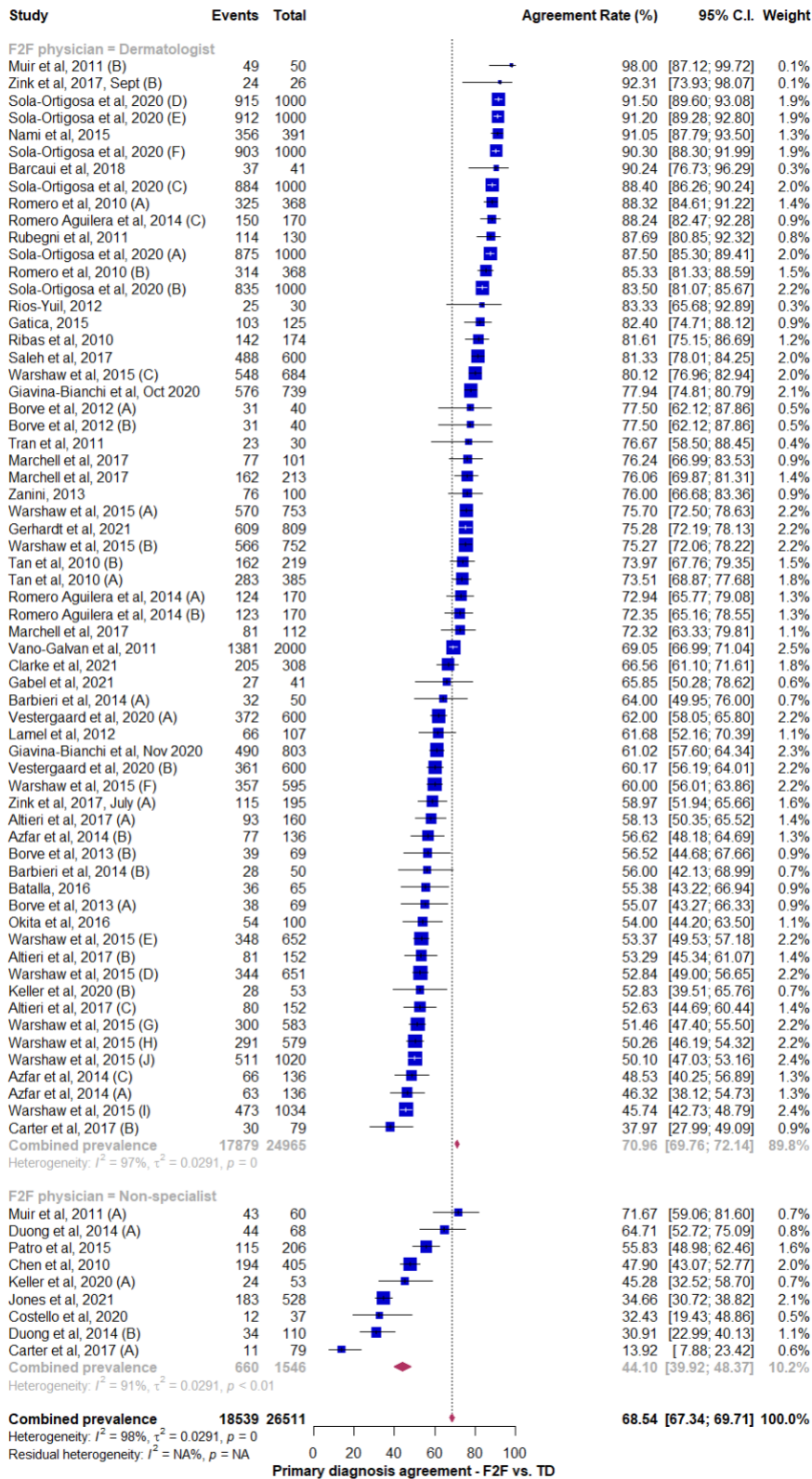
**eFigure 1. Forest plot representing F2F and teledermatology primary diagnostic agreement.** (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 40 studies with a total of 72 unique number of comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology or Teledermatologist).





367 **eFigure 2. Forest plot representing teledermatologists, F2F physicians, and histopathology primary diagnostic**  
 368 **agreements.** (A) Forest plot representing percentage agreement between teledermatologist and teledermatologist and  
 369 95% C.I. for overall concordance across ten studies with a total of 17 unique number of comparisons, N of events and  
 370 total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance  
 371 between two F2F physician diagnoses across four studies with a total of six unique number of comparisons, N of total  
 372 included participants. (C) Forest plot representing percentage agreement between teledermatologists and  
 373 histopathology with 95% C.I. for overall concordance across six studies, N of events and total included participants.  
 374 Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology or Teledermatologist).  
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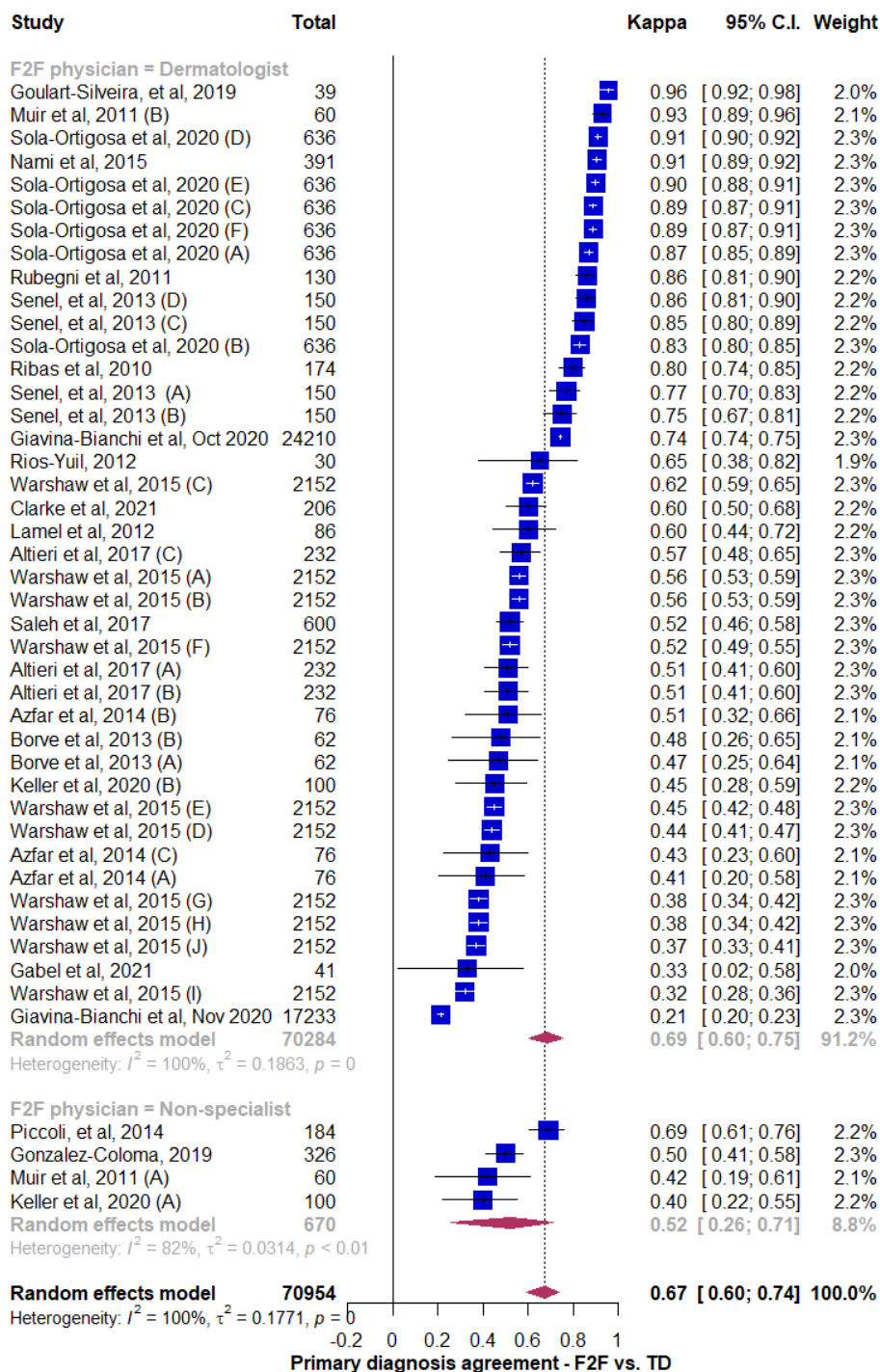
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 378 **eFigure 3. Forest plot representing F2F and teledermatology primary diagnostic agreement by specialization**  
 379 **status of the F2F physician.** Studies were sorted into two groups, a) F2F diagnosis completed by a board-certified  
 380 dermatologist; b) F2F diagnosis completed by a non-specialist (e.g., general practitioner). (A) Forest plot representing  
 381 percentage agreement and 95% C.I. for overall concordance across 40 studies with a total of 72 unique number of  
 382 comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95%  
 383 C.I. for overall concordance across 21 studies with a total of 45 unique number of comparisons, N of total included

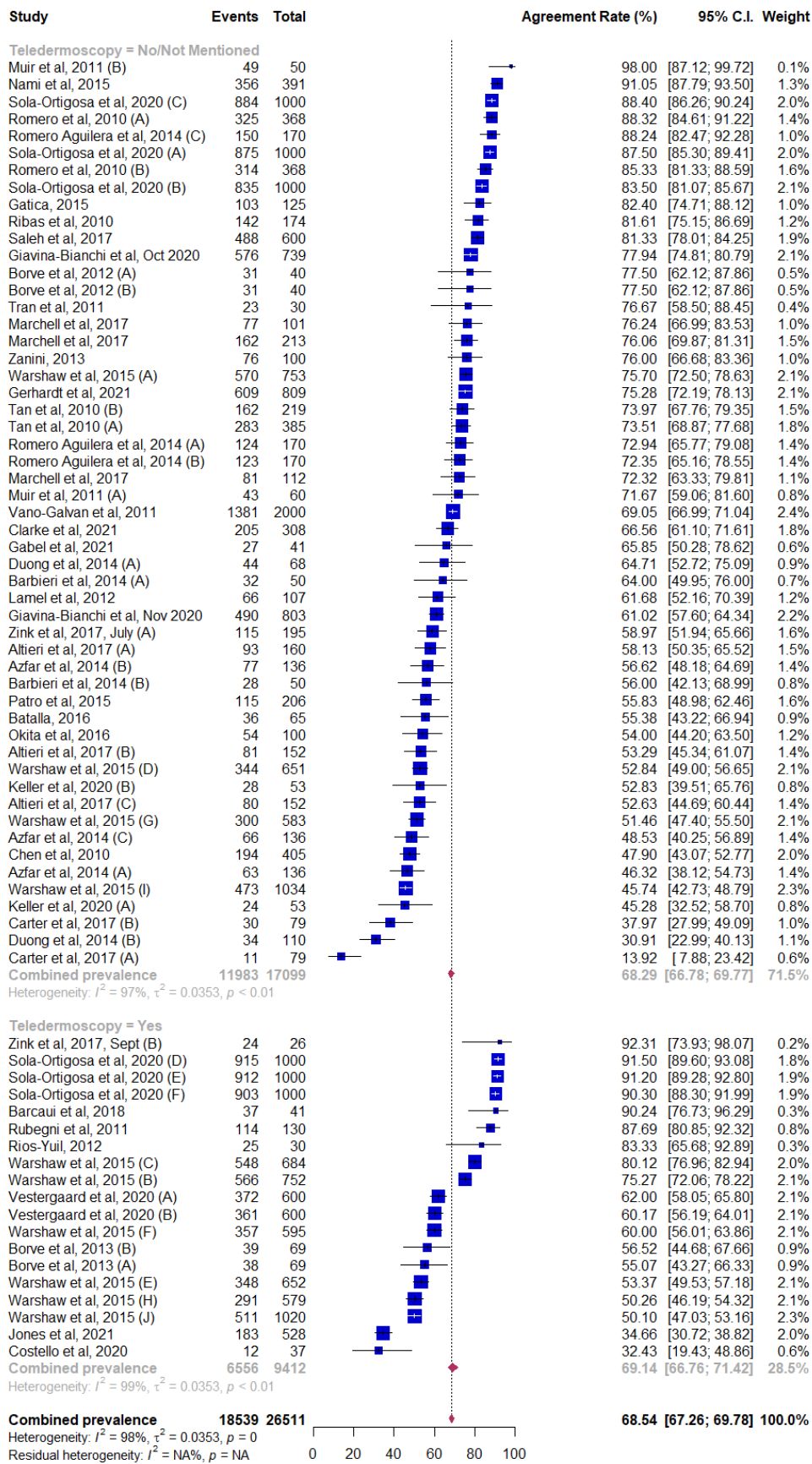


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384 participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology or  
385 Teledermatologist).  
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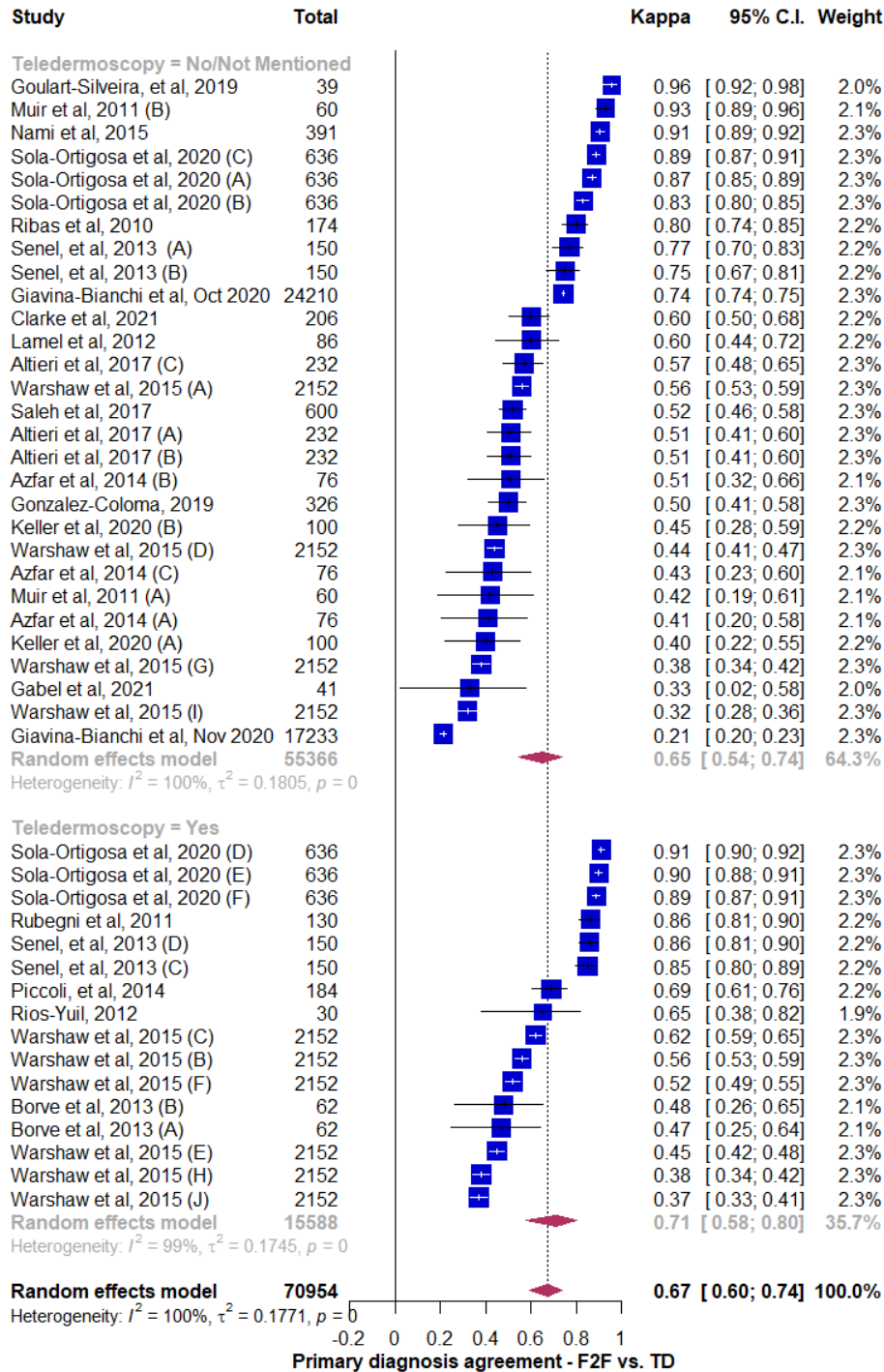
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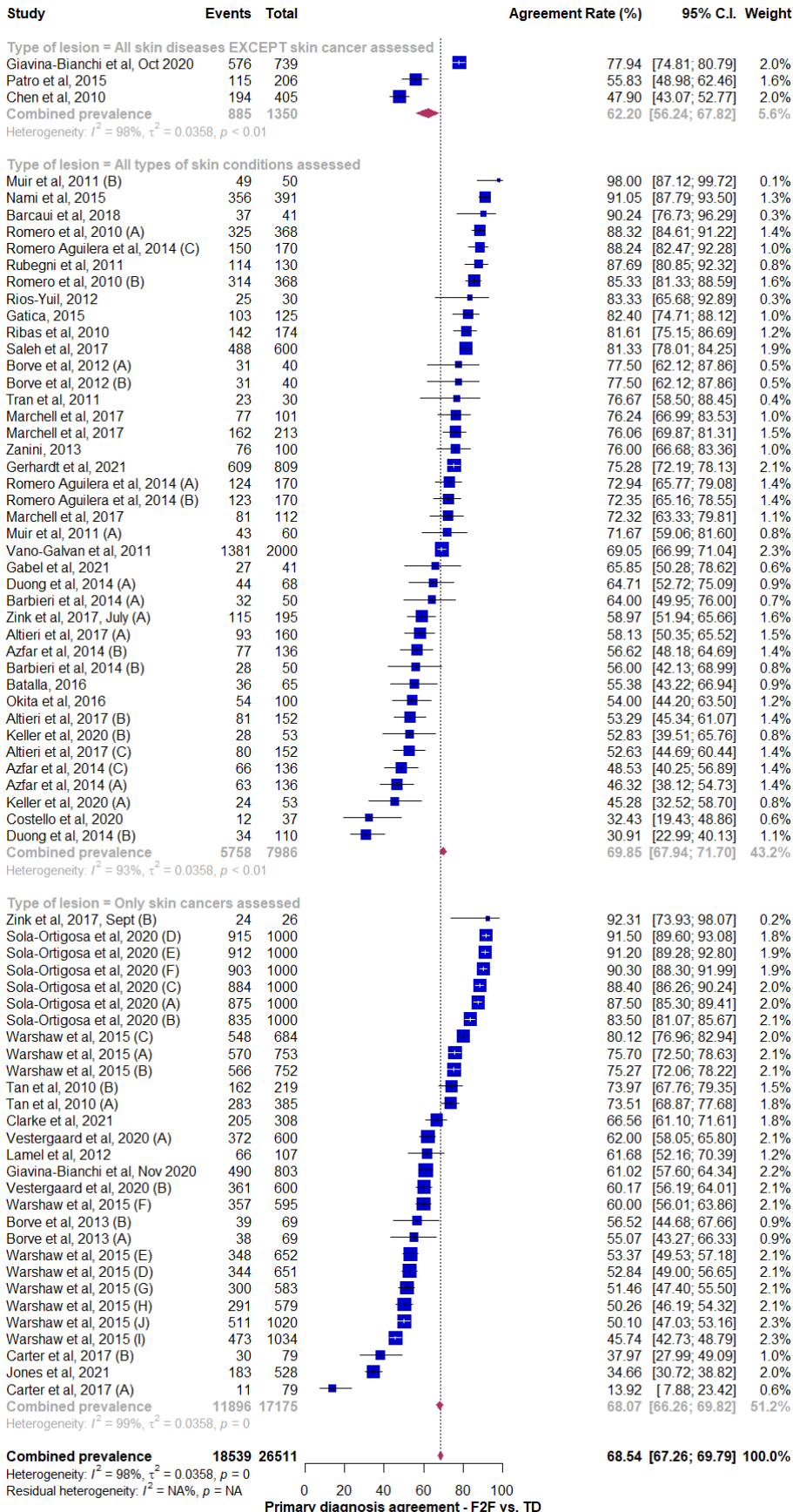
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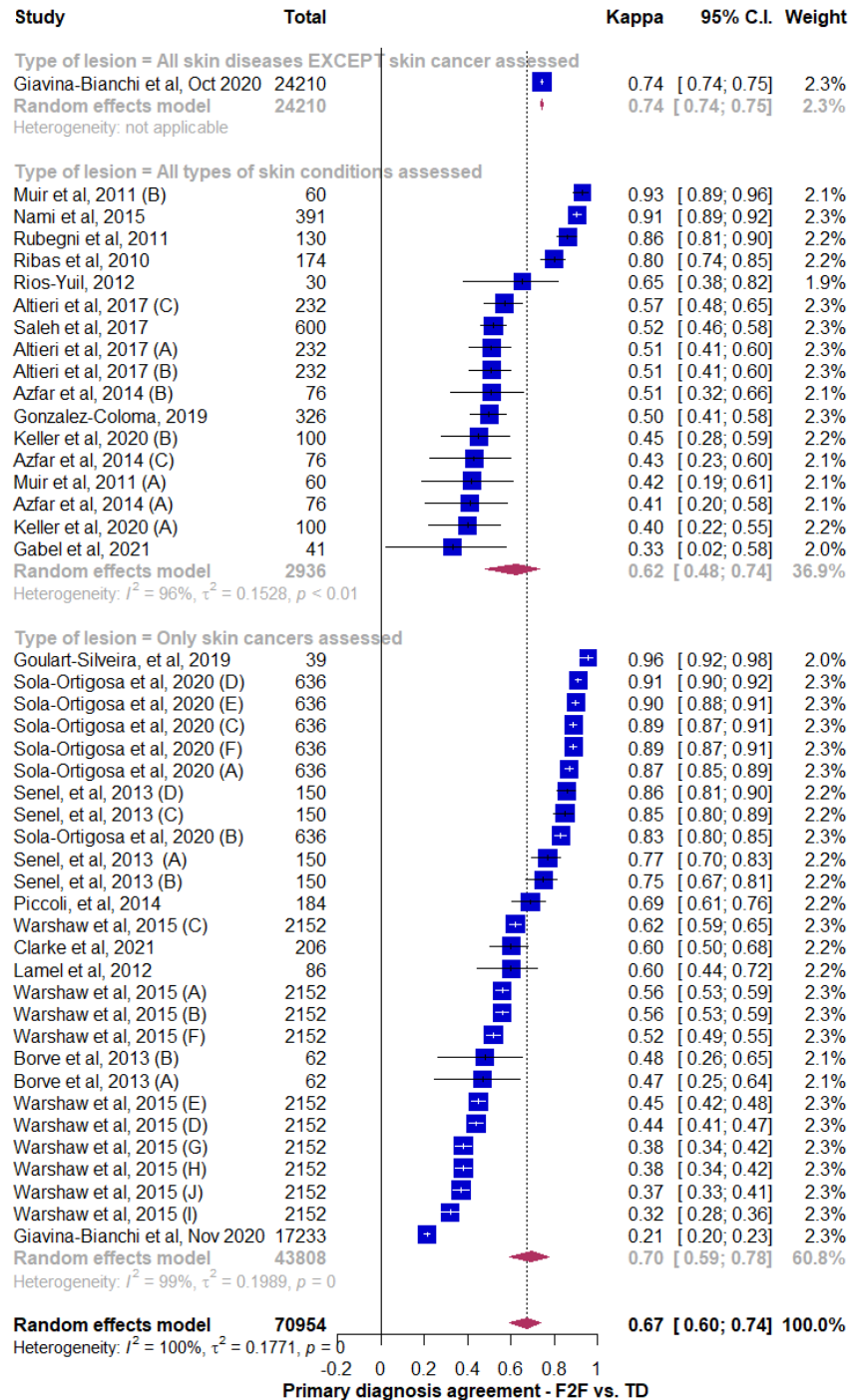


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389 **eFigure 4. Forest plot representing F2F and teledermatology primary diagnostic agreement by utilization of**  
390 **teledermoscopy.** Studies were sorted into two groups, i) Did not use or did not report the use of teledermoscopy; ii)  
391 Used teledermoscopy. (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across  
392 12 studies with a total of 22 unique number of comparisons, N of events and total included participants. (B) Forest  
393 plot representing kappa concordance and 95% C.I. for overall concordance across seven studies with a total of 16  
394 unique number of comparisons, N of total included participants. Abbreviations: F2F (Face-to-Face), PCP (Primary  
395 Care Provider), TD (Teledermatology or Teledermatologist).

A



B



**eFigure 5. Forest plot representing F2F and teledermatology primary diagnostic agreement by skin lesion category.** Studies were sorted into three groups according to the type of lesions included, i) All skin conditions except likely malignant lesions; ii) All skin conditions; iii) Likely malignant lesions only. (A) Forest plot representing percentage agreement and 95% C.I. for overall concordance across 26 studies with a total of 39 unique number of comparisons, N of events and total included participants. (B) Forest plot representing kappa concordance and 95% C.I. for overall concordance across ten studies with a total of 27 unique number of comparisons, N of total included participants. Abbreviations: F2F (Face-to-Face), PCP (Primary Care Provider), TD (Teledermatology or Teledermatologist).



Author, Year	Study design	Country	Funding reported	Intervention	*Outcome	Patients (n)	Female (%)	Mean Age (y)	Lesions (N)
<b>TD vs F2F Dermatologist</b>									
Altieri, et al, 2017	Prospective Cohort	USA	Y	TD and F2F dermatologists via clinical images taken by digital photography	Diagnostic agreement rate, Concordance	232	N/A	NA	232
Azfar, et al, 2014	Prospective Cohort	USA, Botswana	N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate, Concordance	76	57	39	159
Barbieri, et al, 2014	Prospective Cohort	USA	N	TD and F2F dermatologists via smartphone images using the AccessDerm smartphone platform	Diagnostic agreement rate	50	64	55.2	50
Barcaui, et al, 2018	Prospective Cohort	Brazil	N	TD and F2F consult by the same dermatologist via digital photography and dermoscopy images stored in WhatsApp	Diagnostic agreement rate	31	71	56.5	41
Batalla, 2015	Retrospective Cohort	Spain	N	TD and F2F dermatologists by via clinical images	Diagnostic agreement rate	183	66	9	65
Borve, et al, 2012	Prospective Cohort	Sweden	Y	TD and F2F consults by the same dermatologist via smartphone images stored in Tele-Dermis	Diagnostic agreement rate	40	57.5	49	40
Gabel, et al, 2021	Prospective Cohort	USA	Y	TD and F2F dermatologists via clinical images taken by digital photography and tablets	Diagnostic agreement rate, Concordance	41	N/A	N/A	41
Gatica, et al, 2015	Prospective Cohort	Chile	N	TD and F2F dermatologists via clinical images taken by digital photography	Diagnostic agreement rate	125	57.6	37.7	125
Gerhardt, et al, 2021	Retrospective Cohort	USA	Y	TD and F2F dermatologists via clinical images	Diagnostic agreement rate	809	N/A	N/A	809
Keller, et al, 2020	Prospective Cohort	USA	Y	TD and F2F dermatologists or hospitalists on clinical images taken by smartphones and tablets	Diagnostic agreement rate, Concordance	100	43.2	N/A	100
Marchell, et al., 2017	Quasi RCT	USA	Y	TD and F2F dermatologists via digital photography, compressed and uncompressed video	Diagnostic agreement rate (SFTD, video)	216	N/A	N/A	216
Muir, et al, 2011	Prospective Cohort	Australia	N	TD and F2F emergency derms and non-specialists via clinical images taken by digital photography	Diagnostic agreement rate, Concordance	50	65	47	50
Nami, et al, 2015	Prospective Cohort	Italy and Austria	Y	TD and F2F dermatologists via smartphone images stored in MugDerma	Diagnostic agreement rate, Concordance	391	52.2	54	391
Okita, et al, 2016	Prospective Cohort	Brazil	N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate	100	N/A	N/A	100
Ribas, et al, 2010	Prospective Cohort	Brazil	Y	TD and F2F dermatologists via digital photography	Diagnostic agreement rate, Concordance	174	53.4	34.7	174
Rios-Yuil, 2011	RCT	Panama	N	TD and F2F dermatologists via clinical images taken by digital photography for case conferences	Diagnostic agreement rate, Concordance	30	63.3	N/A	30
Romero Aguilera, et al, 2014	Prospective Cohort	Spain	Y	TD and F2F dermatologists via clinical images taken by digital photography stored in DERMARED. Some patients were seen by the same derm for F2F and TD.	Diagnostic agreement rate	457	56%	36	170
Romero, et al, 2010	RCT	Spain	Y	TD and F2F consults by the same dermatologist via digital photography and videoconferences via DERMARED software	Diagnostic agreement rate	328	56%	36	510
Rubegni, et al, 2011	Prospective Cohort	Italy	N	TD and F2F dermatologists via digital photography and dermoscopy images stored in Dermo-image.	Diagnostic agreement rate, Concordance	130	53.9	80.6	130
Saleh, et al, 2017	Prospective Cohort	Egypt	Y	TD and F2F dermatologists via clinical images taken by digital photography stored in Dropbox	Diagnostic agreement rate, Concordance	600	50.7	N/A	600
Tran, et al, 2011	Prospective Cohort	Egypt	Y	TD and F2F dermatologists via smartphone images stored in ClickDoc	Diagnostic agreement rate	30	N/A	N/A	30
Vano-Galvan, et al, 2010	Retrospective, Cross-sectional	Spain	N	TD and F2F dermatologists via clinical images taken by digital photography for case conferences	Diagnostic agreement rate, 100 patients each analyzed by 20 observers	100	N/A	N/A	100
Zanini, 2013	Prospective Cohort	Brazil	N	TD and F2F dermatologists via clinical images taken by digital photography	Diagnostic agreement rate	100	N/A	N/A	100
Zink, et al, 2017, July	Prospective Cohort	Germany	Y	TD and F2F dermatologists via smartphone images stored in the KLARA app	Diagnostic agreement rate	195	20.5	N/A	195

All lesions

Author, Year	Study design	Country	Funding reported	Intervention	*Outcome	Patients (n)	Female (%)	Mean Age (y)	Lesions (N)	
Costello, et al, 2019	Prospective, Cross-sectional	USA	Y	TD and F2F PCP via smartphone and dermoscopy images using the Photo Exam app	Diagnostic agreement rate	37	65	47.9	37	Skin cancers only
Duong, et al, 2014	Prospective, Observational	France	Y	TD and F2F emergency physicians via smartphone images and videoconferences	Diagnostic agreement rate (SFTD, video)	194	N/A	N/A	178	
Gonzalez-Coloma, et al, 2019	Prospective, Cross-sectional	Chile	N	TD and F2F PCP via clinical images	Diagnostic concordance	326	59	35.8	326	
Keller, et al, 2020	Prospective Cohort	USA	Y	TD and F2F dermatologists or hospitalists on clinical images taken by smartphones and tablets	Diagnostic agreement rate, Concordance	100	43.2	N/A	100	
Muir, et al, 2011	Prospective Cohort	Australia	N	TD and F2F emergency physicians via clinical images taken by digital photography	Diagnostic agreement rate, Concordance	60	65	47	60	
Carter, et al, 2017	Ambispective Cohort	USA	Y	TD and F2F dermatologists, as well as F2F PCP via clinical images stored using Epic EHR software	Diagnostic agreement rate	79	74	47	79	
Jones, et al, 2021	Retrospective Cohort	New Zealand	Y	TD and F2F PCP via digital photography and dermoscopy images	SSC matched for age, sex, and ethnicity. Diagnostic agreement rate	481	64	N/A	528	
Piccoli, et al, 2015	Retrospective, Cross-sectional	Brazil	Y	TD and F2F PCP via digital photography and dermoscopy images	Diagnostic concordance	184	73.4	54.7	184	
Chen, et al, 2010	Retrospective Cohort	USA	Y	TD and F2F PCP via clinical images stored in Second Opinion Software	Diagnostic agreement rate	405	50.6	5.9	405	
Patro, et al 2015	Prospective Cohort	India	Y	TD and F2F PCP via digital photography	Diagnostic agreement rate	206	58.7	N/A	206	
Blomberg, et al, 2013	Prospective Cohort	Sweden	Y	TD and F2F consults by the same dermatologist via smartphone and dermoscopy images stored in iDoc 24 app	Diagnostic agreement rate, Concordance	62	38.7	64	69	
Carter, et al, 2017	Ambispective Cohort	USA	Y	TD and F2F dermatologists, as well as F2F PCP via clinical images stored using Epic EHR software	Diagnostic agreement rate	79	74	47	79	
Clarke, et al, 2021	Prospective Cohort	USA	Y	TD and F2F dermatologists via clinical images taken by digital photography stored in Research Electronic Data Capture	Diagnostic agreement rate, Concordance	206	49.5	56.9	308	
Giavina-Bianchi, et al, 2020 Nov	Retrospective Cohort	Brazil	N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate, Concordance	17,233	71.4	N/A	803	
Goulart-Silveira et al, 2019	Prospective Cohort	Brazil	N	TD and F2F dermatologists via smartphone images acquired and stored via Telederma app	Concordance	39	69	68	39	
Lamel, et al, 2012	Prospective Cohort	USA	N	TD and F2F dermatologists via smartphone images stored in ClickDerm	Diagnostic agreement rate, Concordance	86	58.1	45.2	107	
Senel, et al, 2013	Prospective Cohort	Turkey	N	TD and F2F dermatologists via digital photography and dermoscopy images	Concordance with and without dermoscopy	150	49	55	150	
Sola-Ortigosa, et al, 2020	Prospective Cohort	Spain	N	TD and F2F consults by the same dermatologist via dermoscopy and clinical images taken by digital photography and tablets	Diagnostic agreement rate, Concordance	636	43.2	72.8	1,000	
Tan, et al, 2010	Prospective Cohort	New Zealand	Y	TD and F2F consults by the same dermatologist via digital photography	Diagnostic agreement rate	200	63	N/A	491	
Vestergaard, et al, 2020	Prospective Cohort	Denmark	N	TD and F2F dermatologists via smartphone and dermoscopy images using FotoFinder Systems	Diagnostic agreement rate, Concordance	519	57	55	600	
Warshaw, et al, 2015	Prospective, Cross-sectional	USA	N	TD and F2F dermatologists via digital photography and dermoscopy images	Diagnostic agreement rate, Concordance	2,152	3.2	68	3,021	
Zink, et al, 2017, Sept	Prospective Cohort	Germany	Y	TD and F2F dermatologists via smartphone and dermoscopy images using Handfotos	Diagnostic agreement rate	26	N/A	N/A	26	
Giavina-Bianchi, et al, 2020 Oct	Retrospective Cohort	Brazil	N	TD and F2F dermatologists via smartphone images	Diagnostic agreement rate, Concordance	24,210	70	N/A	739	B.
TD vs F2F Non-specialist										
Costello, et al, 2019	Prospective, Cross-sectional	USA	Y	TD and F2F PCP via smartphone and dermoscopy images using the Photo Exam app	Diagnostic agreement rate	37	65	47.9	37	All skin lesions
Duong, et al, 2014	Prospective, Observational	France	Y	TD and F2F emergency physicians via smartphone images and videoconferences	Diagnostic agreement rate (SFTD, video)	194	N/A	N/A	178	
Gonzalez-Coloma, et al, 2019	Prospective, Cross-sectional	Chile	N	TD and F2F PCP via clinical images	Diagnostic concordance	326	59	35.8	326	
Keller, et al, 2020	Prospective Cohort	USA	Y	TD and F2F dermatologists or hospitalists on clinical images taken by smartphones and tablets	Diagnostic agreement rate, Concordance	100	43.2	N/A	100	
Muir, et al, 2011	Prospective Cohort	Australia	N	TD and F2F emergency physicians via clinical images taken by digital photography	Diagnostic agreement rate, Concordance	60	65	47	60	
Carter, et al, 2017	Ambispective Cohort	USA	Y	TD and F2F dermatologists, as well as F2F PCP via clinical images stored using Epic EHR software	Diagnostic agreement rate	79	74	47	79	Skin cancers only
Jones, et al, 2021	Retrospective Cohort	New Zealand	Y	TD and F2F PCP via digital photography and dermoscopy images	SSC matched for age, sex, and ethnicity. Diagnostic agreement rate	481	64	N/A	528	
Piccoli, et al, 2015	Retrospective, Cross-sectional	Brazil	Y	TD and F2F PCP via digital photography and dermoscopy images	Diagnostic concordance	184	73.4	54.7	184	
Chen, et al, 2010	Retrospective Cohort	USA	Y	TD and F2F PCP via clinical images stored in Second Opinion Software	Diagnostic agreement rate	405	50.6	5.9	405	B.
Patro, et al 2015	Prospective Cohort	India	Y	TD and F2F PCP via digital photography	Diagnostic agreement rate	206	58.7	N/A	206	

**eTable 1. Study and patient characteristics for all included studies.** The table is divided into two sections: one comparing teledermatology with Face-to-Face (F2F) dermatologists, and another comparing teledermatologists with F2F non-specialists. The studies are listed alphabetically and grouped by lesion type. \*See supplementary eTable 4 for agreement rates and concordance values. Abbreviations used in the table include B (Benign lesions only), ED (Emergency Department), EHR (Electronic Health Record), F2F (Face-to-Face), Histo



(Histopathology), ICD10 (International Classification of Diseases, 10th Edition), N (No), N/A (Not available), PCP (Primary Care Provider), PLD (Polarized Light Dermoscopy), RCT (Randomized Controlled Trial), SFTD (Store-and-Forward Teledermatology), SSC (Specialized Skin Clinic), TD (Teledermatology or Teledermatologist), and Y (Yes). Patient characteristics for all 44 included studies are also provided, grouped by lesion type, with a column describing special inclusion and exclusion criteria.

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Inclusion criteria	Exclusion criteria
Primary articles assessing diagnostic agreement where store-and-forward technology or live video conference consults were compared with a control group who attend in-person visits.	Survey articles, feasibility studies, studies regarding other forms of telemedicine unrelated to dermatology, cost-effectiveness studies, editorials, and review articles.
Primarily comparing teledermatology to F2F, sometimes using histopathology as the reference standard.	Studies that clearly stated they used telermatologists as the gold- or reference standard.
	Studies that only compared dermatoscopic images in the absence of clinical images.
	Studies where patients captured their own photographs.

**eTable 2. Inclusion and exclusion criteria for screening of literature search results.**

F2F: Face-to-Face.

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<p><b>Study characteristics</b></p> <p>Author, year, title, study type, objective, country of publication. Patient characteristics: total number of participants included declaration of funding source, number of participants per study, mean age +/- SD, age range, gender, mean BMI and range, race/ethnicity, type of lesions evaluated, type of patients evaluated.</p>
<p><b>Methodology - teledermatology and F2F consults</b></p> <p>Method of correspondence, platform used for the teledermatology consult, training on teledermatology platform, length of teledermatology and F2F consult, experience of the teledermatologist and F2F physician, location of the teledermatologist, number of teledermatologists and F2F physicians who made a diagnosis for each patient, total number of telermatologists and F2F physicians in study, order of visits, wait time between teledermatology and F2F consult, whether same specialist conducted teledermatology and F2F visit, specialization of the F2F physician, number of reviews; qualifications of the individual who acquired the clinical photographs and whether they received additional training on taking clinical photographs.</p>
<p><b>Metrics and results</b></p> <p>Technology used for image acquisition and for viewing images with, distance between camera and lesion, number of images taken, use of teledermoscopy &amp; dermoscopy, brand of dermatoscope, use of histopathology, referral content provided to teledermatologist, primary and differential diagnoses agreement and concordance rates, diagnostic accuracy values (if available) such as sensitivity, specificity, PPV and NPV.</p>

**eTable 3. Data extraction form with details of domains record.**

F2F: Face-to-Face, PPV: Positive Predictive Value, NPV: Negative Predictive Value.

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Author and Year	Unique Study Grouping	Participants (n)	Lesions (N)	Primary Diagnosis Agreement F2F vs F2F (%)	Diagnosis Agreement (N) / Total Diagnoses (N)	Primary Diagnosis Agreement TD vs TD (%)	Diagnosis Agreement (N) / Total Diagnoses (N)	Primary Diagnosis Agreement TD vs F2F (%)	Diagnosis Agreement (N) / Total Diagnoses (N)	Primary Diagnosis Agreement TD vs Histo (%)	Diagnosis Agreement (N) / Total Diagnoses (N)	Primary Diagnosis Kappa Value TD vs F2F	Primary Diagnosis Kappa Value TD vs Histo
Altieri et al, 2017 (A)	F2F Derm vs TD1	232	232					58	93/160			0.51	
Altieri et al, 2017 (B)	F2F Derm vs TD2	232	232					53	81/152			0.51	
Altieri et al, 2017 (C)	F2F Derm vs TD3	232	232					53	80/152			0.57	
Azfar et al, 2014 (A)	F2F Derm vs TD1	76	159					47	63/136			0.41	
Azfar et al, 2014 (B)	F2F Derm vs TD2	76	159					57	77/136			0.51	
Azfar et al, 2014 (C)	F2F Derm vs TD3	76	159					49	66/136			0.43	
Barbieri et al, 2014 (A)	F2F Derm vs TD1	50	50			58	29/50	64	32/50				
Barbieri et al, 2014 (B)	F2F Derm vs TD2	50	50					56	28/50				
Barcaui et al, 2018	F2F Derm vs TD	31	41					90	37/41				
Batalla, 2016	F2F Derm vs TD	183	183					55	36/65				
Borve et al, 2012 (A)	F2F Derm vs TD1	40	40	88	35/40	68	27/40	78	31/40				
Borve et al, 2012 (B)	F2F Derm vs TD2	40	40					78	31/40				

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Borve et al, 2013 (A)	F2F Derm vs TD1	62	69	58	40/69	55	38/69		0.47	0.51
Borve et al, 2013 (B)	F2F Derm vs TD2	62	69			57	39/69		0.48	
Carter et al, 2017 (A)	F2F nonspecialist vs TD	79	79	38	30/79	14	11/79			
Carter et al, 2017 (B)	F2F Derm vs TD	79	79			38	30/79			
Chen et al, 2010	F2F nonspecialist vs TD	405	405			48	194/405			
Clarke et al, 2021	F2F Derm vs TD	206	308			67	205/308	65	40/62	0.6
Costello et al, 2020	F2F nonspecialist vs TD	37	37			32	12/37			
Duong et al, 2014 (A)	F2F nonspecialist vs TD (Videoconference)	111	110			65	44/68			
Duong et al, 2014 (B)	F2F nonspecialist vs TD (SFTD)	111	110			31	34/110			
Gabel et al, 2021	F2F Derm vs TD	41	41			67	27/41			0.33
Gatica, 2015	F2F Derm vs TD	125	125			82	103/125			
Gerhardt et al, 2021	F2F Derm vs TD	809	809			75	60/809			
Giavina-Bianchi et al, Nov 2020	F2F Derm vs TD	17233	17233			61	490/803	54	156/89	0.21 0.09
Giavina-Bianchi et al, Oct 2020	F2F Derm vs TD	24210	27519			78	576/739			0.74
Gonzalez-Coloma, 2019	F2F nonspecialist vs TD	326	326							0.5
Goulart-Silveira, et al, 2019	F2F Derm vs TD	39	39							0.96 0.56
Jones et al, 2021	F2F nonspecialist vs TD (Suspicious Skin Cancer pathway)	NA	528			35	183/528	53	60/114	
Keller et al, 2020 (A)	F2F nonspecialist vs TD	100	100			45	24/53			0.4
Keller et al, 2020 (B)	F2F Derm vs TD	100	100			53	28/53			0.45
Lamel et al, 2012	F2F Derm vs TD	86	107			62	66/107			0.6

Marchell et al, 2017	F2F Derm vs TD (SFTD)	216	216	91	122/134		76	162/213		
Marchell et al, 2017	F2F Derm vs TD (Uncompressed video)	216	216				76	77/101		
Marchell et al, 2017	F2F Derm vs TD (Compressed video)	216	216				72	81/112		
Muir et al, 2011 (A)	F2F nonspecialist vs TD	60	60				72	43/60	0.42	
Muir et al, 2011 (B)	F2F Derm vs TD	60	60				98	49/50	0.93	
Nami et al, 2015	F2F Derm vs TD	391	391				91	356/391	0.91	
Okita et al, 2016	F2F Derm vs TD	100	100				54	54/100		
Patro et al, 2015	F2F nonspecialist vs TD	206	206				56	115/206		
Piccoli, et al, 2014	F2F nonspecialist vs TD	184	184						0.69	
Ribas et al, 2010	F2F Derm vs TD	174	174	83	145/174	81	141/174	82	142/174	0.8
Rios-Yuil, 2012	F2F Derm vs TD	30	30				83	25/30	67	0.65
Romero Aguilera et al, 2014 (A)	F2F Derm vs TD1	457	192			69	118/170	73	124/170	
Romero Aguilera et al, 2014 (B)	F2F Derm vs TD2	457	192			73	124/170	72	123/170	
Romero Aguilera et al, 2014 (C)	F2F Derm vs TD3	457	192			67	114/170	88	150/170	
Romero et al, 2010 (A)	F2F Derm vs TD (SFTD)	457	192				88	325/368		
Romero et al, 2010 (B)	F2F Derm vs TD (SFTD and videoconferencing)	457	176				85	314/368		
Rubegni et al, 2011	F2F Derm vs TD	130	130				88	114/130		0.86
Saleh et al, 2017	F2F Derm vs TD	600	600			88	526/600	81	488/600	0.46-0.52
Senel, et al, 2013	F2F Derm vs TD1 (no dermoscopy)	150	150							0.77
Senel, et al, 2013	F2F Derm vs TD2 (no dermoscopy)	150	150							0.75

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Senel, et al, 2013	F2F Derm vs TD1 (dermoscopy)	150	150							0.85
Senel, et al, 2013	F2F Derm vs TD2 (dermoscopy)	150	150							0.86
Sola-Ortigosa et al, 2020 (A)	F2F Derm vs TD1 (no dermoscopy)	636	1000	82	00	88	0	821/1000	875/1000	0.87
Sola-Ortigosa et al, 2020 (B)	F2F Derm vs TD2 (no dermoscopy)	636	1000	83	00	84	0	832/1000	835/1000	0.83
Sola-Ortigosa et al, 2020 (C)	F2F Derm vs TD3 (no dermoscopy)	636	1000	81	00	88	0	813/1000	884/1000	0.89
Sola-Ortigosa et al, 2020 (D)	F2F Derm vs TD1 (dermoscopy)	636	1000	92	00	92	0	915/1000	915/1000	0.91
Sola-Ortigosa et al, 2020 (E)	F2F Derm vs TD2 (dermoscopy)	636	1000	90	00	91	0	902/1000	912/1000	0.9
Sola-Ortigosa et al, 2020 (F)	F2F Derm vs TD3 (dermoscopy)	636	1000	90	00	90	0	899/1000	903/1000	0.89
Tan et al, 2010 (A)	F2F Derm vs TD1, F2F Derm 1 vs F2F Derm 2	200	491	82	91	72	1	157/491	355/491	
Tan et al, 2010 (B)	F2F Derm vs TD2, F2F Derm 2 vs F2F Derm 3	200	491	76	6			80/491		
Tan et al, 2010 (C)	F2F Derm 1 vs F2F Derm 3	200	491	76	94			147/491		
Tran et al, 2011	F2F Derm vs TD	30	30						75/30	
Vano-Galvan et al, 2011	F2F Derm vs TD	100	100						1381/2000	
Vestergaard et al, 2020 (A)	A F2F Derm vs TD1	519	600	62	0	62	58	370/600	372/600	170/292
Vestergaard et al, 2020 (B)	F2F Derm vs TD2	519	600			60	54		361/600	157/292
Warshaw et al, 2015 (A)	F2F Derm vs TD (non biopsied pigmented lesions, Macro)	2152	3021						570/753	0.56
Warshaw et al, 2015 (B)	F2F Derm vs TD (non biopsied pigmented lesions, Macro+PLD)	2152	3021						566/752	0.56
Warshaw et al, 2015 (C)	F2F Derm vs TD (non biopsied pigmented lesions, Macro+PLD)	2152	3021						548/684	0.62

Warshaw et al, 2015 (D)	F2F Derm vs TD (biopsied pigmented lesions, Macro)	2152	3021	53	344/651	0.44
Warshaw et al, 2015 (E)	F2F Derm vs TD (biopsied pigmented lesions, Macro+PLD)	2152	3021	53	348/652	0.45
Warshaw et al, 2015 (F)	F2F Derm vs TD (biopsied pigmented lesions, Macro+PLD)	2152	3021	60	357/595	0.52
Warshaw et al, 2015 (G)	F2F Derm vs TD (NONbiopsied NONpigmented lesions, Macro)	2152	3021	52	300/583	0.38
Warshaw et al, 2015 (H)	F2F Derm vs TD (NONbiopsied NONpigmented lesions, Macro+PLD)	2152	3021	50	291/579	0.38
Warshaw et al, 2015 (I)	F2F Derm vs TD (biopsied NONpigmented lesions, Macro)	2152	3021	46	473/103 4	0.32
Warshaw et al, 2015 (J)	F2F Derm vs TD (biopsied NONpigmented lesions, Macro+PLD)	2152	3021	50	511/102 0	0.37
Zanini, 2013	F2F Derm vs TD	100	100	76	76/100	
Zink et al, 2017, July (A)	F2F Derm vs TD	195	195	59	115/195	56 108/1 95
Zink et al, 2017, Sept (B)	F2F Derm vs TD	26	26	92	24/26	67 17/26

**eTable 4. Included unique study groupings and letter codes for individual agreement rates and kappa concordance values.** The abbreviations used in the text are as follows: TD (Teledermatology or Teledermatologist), Derm (Dermatologist), F2F (Face-to-Face), SFTD (Store and Forward Technology), PLD (Polarized Light Dermoscopy), and Macro (Macroscopic clinical images).



Study ID	Journal	Reason For Exclusion
NCT03034694, 2016	<a href="http://ClinicalTrials.gov">ClinicalTrials.gov</a>	Wrong study design
Andersson et al, 2017	Lakartidningen	Wrong study design
Romero et al, 2018	Actas dermo-sifiliograficas	Wrong study design
Orruno et al, 2016	Health Technology Assessment Database	Wrong study design
Batalla et al, 2016	Piel	Wrong study design
Kroemer et al, 2011	British Journal of Dermatology	Wrong study design
Ernstberger et al, 2014	Zentralblatt fur Chirurgie	Wrong study design
Totty et al, 2018	Journal of wound care	Wrong study design
Wurm et al, 2013	Journal of Telemedicine and Telecare	Wrong study design
Wang et al, 2017	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
Singh et al, 2011	Australasian Journal of Dermatology	Wrong study design
Grey et al, 2017	Dermatitis	Wrong study design
Crompton et al, 2010	Journal of Visual Communication in Medicine	Wrong study design
Ali et al, 2021	JMIR formative research	Wrong study design
Boyce et al, 2011	Dermatology	Wrong study design
Berg et al, 2017	Sarcoidosis Vasculitis and Diffuse Lung Diseases	Wrong study design
Shin et al, 2014	Journal of telemedicine and telecare	Wrong study design
Gacto-Sanchez et al, 2020	Burns : journal of the International Society for Burn Injuries	Wrong study design
Tian et al, 2017	Journal of Cosmetic Dermatology	Wrong study design
Thind et al, 2011	Clinical and Experimental Dermatology	Wrong study design
Silveira et al, 2014	BMC Dermatology	Wrong study design
O'Connor et al, 2017	JAMA Dermatology	Wrong study design
Janda et al, 2020	The Lancet. Digital health	Wrong study design
Day et al, 2020	Military medicine	Wrong study design
Karlsson et al, 2015	Acta Dermato-Venereologica	Wrong study design
Seghers et al, 2015	Australasian Journal of Dermatology	Wrong study design
Hazenberget al, 2010	Journal of Medical Engineering and Technology	Wrong study design
Borve et al, 2015	Acta Dermato-Venereologica	Wrong study design
Boissin et al, 2015	Burns	Wrong study design
Da Silva et al, 2018	Dermatology online journal	Wrong study design
Devrim et al, 2019	BMC pediatrics	Wrong study design
Danielsson et al, 2016	Health Technology Assessment Database	Wrong study design
Berglund et al, 2020	Journal of the European Academy of Dermatology and Venereology : JEADV	Wrong study design
Forsblom et al, 2013	Clinical Infectious Diseases	Wrong study design
G Bianchi et al, 2020	Journal of medical Internet research	Wrong study design
Congalton et al, 2015	Journal of the European Academy of Dermatology and Venereology	Wrong study design
Ferrandiz et al, 2012	Archives of Dermatology	Wrong study design
Ismail et al, 2018	International Journal of Women's Dermatology	Wrong study design
Gamus et al, 2019	International journal of medical informatics	Wrong study design
Paudel et al, 2020	Case reports in dermatological medicine	Wrong study design
Georgesesen et al, 2020	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
Gagnon et al, 2015	Dermatology Times	Wrong study design
Philp et al, 2013	Pediatric Dermatology	Wrong study design
Mooney et al, 2011	Skin Research and Technology	Wrong study design
Do Khac et al, 2021	JMIR mHealth and uHealth	Wrong study design
Chambers et al, 2012	Journal of the American Academy of Dermatology	Wrong study design
Garcia-Romero et al, 2011	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
Ahmed et al, 2020	Annals of internal medicine	Wrong study design
Marwaha et al, 2019	Journal of the American Academy of Dermatology	Wrong study design
NCT02122432, 2014	<a href="http://ClinicalTrials.gov">ClinicalTrials.gov</a>	Wrong study design
Lowe et al, 2021	Clinical and experimental dermatology	Wrong study design

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3	Bowling et al, 2011	Wound Repair and Regeneration	Wrong study design
4	Marin-Gomez et al, 2020	Journal of primary care & community health	Wrong study design
5	Veronese et al, 2021	Diagnostics (Basel, Switzerland)	Wrong study design
6	Ismail et al, 2018	International journal of dermatology	Wrong study design
7	NCT02905851, 2016	<a href="http://ClinicalTrials.gov">ClinicalTrials.gov</a>	Wrong study design
8	Trinidad et al, 2020	Journal of the American Academy of Dermatology	Wrong study design
9	Tensen et al, 2019	Studies in health technology and informatics	Wrong study design
10	Karavan et al, 2014	Journal of telemedicine and telecare	Wrong study design
11	Viola et al, 2011	Archives of Dermatology	Wrong study design
12	van Netten et al, 2017	Scientific reports	Wrong study design
13	Cai et al, 2016	Burns : journal of the International Society for Burn Injuries	Wrong study design
14	Hazenberget al, 2010	Diabetes Technology and Therapeutics	Wrong study design
15	Jacoby et al, 2021	Journal of drugs in dermatology : JDD	Wrong study design
16	Pak et al, 2018	Wound repair and regeneration : official publication of the Wound Healing Society [and] the European Tissue Repair Society	Wrong study design
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18	Kummerow Broman et al, 2019	JAMA surgery	Wrong study design
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20	Munoz-Lopez et al, 2021	Journal of the European Academy of Dermatology and Venereology : JEADV	Wrong study design
21	Markun et al, 2017	Medicine	Wrong study design
22	Piette et al, 2017	Journal of telemedicine and telecare	Wrong study design
23	Tan et al, 2010	British Journal of Dermatology	Wrong study design
24	Watson et al, 2010	Archives of Dermatology	Wrong study design
25	Wiseman et al, 2016	Journal of vascular surgery. Venous and lymphatic disorders	Wrong study design
26	Wolf et al, 2013	JAMA dermatology	Wrong study design
27	Laggis et al, 2020	The American Journal of dermatopathology	Wrong study design
28	Kazi et al, 2021	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong study design
29	Kanthraj et al, 2013	Indian Journal of Dermatology, Venereology and Leprology	Wrong study design
30	Shah et al, 2016	Journal of the American Academy of Dermatology	Wrong study design
31	Kim et al, 2018	Skin research and technology	Wrong study design
32	Nguyen et al, 2017	Journal of Clinical and Aesthetic Dermatology	Wrong study design
33	Rizvi et al, 2020	PloS one	Wrong study design
34	Mehrtens et al, 2019	Clinical and experimental dermatology	Wrong study design
35	Knudsen et al, 2012	Lakartidningen	Research letter or letter to the editor
36	Korman et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
37	Mercer et al, 2014	Journal of Cutaneous Medicine and Surgery	Research letter or letter to the editor
38	Grunig et al, 2015	JAMA Dermatology	Research letter or letter to the editor
39	Cartron et al, 2020	Dermatologic therapy	Research letter or letter to the editor
40	McAfee et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
41	Wong et al, 2021	JAMA dermatology	Research letter or letter to the editor
42	Baranowski et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
43	Micheletti et al, 2014	Journal of the American Academy of Dermatology	Research letter or letter to the editor
44	Osei-Tutu et al, 2013	Journal of the American Academy of Dermatology	Research letter or letter to the editor
45	Nair et al, 2015	International Journal of Dermatology	Research letter or letter to the editor
46	Miller et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
47	Keleshian et al, 2017	Journal of the American Academy of Dermatology	Research letter or letter to the editor
48	HAYES; Inc et al, 2016	Health Technology Assessment Database	Research letter or letter to the editor
49	Jacob et al, 2017	Journal of telemedicine and telecare	Research letter or letter to the editor
50	Perkins et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
51	Halpern et al, 2010	British Journal of Dermatology	Research letter or letter to the editor
52	Newman et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
53	Hunt et al, 2020	Clinical and experimental dermatology	Research letter or letter to the editor
54	2018	Nursing	Research letter or letter to the editor
55	Taneja et al, 2021	Indian journal of dermatology, venereology and leprology	Research letter or letter to the editor
56	Echeverria-Garcia et al, 2019	Actas dermo-sifilograficas	Research letter or letter to the editor
57	Henning et al, 2010	Archives of Dermatology	Research letter or letter to the editor

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Demo et al, 2019	Clinical and experimental dermatology	Research letter or letter to the editor
Byamba et al, 2015	British Journal of Dermatology	Research letter or letter to the editor
Gupta et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
De Giorgi et al, 2017	Journal of the European Academy of Dermatology and Venereology	Research letter or letter to the editor
Duong et al, 2016	Annales de Dermatologie et de Venereologie	Research letter or letter to the editor
Mortimer et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Gravelly et al, 2010	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Choi et al, 2021	International journal of dermatology	Research letter or letter to the editor
Motley et al, 2012	BMJ: British Medical Journal (Clinical Research Edition)	Research letter or letter to the editor
Leavitt et al, 2016	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Cheng et al, 2020	Dermatitis : contact, atopic, occupational, drug	Research letter or letter to the editor
Clark et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Fuesl et al, 2010	MMW-Fortschritte der Medizin	Research letter or letter to the editor
English III et al, 2013	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Cotes et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Abi Rafeh et al, 2021	Journal of cutaneous medicine and surgery	Research letter or letter to the editor
Okeke et al, 2020	The Journal of dermatological treatment	Research letter or letter to the editor
Splete et al, 2014	Emergency Medicine (00136654)	Research letter or letter to the editor
Khosravi et al, 2021	Clinical and experimental dermatology	Research letter or letter to the editor
Sivesind et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Stoecker et al, 2013	JAMA dermatology	Research letter or letter to the editor
Skayem et al, 2020	Journal of the European Academy of Dermatology and Venereology : JEADV	Research letter or letter to the editor
Su et al, 2020	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Massone et al, 2021	Anais brasileiros de dermatologia	Research letter or letter to the editor
Li et al, 2021	The Journal of infection	Research letter or letter to the editor
Afanasiev et al, 2021	Journal of the American Academy of Dermatology	Research letter or letter to the editor
Varma et al, 2011	British Journal of Dermatology	Research letter or letter to the editor
Van Der Heijden et al, 2010	Journal of the European Academy of Dermatology and Venereology	Research letter or letter to the editor
Motley et al, 2012	BMJ (Online)	Research letter or letter to the editor
Villani et al, 2020	Dermatologic therapy	Research letter or letter to the editor
Portnoy et al, 2018	The journal of allergy and clinical immunology. In practice	Research letter or letter to the editor
Tschandl et al, 2018	British Journal of Dermatology	Research letter or letter to the editor
Poolworaluk et al, 2020	Future healthcare journal	Research letter or letter to the editor
Anonymous et al, 2020	Journal of drugs in dermatology : JDD	Research letter or letter to the editor
Tan et al, 2021	Annals of the Academy of Medicine, Singapore	Research letter or letter to the editor
Silva et al, 2021	Anais brasileiros de dermatologia	Research letter or letter to the editor
de Giorgi et al, 2016	International Journal of Dermatology	Wrong outcomes
Senel et al, 2014	Journal of telemedicine and telecare	Wrong outcomes
Goodier et al, 2021	Contact dermatitis	Wrong outcomes
Foolad et al, 2017	International Journal of Dermatology	Wrong outcomes
Wells et al, 2020	The Journal of clinical and aesthetic dermatology	Wrong outcomes
Arzberger et al, 2016	Acta Dermato-Venereologica	Wrong outcomes
Creighton-Smith et al, 2017	International Journal of Dermatology	Wrong outcomes
Marwaha et al, 2019	Journal of the American Academy of Dermatology	Wrong outcomes
Pasquali et al, 2021	Actas dermo-sifiliograficas	Wrong outcomes
Vestergaard et al, 2020	Family practice	Wrong outcomes
Kravets et al, 2018	Acta dermatovenerologica Alpina, Pannonica, et Adriatica	Wrong outcomes
Speiser et al, 2014	American Journal of Dermatopathology	Wrong outcomes
N/A	Journal of the American Academy of Dermatology	Wrong outcomes
Whited et al, 2013	Journal of Telemedicine and Telecare	Wrong outcomes

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3	Abhishek et al, 2021	medRxiv	Wrong outcomes
4	Villa et al, 2020	Internal and emergency medicine	Wrong outcomes
5	Lubeek et al, 2016	Tijdschrift voor gerontologie en geriatrie	review
6	Ndegwa et al, 2016	Health Technology Assessment Database	review
7	Moreno-Ramirez et al, 2017	Acta dermato-venereologica	review
8	Moreno-Ramirez et al, 2017	Acta Dermato-Venereologica	review
9	Van Der Heijden et al, 2010	Huisarts en Wetenschap	review
10	Walocko et al, 2017	Dermatologic Clinics	review
11	Roman et al, 2014	Journal of the Dermatology Nurses' Association	review
12	Hart et al, 2011	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	review
13	Elsner et al, 2020	Journal der Deutschen Dermatologischen Gesellschaft = Journal of the German Society of Dermatology : JDDG	review
14	Kaliyadan et al, 2020	Indian journal of dermatology	review
15	Burch et al,		review
16	Evans et al, 2017	Pharmazeutische Zeitung	Editorial
17	Anonymous. et al, 2016	Journal of AHIMA / American Health Information Management Association	Editorial
18	Luk et al, 2018	Hong Kong Journal of Dermatology and Venereology	Editorial
19	Queen et al, 2018	International wound journal	Editorial
20	Anguita et al, 2014	Nurse Prescribing	Editorial
21	Haworth et al, 2020	Clinical and experimental dermatology	Editorial
22	Romero-Aguilera et al, 2019	Actas dermo-sifiliograficas	Editorial
23	Barrio Garde et al, 2016	Piel	Editorial
24	Morand et al, 2010	Annales de dermatologie et de venereologie	Editorial
25	N/A	Journal of the American Academy of Dermatology	Abstract
26	N/A	Journal of the American Academy of Dermatology	Abstract
27	Bianchi et al, 2020	Journal of the American Academy of Dermatology	Abstract
28	Creadore et al, 2020	Journal of the American Academy of Dermatology	Abstract
29	N/A	Journal of the American Academy of Dermatology	Abstract
30	Tognetti L et al, 2020		Abstract
31	SPLATE et al, 2014	Emergency Medicine (00136654)	Abstract
32	N/A	Journal of the American Academy of Dermatology	Abstract
33	Dahlen Gyllencreutz et al, 2017	Journal of the European Academy of Dermatology and Venereology	Wrong intervention
34	Tandjung et al, 2015	Journal of Evaluation in Clinical Practice	Wrong intervention
35	Paradela-De-La-Morena et al, 2015	European Journal of Dermatology	Wrong intervention
36	Horsham et al, 2015	British Journal of Dermatology	Wrong intervention
37	Saenz et al, 2018	International Journal of Telemedicine and Applications	Wrong intervention
38	Kochmann et al, 2016	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong comparator
39	Markun et al, 2017	Medicine (United States)	Wrong comparator
40	Feigenbaum et al, 2017	Pediatric Dermatology	Wrong comparator
41	Massone et al, 2014	Journal of the European Academy of Dermatology and Venereology	Wrong comparator
42	MacLellan et al, 2021	Journal of the American Academy of Dermatology	Wrong comparator
43	Koysombat et al, 2021	Journal of plastic, reconstructive & aesthetic surgery : JPRAS	Correspondence
44	Jakhar et al, 2020	Clinical and experimental dermatology	Correspondence
45	Alkmim et al, 2013	Journal of Telemedicine and Telecare	Correspondence
46	NCT02836665, 2016	<a href="http://ClinicalTrials.gov">ClinicalTrials.gov</a>	Clinical trial - no associated manuscript
47	JPRN-UMIN000020873 et al, 2016		Clinical trial - no associated manuscript
48	Fogel et al, 2016	Journal of the American Academy of Dermatology	Commentary
49	Hoyer et al, 2020	Cutis	Commentary
50	Pasady et al, 2020	Journal of the American Academy of Dermatology	Duplicate
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3	Moreno-Ramirez et al,	American Journal of Clinical Dermatology	Erratum
4	2017		
5	Trovato et al, 2011	Eplasty	Wrong patient population
6	Bowns et al, 2016	Health Technology Assessment Database	Wrong publication date
7	Gemelas et al, 2019	Telemedicine journal and e-health : the official journal of the American Telemedicine Association	Wrong setting

**eTable 5. List of studies excluded at the full-text screening stage.**

For peer review only

A

Domain 1: SAMPLE SELECTION		
Signalling Q1	<p>Was a consecutive or random sample of patients enrolled?</p> <ul style="list-style-type: none"> <li>- In the study by Giavina-Bianchi et al., a consecutive sample of patients was enrolled, introducing less bias.</li> </ul> <p>Skewed patient demographics: e.g., over 70% female, select age groups, studies.</p> <p>that do not disclose age range and or sex/gender of the patients.</p> <ul style="list-style-type: none"> <li>- In the study by Carter et al., over 70% of the patients were female, which may introduce bias and reduce applicability.</li> </ul>	Yes/No/Unclear
Signalling Q2	<p>Was a case-control design avoided?</p> <ul style="list-style-type: none"> <li>- Gabel et al. avoided a case-control design, which reduces the risk of bias.</li> </ul>	Yes/No/Unclear
Signalling Q3	<p>Did the study avoid inappropriate exclusions?</p> <ul style="list-style-type: none"> <li>- In the study by Giavina-Bianchi et al., complex, and severe cases were excluded, which may introduce bias and affect applicability.</li> </ul>	Yes/No/Unclear
Risk of bias	<p><b>Could the selection of patients have introduced bias?</b></p> <ul style="list-style-type: none"> <li>- For example, Giavina-Bianchi removed the most complex/severe cases and then excluded any non-skin neoplasms, and then they further filtered to only include the 10 most common skin neoplasms.</li> </ul>	RISK: LOW/HIGH/UNCLEAR
Concerns regarding applicability	<p><b>Is there concern that the included patients do not match the review question?</b></p> <ul style="list-style-type: none"> <li>- 'High' if the study only looked at a specific lesion category such as skin cancers only, or pigmented lesions only, or if they had a skewed patient demographics (e.g., 70% female, or geriatric population only). Our study is focuses on generalizability of teledermatology in all skin conditions.</li> </ul>	RISK: LOW/HIGH/UNCLEAR
Domain 2: INDEX TEST (Teledermatology consult)		
Signalling Q1	<p>Were the derms/physicians making the index diagnoses unaware of the reference diagnosis?</p> <ul style="list-style-type: none"> <li>- Same dermatologist doing F2F and teledermatology consults? Is there blinding of dermatologists to each other's diagnoses? In the study by Tan et al., the same dermatologist performed both the F2F and teledermatology consultations, which may introduce bias if they were not blinded to each other's diagnoses.</li> </ul>	Yes/No/Unclear
Signalling Q2	<p>Did the study require physicians to provide a specific primary diagnosis, or were they only required to provide a general grouping, e.g., inflammatory vs. skin neoplasm. Was analysis only performed for categories instead of complete primary diagnoses (such as skin neoplasm vs basal cell carcinoma)? Did physicians use standardized referral/consult sheet with set diagnoses? Did they group similar / synonymous diagnoses (e.g dermatitis / eczema together)? Was a non-specialist in charge of comparing diagnoses and deciding if there was agreement?</p> <ul style="list-style-type: none"> <li>- In the study by Warshaw et al., physicians were required to provide a categorical or pooled diagnosis (e.g., skin neoplasm instead of basal cell carcinoma), which may introduce bias and reduce applicability.</li> </ul>	Yes/No/Unclear
Risk of bias	<p><b>Could the conduct (technology used for taking images/viewing images) or interpretation (what constituted primary diagnosis/ complete agreement) of the index test have introduced bias?</b></p>	RISK: LOW/HIGH/UNCLEAR
Concerns regarding applicability	<p>Is there concern that the index test, its conduct, or interpretation differ from the review question?</p>	RISK: LOW/HIGH/UNCLEAR
Domain 3: REFERENCE TEST (F2F, in some cases histopathology)		
Signalling Q1	<p>Describe the reference standard and how it was conducted and interpreted:</p>	Yes/No/Unclear



	<p>What was the order of visits?</p> <p>What was the experience level and specialization of the F2F physician?</p> <p>Did the same dermatologist do both teledermatology and F2F consult?</p>	
Signalling Q2	Is the reference standard likely to correctly classify the target condition?	Yes/No/Unclear
<b>Risk of bias</b>	<p><b>Could the reference standard, its conduct, or its interpretation have introduced bias?</b></p> <ul style="list-style-type: none"> <li>- In studies where the reference standard was a consultation with a non-specialist, such as Costello et al., there is a risk of introducing bias.</li> </ul>	RISK: LOW/HIGH/UNCLEAR
<b>Concerns regarding applicability</b>	<p><b>Could the reference standard, its conduct, or its interpretation have introduced bias?</b></p> <ul style="list-style-type: none"> <li>- Applicability was impacted by physician specialization.</li> </ul>	RISK: LOW/HIGH/UNCLEAR
<b>Domain 4: FLOW AND TIMING</b>		
Signalling Q1	<p>Was there an appropriate interval between index test(s) and reference standard?</p> <ul style="list-style-type: none"> <li>- Was the time interval greater than 2 weeks? In studies where the same dermatologist did F2F and teledermatology -&gt; Say 'No' regardless of the time between teledermatology and F2F consult.</li> <li>- In the study by Gerhardt et al., there was a 30-day interval between teledermatology and F2F, which may introduce bias.</li> </ul>	Yes/No/Unclear
Signalling Q2	Did all patients receive a reference standard?	
Signalling Q3	<p>Did all patients receive the same reference standard?</p> <ul style="list-style-type: none"> <li>- In studies like Sola-Ortigosa et al., all patients received a reference standard, either histopathology or F2F consultation.</li> </ul> <p>Did a paper use histopathology as the reference standard for cancer lesions but F2F for non-cancer lesions? Were all patients evaluated by physicians with similar level of experience?</p>	Yes/No/Unclear
Signalling Q4	<p>Were all patients included in the analysis?</p> <ul style="list-style-type: none"> <li>- In studies like Gabel et al., all patients were included in the analysis, reducing the risk of bias.</li> </ul>	Yes/No/Unclear
<b>Risk of bias</b>	Could the patient flow have introduced bias?	RISK: LOW/HIGH/UNCLEAR



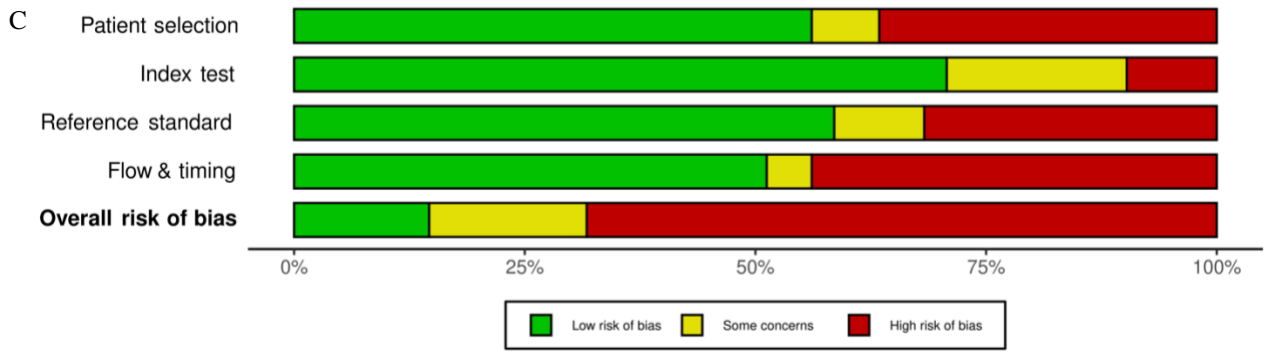
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Study	Risk of bias domains				
	D1	D2	D3	D4	Overall
Altieri, et al, 2017	+	+	+	+	+
Azfar, et al, 2014	+	+	+	+	X
Barbieri, et al, 2014	+	+	-	+	-
Barcaui, et al, 2018	+	+	X	X	X
Batalla, et al, 2015	-	+	+	+	-
Borve, et al, 2012	+	+	X	X	X
Borve, et al, 2013	X	-	+	+	X
Carter, et al, 2017	X	-	+	X	X
Chen, et al, 2010	+	X	X	-	X
Clarke, et al, 2021	X	X	+	+	X
Costello, et al, 2019	X	+	X	X	X
Duong, et al, 2014	+	-	X	X	X
Gabel, et al, 2021	X	+	+	X	X
Gatica, 2015	+	+	-	+	-
Gerhardt, et al, 2021	X	-	X	X	X
Giavina-Bianchi, et al, Oct 2020	X	+	-	X	X
Giavina-Bianchi, et al, Nov 2020	X	+	-	X	X
Gonzalez-Coloma, et al, 2019	+	X	X	+	X
Goulart-Silveira, et al, 2019	X	+	+	X	X
Jones, et al, 2021	+	-	+	+	-
Keller, et al, 2020	+	+	+	+	+
Lamel, et al, 2012	-	-	+	+	-
Marchell, et al, 2017	+	+	+	+	+
Muir, et al, 2011	X	+	+	X	X
Nami, et al, 2015	X	+	+	+	X
Okita, et al, 2016	+	+	+	+	X
Patro, et al, 2015	+	+	X	+	X
Piccoli, et al, 2015	X	+	X	X	X
Ribas, et al, 2010	X	+	X	X	X
Rubegni, et al, 2011	+	+	+	+	+
Saleh, et al, 2017	+	+	+	+	+
Senel, et al, 2013	X	+	+	X	X
Sola-Ortigosa, et al, 2020	+	+	X	X	X
Tan, et al, 2010	X	X	+	X	X
Tran, et al, 2011	+	+	X	+	X
Vano-Galvan, et al, 2010	+	+	+	+	X
Vestergaard, et al, 2020	+	+	+	X	X
Warshaw, et al, 2015	+	-	+	+	-
Zanini, 2013	-	+	+	-	-
Zink, et al, 2017, July	+	-	X	X	X
Zink, et al, 2017, Sept	+	+	+	+	+

Domains:  
 D1: Patient selection.  
 D2: Index test.  
 D3: Reference standard.  
 D4: Flow & timing.

Judgement  
 X High  
 - Some concerns  
 + Low

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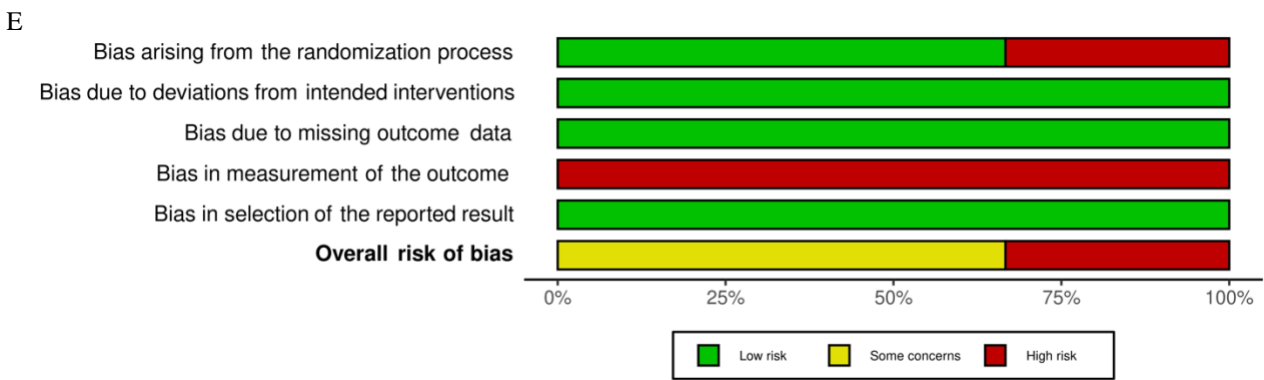
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Risk of bias domains

Study	D1	D2	D3	D4	D5	Overall
Rios-Yuil, 2011	High (X)	Low (+)	Low (+)	High (X)	Low (+)	High (X)
Romero, et al, 2010	Low (+)	Low (+)	Low (+)	High (X)	Low (+)	Some concerns (-)
Romero Aguilera, et al, 2014	Low (+)	Low (+)	Low (+)	High (X)	Low (+)	Some concerns (-)

Domains:  
 D1: Bias arising from the randomization process.  
 D2: Bias due to deviations from intended intervention.  
 D3: Bias due to missing outcome data.  
 D4: Bias in measurement of the outcome.  
 D5: Bias in selection of the reported result.

Judgement  
 High (X)  
 Some concerns (-)  
 Low (+)



**eTable 6. Risk of Bias (ROB) results.**

(A) QUADAS-2 summary sheet. (B,C) QUADAS-2 RoB analysis of 41 observational studies. (D,E) ROB-2 analysis of three randomized controlled trials.

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## MOOSE Checklist for Meta-analyses of Observational Studies

Item No	Recommendation	Reported on Page No
Reporting of background should include		
1	Problem definition	4
2	Hypothesis statement	4
3	Description of study outcome(s)	4-5
4	Type of exposure or intervention used	6-8
5	Type of study designs used	6-8
6	Study population	6-8
Reporting of search strategy should include		
7	Qualifications of searchers (eg, librarians and investigators)	6
8	Search strategy, including time period included in the synthesis and key words	6-8
9	Effort to include all available studies, including contact with authors	6-8
10	Databases and registries searched	6-8
11	Search software used, name and version, including special features used (eg, explosion)	6-8
12	Use of hand searching (eg, reference lists of obtained articles)	6-8
13	List of citations located and those excluded, including justification	Supplement
14	Method of addressing articles published in languages other than English	6-8
15	Method of handling abstracts and unpublished studies	6-8, Supplement
16	Description of any contact with authors	6-8, Supplement
Reporting of methods should include		
17	Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	9-12
18	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	9-12
19	Documentation of how data were classified and coded (eg, multiple raters, blinding and interrater reliability)	9-12
20	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	9-12
21	Assessment of study quality, including blinding of quality assessors, stratification or regression on possible predictors of study results	9-12
22	Assessment of heterogeneity	9-12
23	Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	9-12
24	Provision of appropriate tables and graphics	9-12, Supplement
Reporting of results should include		
25	Graphic summarizing individual study estimates and overall estimate	Fig 1-3, Supplement
26	Table giving descriptive information for each study included	Tables 1, 2, Supplement
27	Results of sensitivity testing (eg, subgroup analysis)	9-12
28	Indication of statistical uncertainty of findings	9-12

Item No	Recommendation	Reported on Page No
Reporting of discussion should include		
29	Quantitative assessment of bias (eg, publication bias)	9-12
30	Justification for exclusion (eg, exclusion of non-English language citations)	9-12
31	Assessment of quality of included studies	9-12
Reporting of conclusions should include		
32	Consideration of alternative explanations for observed results	13-17
33	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	13-17
34	Guidelines for future research	13-17
35	Disclosure of funding source	18

From: Stroup DF, Berlin JA, Morton SC, et al, for the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) Group. Meta-analysis of Observational Studies in Epidemiology. A Proposal for Reporting. *JAMA*. 2000;283(15):2008-2012. doi: 10.1001/jama.283.15.2008.





## PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
<b>TITLE</b>			
Title	1	Identify the report as a systematic review.	p1
<b>ABSTRACT</b>			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p3-4
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	p5-6
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	p5-6
<b>METHODS</b>			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	p8, Supplementary p15
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	p7
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplementary p2
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	p8
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	p8
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Supplementary p15
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	p8 and Supplementary p15
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	p9
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	p8-9
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	p8-9
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	p 8-9 Supplementary p2
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	p 8-9 Supplementary p2
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	p 8-9 Supplementary p2
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	p 8-9 Supplementary p2
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	p9
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA



## PRISMA 2020 Checklist

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Section and Topic	Item #	Checklist item	Location where item is reported
<b>RESULTS</b>			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Figure 1, p10
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Supplementary p23-3
Study characteristics	17	Cite each included study and present its characteristics.	p10-11, Table 1, 2
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	p15, Supplementary eTable 5
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	p15, Supplementary eTable 5
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Figure 2, 3, Supplementary eFigure 1-5
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	p 11-13 Supplementary p3
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	p 11-13 Supplementary p3
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Supplementary eTable 5
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	p 11-13 Supplementary p3
<b>DISCUSSION</b>			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	p14
	23b	Discuss any limitations of the evidence included in the review.	p15-16
	23c	Discuss any limitations of the review processes used.	p16
	23d	Discuss implications of the results for practice, policy, and future research.	p17
<b>OTHER INFORMATION</b>			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	p7
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	p7
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	p18
Competing interests	26	Declare any competing interests of review authors.	p18
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71

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