Smoking and COVID Living Review (v11): a bayesian analysis

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## Abstract

**Aims:** To estimate the association of smoking status with rates of i) infection, ii) hospitalisation, iii) disease severity, and iv) mortality from SARS-CoV-2/COVID-19 disease.

**Design:** Living rapid review of observational and experimental studies with random-effects hierarchical Bayesian meta-analyses. Published articles and pre-prints were identified via MEDLINE and medRxiv.

**Setting:** Community or hospital. No restrictions on location.

**Participants:** Adults who received a SARS-CoV-2 test or a COVID-19 diagnosis.

**Measurements:** Outcomes were SARS-CoV-2 infection, hospitalisation, disease severity and mortality stratified by smoking status. Study quality was assessed (i.e. ‘good’, ‘fair’ and ‘poor’).

**Findings:** v11 (searches up to 2021-02-16) included 405 studies with 62 ‘good’ and ‘fair’ quality studies included in unadjusted meta-analyses. 121 studies (29.9%) reported current, former and never smoking status with the remainder using broader categories. Recorded smoking prevalence among people with COVID-19 was generally lower than national prevalence. Current compared with never smokers were at reduced risk of SARS-CoV-2 infection (RR = 0.71, 95% Credible Interval (CrI) = 0.61-0.82, τ = 0.34). Data for former smokers were inconclusive (RR = 1.03, 95% CrI = 0.95-1.11, τ = 0.17) but favoured there being no important association (4% probability of RR ≥1.1). Former compared with never smokers were at increased risk of hospitalisation (RR = 1.19, CrI = 1.1-1.29, τ = 0.13), greater disease severity (RR = 1.8, CrI = 1.27-2.55, τ = 0.46) and mortality (RR = 1.56, CrI = 1.23-2, τ = 0.43). Data for current smokers on hospitalisation, disease severity and mortality were inconclusive (RR = 1.1, 95% CrI = 0.99-1.21, τ = 0.15; RR 1.26, 95% CrI = 0.92-1.73, τ = 0.32; RR = 1.12, 95% CrI = 0.84-1.47, τ = 0.42, respectively) but favoured there being no important associations with hospitalisation and mortality (49% and 56% probability of RR ≥1.1, respectively) and a small but important association with disease severity (83% probability of RR ≥1.1).

**Conclusions:** Compared with never smokers, current smokers appear to be at reduced risk of SARS-CoV-2 infection while former smokers appear to be at increased risk of hospitalisation, greater disease severity and mortality from COVID-19. However, it is uncertain whether these associations are causal.

v7 of this living review article has been published in [*Addiction*](https://doi-org.libproxy.ucl.ac.uk/10.1111/add.15276)

## Introduction

COVID-19 is a respiratory disease caused by the SARS-CoV-2 virus. Large age and gender differences in case severity and mortality have been observed in the ongoing COVID-19 pandemic (W-j Guan, Z-y Ni, et al., 2020); however, these differences are currently unexplained. SARS-CoV-2 enters epithelial cells through the angiotensin-converting enzyme 2 (ACE-2) receptor (Hoffmann et al., 2020). Some evidence suggests that gene expression and subsequent receptor levels are elevated in the airway and oral epithelium of current smokers (Brake et al., 2020; Cai, 2020), which could put smokers at higher risk of contracting SARS-CoV-2. Other studies, however, suggest that nicotine downregulates the ACE-2 receptor (Oakes et al., 2018). These uncertainties notwithstanding, both former and current smoking is known to increase the risk of respiratory viral (Abadom et al., 2016; Denholm et al., 2010) and bacterial (Almirall et al., 1999; Feldman and Anderson, 2013) infections and is associated with worse outcomes once infected. Cigarette smoke reduces the respiratory immune defence through peri-bronchiolar inflammation and fibrosis, impaired mucociliary clearance and disruption of the respiratory epithelium (Dye and Adler, 1994). There is also reason to believe that behavioural factors (e.g. regular hand-to-mouth movements) involved in smoking may increase SARS-CoV-2 infection and transmission in current smokers. However, early data from the COVID-19 pandemic have not provided clear evidence for a negative impact of current or former smoking on SARS-CoV-2 infection or COVID-19 disease outcomes, such as hospitalisation or mortality (Vardavas and Nikitara, 2020). It has also been hypothesised that nicotine might protect against a hyper-inflammatory response to SARS-CoV-2 infection, which may lead to adverse outcomes in patients with COVID-19 disease (Farsalinos, Niaura, et al., 2020).

There are several reviews that fall within the scope of smoking and COVID-19 (Alqahtani et al., 2020; Berlin et al., 2020; Emami et al., 2020; Farsalinos, Barbouni, et al., 2020; Grundy\* et al., 2020; Patanavanich and Glantz, 2020; Vardavas and Nikitara, 2020). We aimed to produce a rapid synthesis of available evidence pertaining to the rates of infection, hospitalisation, disease severity and mortality from SARS-CoV-2/COVID-19 stratified by smoking status. Given the increasing availability of data on this topic, this is a living review with regular updates. As evidence accumulates, the review will be expanded to include studies reporting COVID-19 outcomes by alternative nicotine use (e.g., nicotine replacement therapy or e-cigarettes).

## Methods

*Study design*

This is a living evidence review which is updated as new evidence becomes available (Elliott et al., 2014). We adopted recommended best practice for rapid evidence reviews, which involved limiting the search to main databases and having one reviewer extract the data and another verify (Tricco et al., 2015). This study was not pre-registered but evolved from a report written for a UK medical society (D Simons, J Brown, et al., 2020). The most recent version of this living review is available [here](https://www.qeios.com/read/latest-UJR2AW). Version 7 of this living review has been published in a peer-reviewed journal (D Simons, Shahab, et al., 2020). A completed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist is included in Supplementary file 1.

*Eligibility criteria*

Studies were included if they:

1. Were primary research studies using experimental (e.g. randomised controlled trial), quasi-experimental (e.g. pre- and post-test) or observational (e.g. case-control, retrospective cohort, prospective cohort) study designs;
2. Included adults aged 16+ years;
3. Recorded as outcome i) results of a SARS-CoV-2 diagnostic test (including antibody assays), ii) clinical diagnosis of COVID-19, iii) hospitalisation with COVID-19, iv) severity of COVID-19 disease in those hospitalised or v) mortality from COVID-19; Reported any of the outcomes of interest by self-reported or biochemically verified smoking status (e.g. current smoker, former smoker, never smoker) or current vaping and nicotine replacement therapy (NRT) use;
4. Were available in English;
5. Were published in a peer-reviewed journal, as a pre-print or a public health report by reputable bodies (e.g. governments, scientific societies).

*Search strategy*

The following terms were searched for in Ovid MEDLINE (2019-search date) as free text or Medical Subject Headings:

1. Tobacco Smoking/ or Smoking Cessation/ or Water Pipe Smoking/ or Smoking/ or Smoking Pipes/ or Cigar Smoking/ or Smoking Prevention/ or Cigarette Smoking/ or smoking.mp. or Pipe Smoking/ or Smoking, Non-Tobacco Products/ or Smoking Water Pipes/
2. Nicotine/ or nicotine.mp. or Electronic Nicotine Delivery Systems/ or Nicotine Chewing Gum/
3. vaping.mp. or Vaping/
4. 1 or 2 or 3
5. Coronavirus/ or Severe Acute Respiratory Syndrome/ or Coronavirus Infections/ or covid.mp.
6. 4 and 5

The following terms were searched for in titles, abstracts and full texts in medRxiv (no time limitations):

1. covid (this term captures both covid and SARS-CoV-2) AND smoking
2. covid AND nicotine
3. covid AND vaping

Additional articles/reports of interest were identified through mailing lists, Twitter, the International Severe Acute Respiratory and Emerging Infection Consortium (ISARIC) and the US Centers for Disease Control and Prevention (CDC). Where updated versions of pre-prints or public health reports were available, old versions were superseded.

*Selection of studies*

One reviewer screened titles, abstracts and full texts against the inclusion criteria.

*Data extraction*

Data were extracted by one reviewer and verified (i.e. independently checked against pre-prints and published reports) by another on i) author (year); ii) date published; iii) country; iv) study design; v) study setting; vi) sample size; vii) sex; viii) age; ix) smoking status (e.g. current, former, never, not stated, missing) and whether it was biochemically verified; x) use of alternative nicotine products; xi) SARS-CoV-2 testing; xii) SARS-CoV-2 infection; xiii) diagnosis of COVID-19; xiv) hospitalisation with COVID-19; xv) disease severity in those hospitalised with COVID-19; xvi) mortality; xvii) adjustment of smoking specific risk estimates for relevant covariates (e.g. age, sex); and xviii) whether a representative or random sampling method was used.

*Quality appraisal*

The quality of included studies was assessed to determine suitability for inclusion in meta-analyses. Studies were judged as ‘good’ quality if they: i) had <20% missing data on smoking status and used a reliable self-report measure that distinguished between current, former and never smoking status; AND ii) used biochemical verification of smoking status and reported results from adjusted analyses; OR reported data from a representative/random sample. Studies were rated as ‘fair’ if they fulfilled only criterion i) and were otherwise rated as ‘poor’. The quality appraisal was conducted by one reviewer and verified by a second.

*Evidence synthesis*

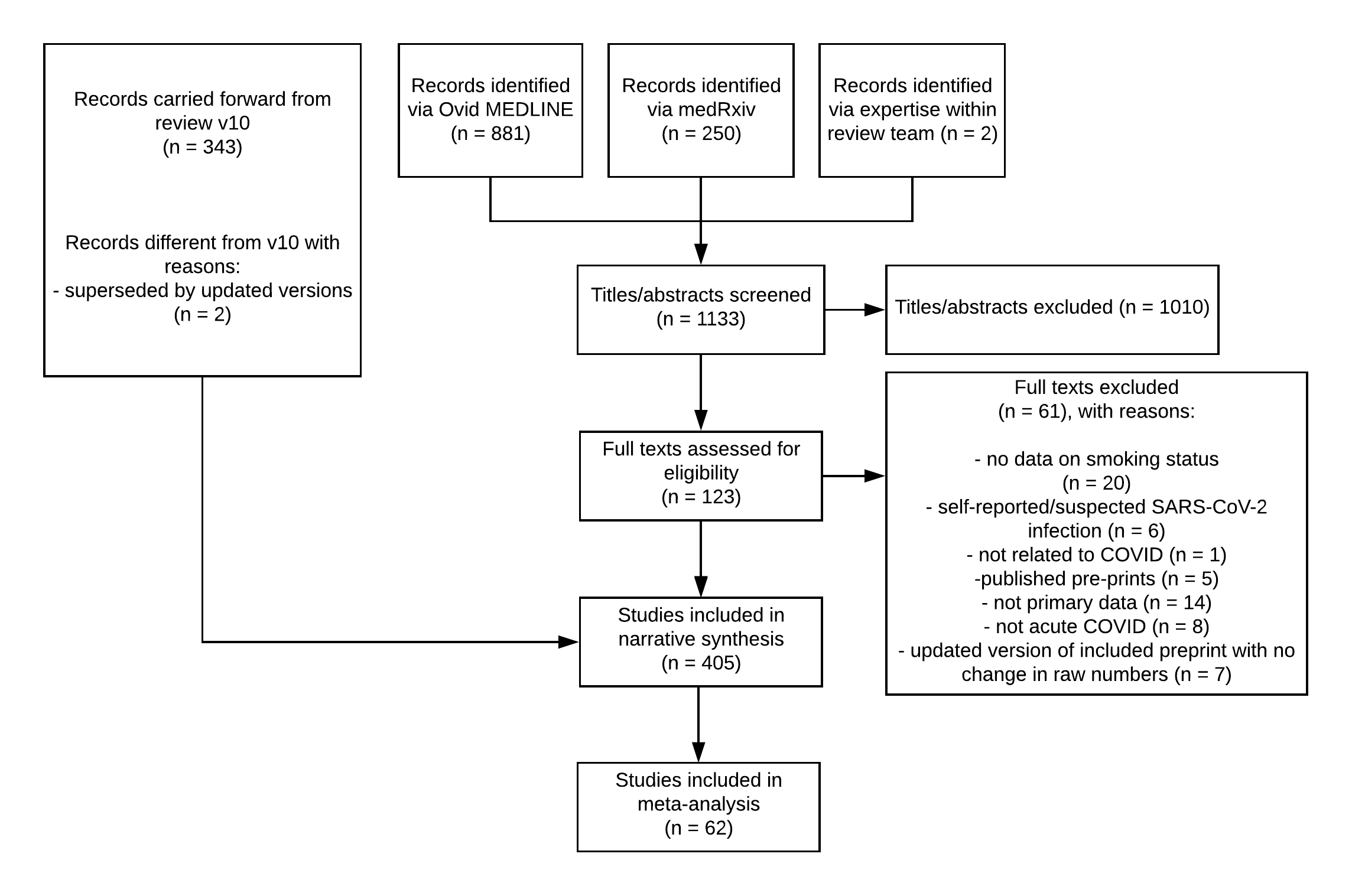
A narrative synthesis was conducted. Data from ‘good’ and ‘fair’ quality studies were pooled in R v.3.6.3 (Team, 2013). In a living review where new data are regularly added to the analyses, it may be more appropriate to use a Bayesian (as opposed to frequentist) approach where prior knowledge is used in combination with new data to estimate a posterior risk distribution. A Bayesian approach mitigates the issue of performing multiple statistical tests, which can inflate family-wise error. A series of random-effects hierarchical Bayesian meta-analyses were performed with the brms (Bürkner, 2018) package to estimate the relative risk for each comparison with accompanying 95% credible intervals (CrIs). We first defined prior distributions for the true pooled effect size (µ) and the between-study heterogeneity (τ), with µ specified as a normal distribution with a mean equal to the derived point estimate from each comparison of interest in the immediately preceding version of this living review, and τ specified as a half-Cauchy distribution with a mean of 0 and standard deviation of 1. The half-Cauchy distribution was selected to reflect prior knowledge that high levels of between-study heterogeneity are more likely than lower levels. Markov Chain Monte Carlo methods (20,000 burn-ins followed by 80,000 iterations) were then used to generate a risk distribution for each study, in addition to a pooled effect for the posterior risk distribution. We report forest plots with the pooled effect for the posterior risk distribution displayed as the median relative risk with an accompanying 95% CrIs. We used the empirical cumulative distribution function (ECDF) to estimate the probability of there being a 10% reduction or 10% increase in relative risk (RR) (i.e. RR ≥1.1 or RR ≤0.9). Due to a lack of indication as to what constitutes a clinically or epidemiologically meaningful effect (e.g. with regards to onward disease transmission or requirements for intensive care beds), we deemed a 10% change in risk as small but important. Where data were inconclusive (as indicated by CrIs crossing RR = 1.0), to disambiguate whether data favoured no effect or there being a small but important association, we estimated whether there was ≥75% probability of RR ≥1.1 or RR ≤0.9.

Two sensitivity analyses were performed. First, a minimally informative prior for µ was specified as a normal distribution with a mean of 0 and standard deviation of 1 and τ as described above. Second, an informative prior as described above for µ was used with τ specified as a half-Cauchy distribution with a mean of 0.3 and standard deviation of 1 to reflect greater between-study heterogeneity.

To aid in the visualisation of smoking prevalence in the included studies, the weighted mean prevalence of current and former smoking was calculated for countries with ≥3 studies and plotted for comparison with national prevalence estimates. It should be noted that prevalence estimates in the included studies were not adjusted for age, sex, socioeconomic position, or geographic region within countries.

## Results

In the current review version (v11) with searches up to 2021-02-16, a total of 1133 records were identified, with 405 studies included in a narrative synthesis and 62 studies included in meta-analyses (see [Figure 1](#fig-1)).



*Figure 1.* PRISMA flow diagram of included studies.

Characteristics of included studies are presented in [Table 1](#table-1). Studies were conducted across 41 countries. 109 studies were conducted in the USA, 70 in China, 44 in the UK, 28 in Spain, 20 in France, 18 in Mexico, 16 in Italy, 13 in Multiple, 8 in Turkey, 7 in Brazil and Iran, 5 in Israel and Switzerland, 4 in Finland and India, with 3 each from Australia, Austria, Japan, Saudi Arabia, and South Korea and a single study from 10 further countries. The majority of studies used observational designs (see [Supplementary table S1](#supplementary-t1)). 256 (63.2%) were conducted in hospital settings, 106 studies (26.2%) included individuals from community and hospital settings, 40 studies (9.9%) were conducted exclusively in the community, with one study each conducted in a homeless shelter and a quarantine centre, and one study that did not state the study setting. Studies had a median of 502 (interquartile range = 146-2038) participants. The majority of studies (87.8%) used reverse transcriptase polymerase chain reaction (RT-PCR) for confirmation of SARS-CoV-2 infection, 12.2% used an antibody test to confirm prior infection and 6.8% of studies relied on a combination of RT-PCR or antibody assays.

### Smoking status

Categorisation of smoking status was heterogeneous (see [Table 1](#table-1)). 236 studies collected data on smoking status through routine electronic health records (EHRs), 129 studies used a bespoke case report form for COVID-19 and 40 studies did not state the source for information on smoking status. None of the studies verified smoking status biochemically. Notably, only 121 (29.9%) studies reported current, former and never smoking status (see [Supplementary table S2a](#supplementary-t2a)), with a further 26 studies reporting only ever and never smoking status (see [Supplementary table S2b](#supplementary-t2b)). The remaining 252 studies reported current, current/former or current and former smoking status but did not explicitly state whether remaining participants were never smokers or if data were missing on smoking status (see [Supplementary table S2c](#supplementary-t2c)). 133 studies explicitly reported the proportion with missing data on smoking status, which ranged from 0% to 97.6%.

### Use of alternative nicotine products

Eight studies recorded the use of alternative nicotine products in current and/or former smokers but did not report COVID-19 outcomes stratified by alternative nicotine use (Crooks et al., 2020; Ebinger et al., 2020; Gallichotte et al., 2020; Girardeau et al., 2020; Islam et al., 2020; Kantele et al., 2020; Miyara et al., 2020; Rimland et al., 2020). One additional study grouped together current smokers and vapers (Schubl et al., 2020).

### Quality appraisal

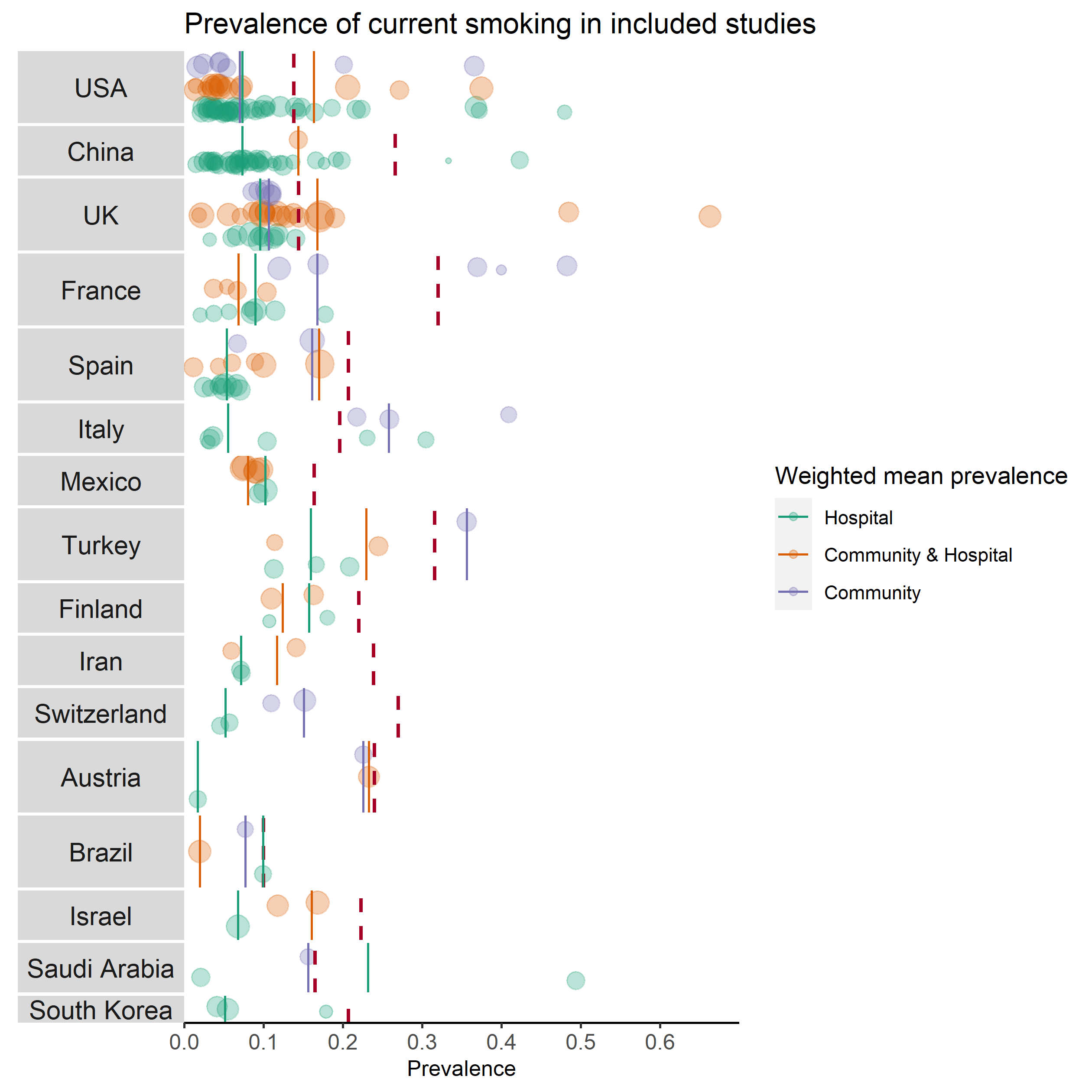
Three studies were performed in random or representative population samples and were rated as ‘good’ quality, and 94 studies were rated as ‘fair’ quality, of which 62 studies reported results stratified by smoking status for the outcomes of interest and could be included in meta-analyses. The remaining 308 studies were rated as ‘poor’ quality (see [Table 1](#table-1)).

#### *Table 1.* All studies included in narrative review and meta-analysis

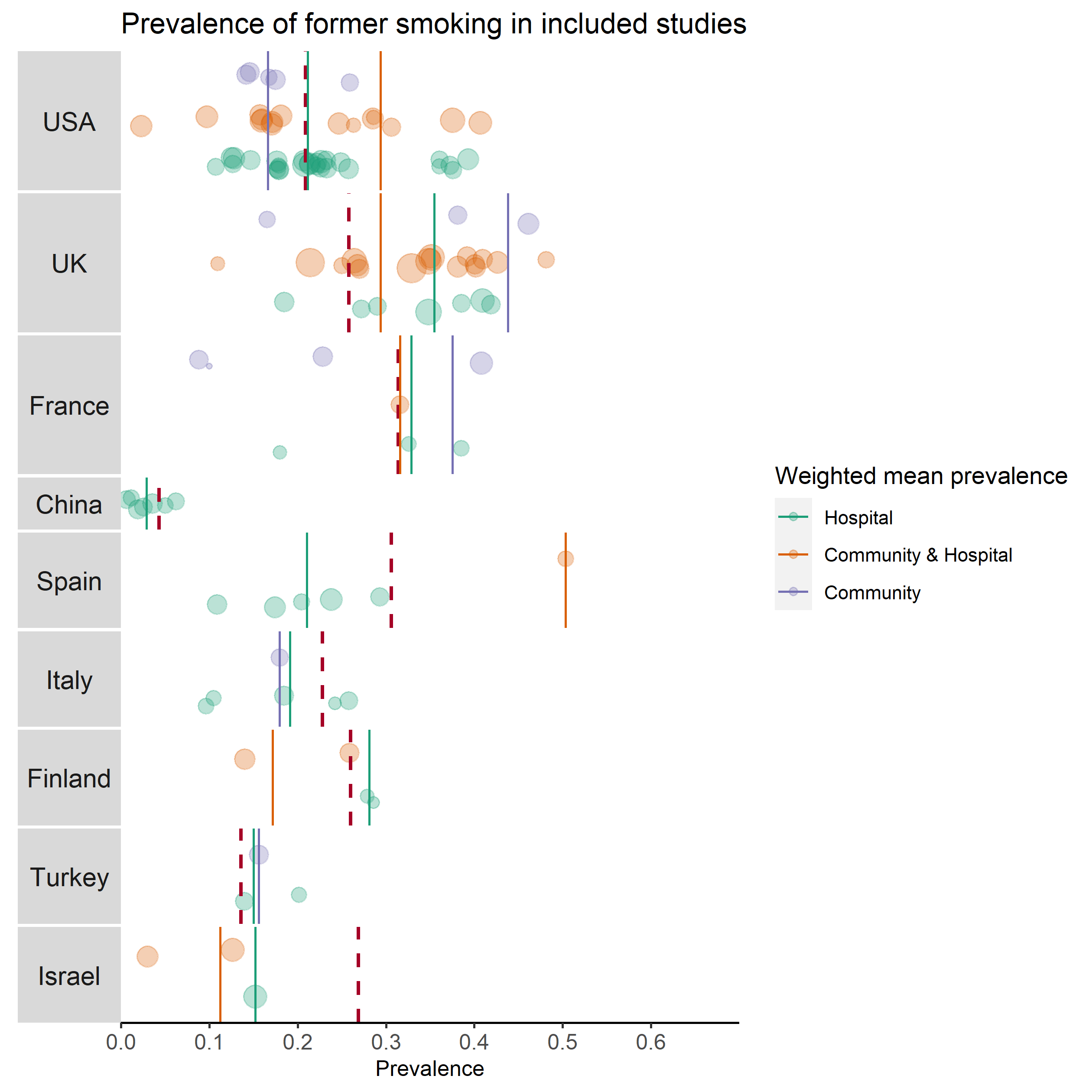
| ref | Lead author | Date published | Country | Sample size | Study setting | Median (IQR) | Female % | Current smoker % | Former smokers % | Current/former smokers % | Never smokers % | Never/unknown smokers % | Missing % | Study quality |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Huang et al. (2020) | Huang, Wang | 2020-01-24 | China | 41 | Hospital | 49 (41-58) | 27.0 | 7.3 | - | - | - | - | 92.68 | poor |
| Li et al. (2020) | Li | 2020-02-12 | China | 17 | Hospital | 45 (33-57) | 47.1 | 17.6 | - | - | - | - | 82.35 | poor |
| Zhang et al. (2020) | Zhang, Dong | 2020-02-19 | China | 140 | Hospital | 57^ (25-87) | 46.3 | 1.4 | 5.00 | - | - | - | 93.57 | poor |
| Yang et al. (2020) | Yang, Yu | 2020-02-24 | China | 52 | Hospital | 60 (47-73) | 37.0 | 3.8 | - | - | - | - | 96.15 | poor |
| Guan et al. (2020) | Guan, Ni | 2020-02-28 | China | 1,099 | Hospital | 47 (35-58) | 41.9 | 12.5 | 1.91 | - | 84.3 | - | 1.27 | fair |
| Liu et al. (2020) | Liu, Tao | 2020-02-28 | China | 78 | Hospital | 38 (33-57) | 50.0 | - | - | 6.41 | - | - | 93.59 | poor |
| Qi et al. (2020) | Qi | 2020-03-03 | China | 267 | Hospital | 48 (35-65) | 45.2 | 19.9 | - | - | - | 80 | 0.00 | poor |
| Huang et al. (2020) | Huang, Yang | 2020-03-05 | China | 36 | Hospital | 69 (60-78) | 30.6 | - | - | 11.11 | - | - | 88.89 | poor |
| Xu et al. (2020) | Xu | 2020-03-08 | China | 53 | Hospital | NA | 47.2 | 11.3 | - | - | - | - | 88.68 | poor |
| Zhou et al. (2020) | Zhou, Yu | 2020-03-11 | China | 191 | Hospital | 56 (46-67) | 38.0 | 5.8 | - | - | - | - | 94.24 | poor |
| Liu et al. (2020) | Liu, Ming | 2020-03-12 | China | 41 | Hospital | 39 (30-48) | 58.5 | 9.8 | - | - | - | - | 90.24 | poor |
| Mo et al. (n.d.) | Mo | 2020-03-16 | China | 155 | Hospital | 54 (53-66) | 44.5 | 3.9 | - | - | - | - | 96.13 | poor |
| Shi et al. (2020) | Shi, Yu | 2020-03-18 | China | 487 | Hospital | 46 (27-65) | 46.8 | - | - | 8.21 | - | - | 91.79 | poor |
| Zhang et al. (2020) | Zhang, Cai | 2020-03-20 | China | 645 | Hospital | NA | 49.1 | 6.4 | - | - | - | - | 93.64 | poor |
| Dong et al. (2020) | Dong, Cao | 2020-03-20 | China | 9 | Hospital | 44 (30-46) | 66.7 | 11.1 | - | - | - | - | 88.89 | poor |
| Wan et al. (2020) | Wan | 2020-03-21 | China | 135 | Hospital | 47 (36-55) | 46.7 | 6.7 | - | - | - | - | 93.33 | poor |
| Jin et al. (2020) | Jin | 2020-03-24 | China | 651 | Hospital | 46 (32-60) | 49.2 | 6.3 | - | - | - | - | 93.70 | poor |
| Wang et al. (2020) | Wang, Pan | 2020-03-24 | China | 125 | Hospital | 41 (26-66) | 43.2 | - | - | 12.80 | - | - | 87.20 | poor |
| Lian et al. (n.d.) | Lian | 2020-03-25 | China | 788 | Hospital | NA | 38.5 | 6.9 | - | - | - | - | 93.15 | poor |
| Hu et al. (2020) | Hu | 2020-03-25 | China | 323 | Hospital | 61^ (23-91) | 48.6 | - | - | 11.76 | - | - | 88.24 | poor |
| Guan et al. (2020) | Guan, Liang | 2020-03-26 | China | 1,590 | Hospital | 49 (33-64) | 42.7 | - | - | 6.98 | 93.0 | - | 0.00 | poor |
| Chen et al. (2020) | Chen | 2020-03-26 | China | 548 | Hospital | 62 (44-70) | 37.6 | 4.4 | 2.55 | - | - | - | 93.07 | poor |
| Guo et al. (2020) | Guo | 2020-03-27 | China | 187 | Hospital | 59 (45-73) | 51.3 | 9.6 | - | - | - | - | 90.37 | poor |
| CDCMMWR (2020) | Chow (US CDC) | 2020-03-31 | USA | 7,162 | Community and Hospital | NA | - | 1.3 | 2.30 | - | - | - | 96.36 | poor |
| Kim et al. (2020) | Kim | 2020-04-01 | South Korea | 28 | Hospital | 43 (30-56) | 46.4 | 17.9 | - | - | - | - | 82.14 | poor |
| Feng et al. (2020) | Feng | 2020-04-10 | China | 476 | Hospital | 53 (40-64) | 43.1 | 9.2 | - | - | - | - | 90.76 | poor |
| Rentsch et al. (2020) | Rentsch | 2020-04-14 | USA | 3,528 | Community and Hospital | 66 (60-70) | 4.6 | 27.2 | 30.60 | - | 36.9 | - | 5.30 | fair |
| Goyal et al. (2020) | Goyal | 2020-04-17 | USA | 393 | Hospital | 62.2 (49-74) | 39.3 | 5.1 | - | - | - | - | 94.91 | poor |
| Zheng et al. (2020) | Zheng, Gao | 2020-04-19 | China | 66 | Hospital | 47^ (NA) | 25.8 | 12.1 | - | - | - | - | 87.88 | poor |
| Gold et al. (2020) | Gold (US CDC) | 2020-04-20 | USA | 305 | Hospital | NA | 50.5 | 5.2 | - | - | - | - | 94.75 | poor |
| Argenziano et al. (2020) | Argenziano | 2020-04-22 | USA | 1,000 | Hospital | 63 (50-75) | 40.4 | 4.9 | 17.90 | - | 77.2 | - | 0.00 | fair |
| Richardson et al. (2020) | Richardson | 2020-04-22 | USA | 5,700 | Hospital | 63 (52-75) | 39.7 | - | - | 9.79 | 52.8 | - | 37.42 | poor |
| Fontanet et al. (2020) | Fontanet | 2020-04-23 | France | 661 | Community and Hospital | 37 (16-47) | 62.0 | 10.4 | - | - | - | 90 | 0.00 | poor |
| Shi et al. (2020) | Shi, Ren | 2020-04-23 | China | 134 | Hospital | 46 (34-58) | 51.5 | - | - | 10.45 | - | - | 89.55 | poor |
| Hadjadj et al. (2020) | Hadjadj | 2020-04-23 | France | 50 | Hospital | 55 (50-63) | 22.0 | 2.0 | 18.00 | - | 80.0 | - | 0.00 | fair |
| Liao et al. (2020) | Liao, Feng | 2020-04-24 | China | 1,848 | Hospital | 55 (48-61) | 54.7 | - | - | 0.43 | - | - | 99.57 | poor |
| Gil-Agudo et al. (2020) | Gil-Agudo | 2020-04-24 | Spain | 7 | Hospital | 68 (34-75) | 28.6 | - | - | 42.86 | 57.1 | - | 0.00 | poor |
| Yao et al. (n.d.) | Yao | 2020-04-24 | China | 108 | Hospital | 52 (37-58) | 60.2 | 3.7 | - | - | - | - | 96.30 | poor |
| Zuo et al. (2020) | Zuo, Yalavarthi | 2020-04-24 | USA | 50 | Hospital | 61 (46-76) | 34.0 | - | - | 36.00 | - | - | 64.00 | poor |
| Solís and Carreño (2020) | Solis | 2020-04-25 | Mexico | 650 | Hospital | 46 (NA) | 42.1 | 9.4 | - | - | - | - | 90.62 | poor |
| Yu et al. (2020) | Yu, Cai | 2020-04-27 | China | 95 | Hospital | NA | 44.2 | 8.4 | - | - | - | - | 91.58 | poor |
| Ziehr et al. (2020) | Ziehr | 2020-04-29 | USA | 66 | Hospital | 58 (23-87) | 35.0 | - | - | 33.33 | 63.6 | - | 3.03 | poor |
| Zheng et al. (2020) | Zheng, Xiong | 2020-04-30 | China | 73 | Hospital | 43^ (NA) | 45.2 | - | - | 10.96 | 89.0 | - | 0.00 | poor |
| Kalan et al. (2020) | Kalan | 2020-05-01 | Iran | 193 | Hospital | 52.6^ (37-67) | 36.3 | 7.3 | - | - | 85.0 | - | 7.77 | poor |
| Kolin et al. (2020) | Kolin | 2020-05-05 | UK | 1,474 | Community and Hospital | 58 (49-67) | 46.6 | 14.5 | 40.16 | - | 44.6 | - | 0.81 | fair |
| Borobia et al. (2020) | Borobia | 2020-05-06 | Spain | 2,226 | Hospital | 61 (46-78) | 52.0 | 7.1 | - | - | - | - | 92.95 | poor |
| Giacomelli et al. (2020) | Giacomelli | 2020-05-06 | Italy | 233 | Hospital | 61 (50-72) | 31.9 | - | - | 30.04 | 70.0 | - | 0.00 | poor |
| Shah et al. (2020) | Shah | 2020-05-06 | USA | 316 | Hospital | 63 (43-72) | 48.1 | 16.5 | 17.72 | - | 42.1 | - | 23.73 | poor |
| Williamson et al. (2020) | The OpenSAFELY Collaborative | 2020-05-07 | UK | 17,425,445 | Community and Hospital | NA | 50.1 | 17.0 | 32.93 | - | 45.9 | - | 4.16 | fair |
| Allenbach et al. (2020) | Allenbach | 2020-05-08 | France | 152 | Hospital | 77 (60-83) | 31.1 | - | - | 6.58 | - | - | 93.42 | poor |
| Robilotti et al. (2020) | Robilotti | 2020-05-08 | USA | 423 | Hospital | NA | 50.0 | 2.1 | 37.59 | - | 58.6 | - | 1.65 | fair |
| Lubetzky et al. (2020) | Lubetzky | 2020-05-08 | USA | 54 | Hospital | 57 (29-83) | 62.0 | - | - | 22.22 | - | - | 77.78 | poor |
| Yin et al. (2020) | Yin, Yang | 2020-05-10 | China | 106 | Hospital | 73 (61-85) | 39.6 | - | - | 16.98 | - | - | 83.02 | poor |
| Rica et al. (2020) | de la Rica | 2020-05-11 | Spain | 48 | Hospital | 66^ (33-88) | 33.0 | - | - | 20.83 | - | - | 79.17 | poor |
| Cho et al. (2020) | Cho | 2020-05-11 | UK | 1,331 | Community and Hospital | NA | 49.2 | 19.0 | 26.97 | - | 54.0 | - | 0.00 | fair |
| Yanover et al. (2020) | Yanover | 2020-05-13 | Israel | 4,353 | Community and Hospital | 35 (22-54) | 44.5 | 11.8 | 2.96 | - | 85.2 | - | 0.00 | fair |
| Hamer et al. (2020) | Hamer | 2020-05-13 | UK | 387,109 | Hospital | 56.2 (48-64) | 55.1 | 9.7 | 34.84 | - | 55.5 | - | 0.00 | fair |
| Targher et al. (2020) | Targher | 2020-05-13 | China | 339 | Hospital | 48.4^ (NA) | 52.8 | 8.3 | - | - | - | - | 91.74 | poor |
| Carrillo-Vega et al. (2020) | Carillo-Vega | 2020-05-14 | Mexico | 10,544 | Community and Hospital | 46.5^ (30-62) | 42.3 | 8.9 | - | - | - | - | 91.12 | poor |
| Regina et al. (2020) | Regina | 2020-05-14 | Switzerland | 200 | Hospital | 70 (55-81) | 40.0 | 4.5 | - | - | - | - | 95.50 | poor |
| Almazeedi et al. (2020) | Almazeedi | 2020-05-15 | Kuwait | 1,096 | Hospital | 41 (25-57) | 19.0 | 4.0 | - | - | - | 96 | 0.00 | poor |
| Lusignan et al. (2020) | de Lusignan | 2020-05-15 | UK | 3,802 | Community | 58 (34-73) | 57.6 | 10.9 | 46.11 | - | 29.6 | - | 13.44 | fair |
| Palaiodimos et al. (2020) | Palaiodimos | 2020-05-15 | USA | 200 | Hospital | 64 (50-73.5) | 51.0 | - | - | 32.50 | 67.5 | - | 0.00 | poor |
| Mejia-Vilet et al. (2020) | Mejia-Vilet | 2020-05-16 | Mexico | 329 | Hospital | 49 (41-60) | 36.0 | - | - | 6.99 | - | - | 93.01 | poor |
| Chen et al. (2020) | Chen, Jiang | 2020-05-16 | China | 135 | Hospital | NA | 42.2 | - | - | 9.63 | - | - | 90.37 | poor |
| Li et al. (2020) | Li, Chen | 2020-05-16 | China | 1,008 | Hospital | 55 (44-65) | 43.6 | 5.7 | - | - | - | - | 94.35 | poor |
| Valenti et al. (2020) | Valenti | 2020-05-18 | Italy | 789 | Community | 40.7^ (NA) | 35.0 | 25.9 | - | - | - | - | 74.14 | poor |
| Feuth et al. (2020) | Feuth | 2020-05-18 | Finland | 28 | Hospital | 56 (47-72) | 46.0 | 10.7 | 28.57 | - | 60.7 | - | 0.00 | fair |
| Ge et al. (2020) | Ge | 2020-05-18 | China | 51 | Hospital | 70 (58-79) | 27.5 | 13.7 | - | - | - | - | 86.27 | poor |
| Parrotta et al. (2020) | Parrotta | 2020-05-18 | USA | 76 | Community and Hospital | 44.9 (13-71) | 61.8 | 2.6 | 26.32 | - | 68.4 | - | 2.63 | fair |
| Shekhar et al. (2020) | Shekhar | 2020-05-18 | USA | 50 | Hospital | 55.5 (20-85) | 54.0 | 48.0 | - | - | - | - | 52.00 | poor |
| Rimland et al. (2020) | Rimland | 2020-05-19 | USA | 11 | Hospital | 59 (48-65) | 18.2 | 9.1 | - | - | - | - | 81.82 | poor |
| Basse et al. (2020) | Basse | 2020-05-19 | France | 141 | Hospital | 62 (52-72) | 72.0 | 17.7 | - | - | - | - | 82.27 | poor |
| Freites et al. (2020) | Freites | 2020-05-19 | Spain | 123 | Hospital | 59.88^ (44-74) | 69.9 | 3.3 | - | - | - | - | 96.75 | poor |
| Alshami et al. (2020) | Alshami | 2020-05-19 | Saudi Arabia | 128 | Quarantine Centre | 39.6^ (24-55) | 53.9 | 15.6 | 2.34 | - | - | - | 82.03 | poor |
| Shi et al. (2020) | Shi, Zhao | 2020-05-20 | China | 101 | Hospital | 71 (59-80) | 40.6 | - | - | 4.95 | - | - | 95.05 | poor |
| Al-Hindawi et al. (2020) | Al-Hindawi | 2020-05-20 | UK | 31 | Hospital | 61 (NA) | 12.9 | 3.2 | 70.97 | - | 25.8 | - | 0.00 | fair |
| Wu et al. (2020) | Wu | 2020-05-21 | Italy | 174 | Hospital | 61.2^ (50-71) | 30.5 | - | - | 33.33 | - | - | 66.67 | poor |
| Kim et al. (2020) | Kim, Garg | 2020-05-22 | USA | 2,491 | Hospital | 62 (50-75) | 46.8 | 6.0 | 25.77 | - | - | 68 | 0.08 | poor |
| Docherty et al. (2020) | Docherty | 2020-05-22 | Multiple | 20,133 | Hospital | 72.9 (58-82) | 40.0 | 4.2 | 21.68 | - | 44.5 | - | 29.55 | poor |
| Petrilli et al. (2020) | Petrilli | 2020-05-22 | USA | 5,279 | Community and Hospital | 54 (38-66) | 51.5 | 5.5 | 17.09 | - | 61.9 | - | 15.55 | fair |
| Klang et al. (n.d.) | Klang | 2020-05-23 | USA | 3,406 | Hospital | NA | 61.8 | - | - | 23.28 | - | - | 76.72 | poor |
| Vaquero et al. (2020) | Vaquero-Roncero | 2020-05-24 | Spain | 146 | Hospital | 66^ (59-72) | 32.2 | - | - | 6.85 | - | - | 93.15 | poor |
| Ip et al. (2020) | Ip | 2020-05-25 | USA | 2,512 | Hospital | 64 (52-76) | 37.6 | 3.1 | 17.83 | - | 64.5 | - | 14.61 | fair |
| Heili-Frades (n.d.) | Heili-Frades | 2020-05-25 | Spain | 4,712 | Hospital | 62 (47-77) | 50.5 | 4.9 | 17.40 | - | - | 66 | 11.16 | poor |
| Berumen et al. (2020) | Berumen | 2020-05-26 | Mexico | 102,875 | Hospital | NA | 49.1 | - | - | 9.64 | - | 90 | 0.00 | poor |
| Garibaldi et al. (2020) | Garibaldi | 2020-05-26 | USA | 832 | Hospital | 63 (49-75) | 47.0 | 5.5 | 22.60 | - | - | - | 71.88 | poor |
| Soto-Mota et al. (2020) | Soto-Mota | 2020-05-27 | Mexico | 400 | Hospital | NA | 30.0 | - | - | 12.00 | - | - | 88.00 | poor |
| Li et al. (n.d.) | Li, Long | 2020-05-28 | China | 145 | Not Stated | 49^ (13-80) | 61.0 | - | - | 5.52 | - | - | 94.48 | poor |
| Louis et al. (2020) | Louis | 2020-05-28 | USA | 22 | Hospital | 66.5^ (55-77) | 36.4 | - | - | 45.45 | - | - | 54.55 | poor |
| Kuderer et al. (2020) | Kuderer | 2020-05-28 | Multiple | 928 | Community and Hospital | 66 (57-76) | 50.0 | 4.6 | 35.13 | - | 50.5 | - | 9.70 | fair |
| Gianfrancesco et al. (2020) | Gianfrancesco | 2020-05-29 | Multiple | 600 | Community and Hospital | 56 (45-67) | 71.0 | - | - | 21.50 | 64.8 | - | 13.67 | poor |
| Chaudhry et al. (2020) | Chaudhry | 2020-05-29 | USA | 40 | Community and Hospital | 52 (45.5-61) | 60.0 | - | - | 15.00 | - | - | 85.00 | poor |
| Niedzwiedz et al. (2020) | Niedzwiedz | 2020-05-29 | UK | 392,116 | Community and Hospital | NA | 54.9 | 9.8 | 34.81 | - | 55.4 | - | 0.00 | fair |
| Valle et al. (2020) | del Valle | 2020-05-30 | USA | 1,484 | Hospital | 62 (52-72) | 40.6 | 5.5 | 23.32 | - | - | - | 71.16 | poor |
| Bello-Chavolla et al. (2020) | Bello-Chavolla | 2020-05-31 | Mexico | 177,133 | Community and Hospital | 42.6 (26-59) | 48.9 | - | - | 9.28 | - | - | 90.72 | poor |
| Batty et al. (2020) | Batty | 2020-06-01 | UK | 908 | Hospital | 57.27^ (48-66) | 44.3 | 11.2 | - | - | - | - | 88.77 | poor |
| Israel et al. (2020) | Israel | 2020-06-01 | Israel | 24,906 | Community and Hospital | 40 (27-59) | 48.7 | 16.8 | 12.66 | - | 70.5 | - | 0.00 | fair |
| Hao et al. (2020) | Hao | 2020-06-01 | China | 788 | Hospital | 46 (35-56) | 48.4 | 6.9 | - | - | - | - | 93.15 | poor |
| Lassale et al. (2020) | Lassale | 2020-06-01 | UK | 900 | Hospital | 57.2^ (48-66) | 44.4 | 11.4 | 41.89 | - | 46.7 | - | 0.00 | fair |
| Eugen-Olsen et al. (2020) | Eugen-Olsen | 2020-06-02 | Denmark | 407 | Hospital | 64 (47-77) | 57.7 | 20.6 | 36.86 | - | 39.6 | - | 2.95 | fair |
| Martinez-Portilla et al. (2020) | Martinez-Portilla | 2020-06-02 | Mexico | 224 | Community and Hospital | 29 (26-33) | 100.0 | - | - | 3.12 | - | - | 96.88 | poor |
| Raisi-Estabragh et al. (n.d.) | Raisi-Estabragh | 2020-06-02 | UK | 4,510 | Hospital | NA | 48.8 | - | - | 51.80 | - | - | 48.20 | poor |
| Luo et al. (2020) | Luo | 2020-06-02 | China | 625 | Hospital | 46 (NA) | 47.7 | 3.0 | - | - | - | - | 96.96 | poor |
| Boulware et al. (2020) | Boulware | 2020-06-03 | Multiple | 821 | Community | 40 (33-50) | 51.6 | 3.3 | - | - | - | - | 96.71 | poor |
| Ikitimur et al. (n.d.) | Ikitimur | 2020-06-03 | Turkey | 81 | Hospital | 55^ (38-72) | 44.0 | - | - | 28.40 | - | - | 71.60 | poor |
| Sierpiński et al. (2020) | Sierpinski | 2020-06-03 | Poland | 1,942 | Community | 50 (NA) | 60.0 | 6.3 | - | - | - | 50 | 44.03 | poor |
| Wang et al. (2020) | Wang, Oekelen | 2020-06-05 | USA | 58 | Community and Hospital | 67 (NA) | 48.0 | - | - | 36.21 | - | - | 63.79 | poor |
| Perrone et al. (2020) | Perrone | 2020-06-05 | Italy | 1,189 | Hospital | NA | 21.2 | - | - | 21.87 | - | - | 78.13 | poor |
| Sharma et al. (2020) | Sharma | 2020-06-05 | India | 501 | Hospital | 35.1^ (18-51) | 36.0 | - | - | 4.19 | - | - | 95.81 | poor |
| Magagnoli et al. (2020) | Magagnoli | 2020-06-05 | USA | 807 | Hospital | 70 (60-75) | 4.3 | - | - | 15.86 | - | - | 84.14 | poor |
| Ramlall et al. (2020) | Ramlall | 2020-06-06 | USA | 11,116 | Community and Hospital | 52 (34.7-69.5) | 55.2 | - | - | 26.80 | 73.2 | - | 0.00 | poor |
| Giannouchos et al. (2020) | Giannouchos | 2020-06-07 | Mexico | 236,439 | Community and Hospital | 42.5^ (25-59) | 49.1 | 9.1 | - | - | - | 91 | 0.00 | poor |
| Romão et al. (2020) | Romao | 2020-06-08 | Portugal | 34 | Community | 41^ (26-66) | 67.7 | - | - | 26.47 | - | - | 73.53 | poor |
| Cen et al. (2020) | Cen | 2020-06-08 | China | 1,007 | Hospital | 61 (49-68) | 51.0 | - | - | 8.74 | - | - | 91.26 | poor |
| Houlihan et al. (2020) | Houlihan | 2020-06-09 | UK | 200 | Community | 34 (29-44) | 61.0 | 11.0 | 16.50 | - | 66.5 | - | 6.00 | fair |
| Lan et al. (2020) | Lan | 2020-06-09 | USA | 104 | Community | 49^ (34-63) | 47.1 | - | - | 24.04 | - | - | 75.96 | poor |
| Russell et al. (2020) | Russell | 2020-06-09 | UK | 156 | Community and Hospital | 65.18^ (50-79) | 42.3 | 7.1 | 25.00 | - | 37.8 | - | 30.13 | poor |
| Veras et al. (2020) | Veras | 2020-06-09 | Brazil | 32 | Hospital | 58.9^ (40-77) | 47.0 | - | - | 25.00 | - | - | 75.00 | poor |
| Rossi et al. (2020) | Rossi | 2020-06-09 | France | 246 | Hospital | 68^ (53-83) | 39.0 | - | - | 25.20 | - | - | 74.80 | poor |
| Martin-Jimenez et al. (2020) | Martin-Jiminez | 2020-06-09 | Spain | 339 | Hospital | 81.6 (72-87) | 39.5 | - | - | 30.68 | - | - | 69.32 | poor |
| Rajter et al. (2020) | Rajter | 2020-06-10 | USA | 280 | Hospital | 59.6^ (41-77) | 45.5 | 5.7 | 10.71 | - | 74.6 | - | 8.93 | fair |
| Zhou et al. (2020) | Zhou, He | 2020-06-10 | China | 238 | Hospital | 55.5 (35-67) | 57.0 | 2.9 | - | - | - | - | 97.06 | poor |
| Woolford et al. (2020) | Woolford | 2020-06-11 | UK | 4,510 | Community and Hospital | 70.5 (NA) | 51.2 | 13.0 | 38.12 | - | 48.1 | - | 0.80 | fair |
| Hultcrantz et al. (2020) | Hultcrantz | 2020-06-11 | USA | 127 | Community and Hospital | 68 (41-91) | 46.0 | - | - | 26.77 | 72.4 | - | 0.79 | poor |
| Hernández-Garduño (2020) | Hernandez, Garduno | 2020-06-11 | Mexico | 32,583 | Community and Hospital | 45 (34-56) | 48.7 | - | - | 11.02 | - | 89 | 0.15 | poor |
| Sterlin et al. (2020) | Sterlin | 2020-06-11 | France | 135 | Hospital | 61 (50-72) | 41.0 | 3.7 | 38.52 | - | 57.8 | - | 0.00 | fair |
| Maraschini et al. (2020) | Maraschini | 2020-06-12 | Italy | 146 | Hospital | 32.5^ (27-38) | 100.0 | - | 9.59 | - | 80.8 | - | 9.59 | poor |
| Wang et al. (2020) | Wang, Zhong | 2020-06-12 | USA | 7,592 | Community and Hospital | NA | 45.1 | 3.6 | 17.08 | - | 51.9 | - | 27.42 | poor |
| McQueenie et al. (2020) | McQueenie | 2020-06-12 | UK | 428,199 | Community and Hospital | NA | 54.9 | - | - | 44.36 | 55.0 | - | 0.59 | poor |
| Miyara et al. (2020) | Miyara | 2020-06-12 | France | 479 | Community and Hospital | NA | 44.7 | 6.7 | 31.60 | - | 59.5 | - | 1.87 | fair |
| Apea et al. (2021) | Apea | 2020-06-12 | UK | 1,737 | Hospital | 63.4^ (NA) | 30.4 | - | - | 9.96 | - | - | 90.04 | poor |
| Garassino et al. (2020) | Garassino | 2020-06-12 | Multiple | 200 | Community and Hospital | 68 (61.8-75) | 30.0 | 24.0 | 55.50 | - | 18.5 | - | 2.00 | fair |
| Zeng et al. (2020) | Zeng | 2020-06-16 | China | 1,031 | Hospital | 60.3^ (46-74) | 47.8 | - | - | 10.18 | - | - | 89.82 | poor |
| Suleyman et al. (2020) | Suleyman | 2020-06-16 | USA | 463 | Hospital | 57.5^ (40-74) | 55.9 | - | - | 34.56 | - | - | 65.44 | poor |
| Chen et al. (2020) | Chen, Yu | 2020-06-16 | China | 1,859 | Hospital | 59 (45-68) | 50.0 | 2.4 | 3.55 | - | 94.0 | - | 0.00 | fair |
| Kibler et al. (2020) | Kibler | 2020-06-16 | France | 702 | Community and Hospital | 82^ (75-88) | 56.0 | 3.7 | - | - | - | - | 96.30 | poor |
| Olivares et al. (2020) | Olivares | 2020-06-16 | Chile | 21 | Hospital | 61^ (26-85) | 76.2 | - | - | 9.52 | - | - | 90.48 | poor |
| Elezkurtaj et al. (2020) | Elezkurtaj | 2020-06-17 | Germany | 26 | Hospital | 70 (61.8-78.3) | 34.6 | - | - | 19.23 | - | - | 80.77 | poor |
| Zuo et al. (2020) | Zuo, Estes | 2020-06-17 | China | 172 | Hospital | 61^ (25-95) | 44.0 | - | - | 26.16 | - | - | 73.84 | poor |
| Killerby (2020) | Killerby | 2020-06-17 | USA | 531 | Community and Hospital | 51.6 (38-62) | 57.1 | - | - | 17.14 | 71.4 | - | 11.49 | poor |
| Gu et al. (2020) | Gu | 2020-06-18 | USA | 5,698 | Community and Hospital | 47^ (26-67) | 62.0 | 7.0 | 24.68 | - | 50.8 | - | 17.53 | fair |
| Wei et al. (2020) | Wei | 2020-06-18 | USA | 147 | Hospital | 52^ (34-70) | 41.0 | 14.3 | - | - | - | - | 85.71 | poor |
| Crovetto et al. (2020) | Crovetto | 2020-06-19 | Spain | 874 | Community and Hospital | 33.7^ (28-38) | 100.0 | 1.1 | - | - | - | 13 | 85.70 | poor |
| Govind et al. (2020) | Govind | 2020-06-20 | UK | 6,309 | Community and Hospital | 46.5^ (31-61) | 38.3 | 66.3 | 26.77 | - | 5.5 | - | 1.49 | fair |
| Sisó-Almirall et al. (2020) | Siso-Almirall | 2020-06-20 | Spain | 322 | Community and Hospital | 56.7^ (38-74) | 50.0 | - | - | 25.16 | - | - | 74.84 | poor |
| Salton et al. (2020) | Salton | 2020-06-20 | Italy | 173 | Hospital | 64.4^ (NA) | 34.9 | - | - | 29.48 | - | - | 70.52 | poor |
| Duan et al. (2020) | Duan | 2020-06-22 | China | 616 | Hospital | 64 (53-70) | 57.5 | 3.7 | - | - | - | - | 96.27 | poor |
| Lenka et al. (2020) | Lenka | 2020-06-22 | USA | 32 | Hospital | 62.2^ (51-73) | 37.5 | - | - | 50.00 | - | - | 50.00 | poor |
| Fisman et al. (2020) | Fisman | 2020-06-23 | Canada | 21,922 | Community and Hospital | NA | 57.0 | - | - | 2.35 | - | - | 97.65 | poor |
| Madariaga et al. (2020) | Madariaga | 2020-06-23 | USA | 103 | Community and Hospital | 41.8^ (27-55) | 48.5 | - | - | 25.24 | 74.8 | - | 0.00 | poor |
| Jin et al. (2020) | Jin, Gu | 2020-06-25 | China | 6 | Hospital | 60.5^ (51-75) | 33.3 | 33.3 | - | - | - | - | 66.67 | poor |
| Mendy et al. (2020) | Mendy | 2020-06-27 | USA | 689 | Community and Hospital | 49.5 (35.2-67.5) | 47.0 | - | - | 24.67 | - | - | 75.33 | poor |
| Sigel et al. (n.d.) | Sigel | 2020-06-28 | USA | 493 | Hospital | 60 (55-67) | 24.1 | - | - | 28.60 | - | - | 71.40 | poor |
| Souza et al. (2020) | de Souza | 2020-06-28 | Brazil | 8,443 | Hospital | NA | 53.0 | - | - | 1.68 | - | 96 | 2.01 | poor |
| Nguyen et al. (2020) | Nguyen | 2020-06-29 | USA | 689 | Community and Hospital | 55 (40-68) | 57.0 | - | - | 24.82 | - | - | 75.18 | poor |
| Melo et al. (2020) | de Melo | 2020-06-29 | Brazil | 181 | Hospital | 55.3^ (34-76) | 60.8 | 9.9 | 12.15 | - | 38.1 | - | 39.78 | poor |
| Auvinen et al. (2020) | Auvinen | 2020-06-29 | Finland | 61 | Hospital | 53 (41-67) | 36.0 | 18.0 | 27.87 | - | 54.1 | - | 0.00 | fair |
| Magleby et al. (n.d.) | Magleby | 2020-06-30 | USA | 678 | Hospital | 68 (50-81) | 38.9 | - | - | 28.61 | - | - | 71.39 | poor |
| Hewitt et al. (2020) | Hewitt | 2020-06-30 | Multiple | 1,564 | Hospital | 74 (61-83) | 42.3 | 7.7 | 38.55 | - | 52.0 | - | 1.66 | fair |
| Mohamud et al. (2020) | Mohamud | 2020-07-02 | USA | 6 | Hospital | 65.8^ (55-78) | 16.7 | - | - | 16.67 | - | - | 83.33 | poor |
| Trubiano et al. (2020) | Trubiano | 2020-07-02 | Australia | 2,935 | Community and Hospital | 39 (29-53) | 63.5 | - | - | 8.82 | - | - | 91.18 | poor |
| Patel et al. (2020) | Patel | 2020-07-03 | USA | 129 | Hospital | 60.8^ (47-74) | 45.0 | 37.2 | - | - | - | 56 | 6.98 | poor |
| Merzon et al. (2020) | Merzon | 2020-07-03 | Israel | 7,807 | Community and Hospital | 46.2^ (NA) | 58.6 | - | - | 16.18 | - | - | 83.82 | poor |
| Bello-Chavolla et al. (2020) | Bello-Chavolla, Antonio-Villa | 2020-07-04 | Mexico | 60,121 | Community and Hospital | 45.5^ (29-61) | 47.0 | - | - | 10.48 | - | - | 89.52 | poor |
| Zacharioudakis et al. (2020) | Zacharioudakis | 2020-07-04 | USA | 314 | Hospital | 64 (54-72) | 34.7 | - | - | 22.78 | - | - | 77.22 | poor |
| Antonio-Villa et al. (2020) | Antonio-Villa | 2020-07-04 | Mexico | 34,263 | Community and Hospital | 40^ (29-50) | 62.9 | 9.7 | - | - | - | - | 90.32 | poor |
| Kimmig et al. (2020) | Kimmig | 2020-07-06 | USA | 111 | Hospital | 63^ (48-78) | 44.1 | 7.2 | 36.04 | - | 56.8 | - | 0.00 | fair |
| Senkal (2020) | Senkal | 2020-07-07 | Turkey | 611 | Hospital | 57^ (18-98) | 40.6 | 11.3 | - | - | - | - | 88.71 | poor |
| Xie et al. (2020) | Xie | 2020-07-07 | China | 619 | Hospital | NA | 52.0 | - | - | 8.24 | - | - | 91.76 | poor |
| Elmunzer et al. (2020) | Elmunzer | 2020-07-09 | Multiple | 1,992 | Hospital | 60^ (43-76) | 43.0 | 6.3 | 28.56 | - | 59.0 | - | 6.12 | fair |
| Alizadehsani et al. (2020) | Alizadehsani | 2020-07-09 | Iran | 319 | Hospital | 45.48^ (26-63) | 55.5 | - | - | 0.31 | - | - | 99.69 | poor |
| Maucourant et al. (2020) | Maucourant | 2020-07-10 | Sweden | 27 | Hospital | 57 (18-78) | 22.2 | 11.1 | 25.93 | - | 40.7 | - | 22.22 | poor |
| Fan et al. (2020) | Fan | 2020-07-11 | UK | 1,425 | Community and Hospital | NA | 46.7 | 12.2 | 40.07 | - | 46.9 | - | 0.84 | fair |
| Shi et al. (2020) | Shi, Resurreccion | 2020-07-11 | UK | 1,521 | Community and Hospital | 61.5^ (57-66.8) | 45.9 | - | - | 54.90 | - | - | 45.10 | poor |
| REACT Study Investigators et al. (2020) | Riley | 2020-07-11 | UK | 120,620 | Community and Hospital | NA | 54.0 | 2.2 | - | - | - | 17 | 81.32 | poor |
| Hippisley-Cox et al. (2020) | Hippisley-Cox | 2020-07-13 | UK | 8,275,949 | Community and Hospital | 48.5^ (30-66) | 50.3 | 17.2 | 21.44 | - | 57.3 | - | 4.04 | fair |
| Zhang et al. (2020) | Zhang, Cao | 2020-07-14 | China | 289 | Hospital | 57 (22-88) | 46.6 | 3.5 | 6.23 | - | - | - | 90.31 | poor |
| Eiros et al. (2020) | Eiros | 2020-07-14 | Spain | 139 | Community and Hospital | 52 (41-57) | 72.0 | 4.3 | 50.36 | - | - | - | 45.32 | poor |
| Marcos et al. (2020) | Marcos | 2020-07-14 | Spain | 918 | Hospital | 72.8^ (58-87) | 42.2 | 6.1 | - | 15.25 | - | - | 78.65 | poor |
| Hoertel et al. (2020) | Hoertel, Sanchez, Rico | 2020-07-14 | France | 7,345 | Hospital | NA | 49.3 | 8.5 | - | - | - | - | 91.52 | poor |
| Shi et al. (2020) | Shi, Zuo | 2020-07-15 | USA | 172 | Hospital | 61.48^ (25-96) | 44.0 | - | - | 26.16 | - | - | 73.84 | poor |
| Hussein et al. (2020) | Hussein | 2020-07-15 | USA | 502 | Hospital | 60.9^ (45-76) | 52.0 | 9.0 | 22.11 | - | - | 69 | 0.00 | poor |
| Bian et al. (2020) | Bian | 2020-07-15 | China | 28 | Hospital | 56^ (42-67) | 42.9 | 7.1 | - | - | - | - | 92.86 | poor |
| Zhan et al. (2020) | Zhan | 2020-07-16 | China | 75 | Hospital | 57 (25-75) | 48.0 | - | - | 12.00 | - | - | 88.00 | poor |
| Omrani et al. (2020) | Omrani | 2020-07-16 | Qatar | 1,409 | Community and Hospital | 39 (30-50) | 17.2 | - | - | 9.23 | - | - | 90.77 | poor |
| Gupta et al. (2020) | Gupta | 2020-07-16 | USA | 496 | Hospital | 70 (60-78) | 46.0 | - | - | 7.26 | - | 32 | 61.09 | poor |
| Soares et al. (2020) | Soares | 2020-07-16 | Brazil | 10,713 | Community and Hospital | NA | 55.0 | 2.0 | - | - | - | 98 | 0.00 | poor |
| Abolghasemi et al. (2020) | Abolghasemi | 2020-07-17 | Iran | 24 | Hospital | 49^ (29-64) | 37.5 | - | - | 4.17 | - | - | 95.83 | poor |
| Merkely et al. (2020) | Merkely | 2020-07-17 | Hungary | 10,474 | Community | 48.7^ (30-66) | 53.6 | 28.0 | 20.46 | - | 51.4 | - | 0.16 | good |
| Fox et al. (n.d.) | Fox | 2020-07-17 | UK | 55 | Community and Hospital | 63 (23-88) | 31.0 | 1.8 | 10.91 | - | 56.4 | - | 30.91 | poor |
| Pandolfi et al. (2020) | Pandolfi | 2020-07-17 | Italy | 33 | Hospital | 62 (52-65) | 21.1 | 3.0 | 24.24 | - | 72.7 | - | 0.00 | fair |
| Girardeau et al. (2020) | Girardeau | 2020-07-17 | France | 10 | Community | 30 (29-33) | 50.0 | 40.0 | 10.00 | - | - | - | 40.00 | poor |
| Kurashima et al. (2020) | Kurashima | 2020-07-17 | Japan | 53 | Hospital | 62.9^ (49-76) | 35.8 | - | - | 50.94 | - | - | 49.06 | poor |
| McGrail and Edwards (2020) | Edwards | 2020-07-19 | USA | 209 | Hospital | 62.5 (NA) | 38.8 | - | - | 18.66 | - | - | 81.34 | poor |
| Martinez-Resendez et al. (2020) | Martinez-Resendez | 2020-07-20 | Mexico | 8 | Hospital | 57 (48-69) | 25.0 | - | - | 12.50 | - | - | 87.50 | poor |
| Hoertel et al. (2020) | Hoertel | 2020-07-20 | France | 12,612 | Hospital | 58.7^ (39-77) | 49.6 | - | - | 9.28 | - | - | 90.72 | poor |
| Wang et al. (2020) | Wang, Shu | 2020-07-20 | China | 59 | Hospital | 67.4^ (56-78) | 35.6 | - | - | 15.25 | - | - | 84.75 | poor |
| Bernaola et al. (2020) | Bernaola | 2020-07-21 | Spain | 1,645 | Hospital | NA | 38.5 | 2.5 | 10.88 | - | 86.6 | - | 0.00 | fair |
| Schneeweiss et al. (2020) | Schneeweiss | 2020-07-22 | USA | 24,313 | Community and Hospital | 67^ (53-80) | 53.0 | - | - | 2.88 | - | - | 97.12 | poor |
| Concha-Mejia and Rincon-Sanchez (2020) | Mejia | 2020-07-24 | Colombia | 72 | Community and Hospital | 46 (28-64) | 47.0 | 8.3 | 11.11 | - | - | - | 80.56 | poor |
| Izquierdo et al. (2020) | Izquierdo | 2020-07-24 | Spain | 71,192 | Community and Hospital | 42^ (18-66) | 59.0 | 10.0 | - | - | - | 90 | 0.00 | poor |
| Santos et al. (2020) | Santos | 2020-07-25 | USA | 23 | Community and Hospital | NA | - | - | - | 8.70 | - | - | 91.30 | poor |
| Reiter et al. (2020) | Reiter | 2020-07-26 | Austria | 235 | Community | 44.2^ (32-55) | 70.0 | 22.6 | 22.55 | - | 54.5 | - | 0.43 | fair |
| Motta et al. (2020) | Motta | 2020-07-26 | USA | 374 | Hospital | 64.7^ (46-82) | 41.4 | - | - | 33.16 | 66.8 | - | 0.00 | poor |
| Altamimi et al. (2020) | Altamimi | 2020-07-27 | Qatar | 68 | Hospital | 49^ (40-58) | 2.0 | 16.2 | - | - | - | 84 | 0.00 | poor |
| Thompson et al. (2020) | Thompson | 2020-07-27 | UK | 470 | Hospital | 71 (57-82) | 46.0 | 14.0 | 27.23 | - | 58.7 | - | 0.00 | fair |
| Zobairy et al. (2020) | Zobairy | 2020-07-28 | Iran | 203 | Community and Hospital | 49.2^ (32-65) | 44.8 | 5.9 | - | - | - | 94 | 0.00 | poor |
| Zhou et al. (2020) | Zhou, Sun | 2020-07-29 | China | 144 | Hospital | 47 (38-56) | 46.5 | 9.0 | - | - | - | 91 | 0.00 | poor |
| Kumar et al. (2020) | Kumar | 2020-07-29 | India | 91 | Hospital | 47^ (41-52) | 21.0 | 44.0 | - | - | - | - | 56.04 | poor |
| Qu et al. (2020) | Qu | 2020-07-29 | China | 246 | Hospital | 53.6^ (38-68) | 53.3 | 42.3 | - | - | - | - | 57.72 | poor |
| Higuchi et al. (2020) | Higuchi | 2020-07-30 | Japan | 57 | Hospital | 52 (35-70) | 43.9 | 12.3 | 29.82 | - | 57.9 | - | 0.00 | fair |
| Zhao et al. (2020) | Zhao, Chen | 2020-07-30 | USA | 641 | Hospital | 60 (NA) | 40.1 | 21.7 | - | - | - | - | 78.32 | poor |
| Fond et al. (2020) | Fond | 2020-07-30 | France | 1,092 | Hospital | 62.5 (51-76) | 45.7 | 11.4 | - | - | - | 89 | 0.00 | poor |
| Jun et al. (2020) | Jun | 2020-08-01 | USA | 3,086 | Hospital | 66 (56-77) | 40.9 | 3.7 | 21.32 | - | 52.8 | - | 22.23 | poor |
| Morshed et al. (2020) | Morshed | 2020-08-02 | Bangladesh | 103 | Community | 37 (31-53) | 28.2 | 31.1 | - | - | - | 69 | 0.00 | poor |
| Iversen et al. (2020) | Iversen | 2020-08-03 | Denmark | 28,792 | Community and Hospital | 44.4^ (31-57) | 78.9 | 16.0 | 6.52 | - | 76.8 | - | 0.67 | fair |
| Ebinger et al. (2020) | Ebinger | 2020-08-04 | USA | 6,062 | Community | 41.5^ (29-53) | 67.8 | 1.7 | - | - | - | - | 96.88 | poor |
| Hadi et al. (2020) | Hadi | 2020-08-05 | USA | 370 | Community and Hospital | 48.2^ (34-62) | 29.5 | - | - | 15.14 | 84.9 | - | 0.00 | poor |
| Tao et al. (2020) | Tao | 2020-08-06 | China | 70 | Community | 33.2^ (12-53) | 48.6 | - | - | 15.71 | - | 84 | 0.00 | poor |
| Klang et al. (2020) | Klang, Soffer | 2020-08-09 | USA | 1,320 | Hospital | NA | 41.5 | - | - | 24.70 | - | - | 75.30 | poor |
| Zhou et al. (2021) | Zhou, Ma | 2020-08-10 | China | 429 | Hospital | 58.3^ (42-74) | 50.6 | - | - | 8.39 | - | 92 | 0.00 | poor |
| Altibi et al. (2020) | Altibi | 2020-08-11 | USA | 706 | Hospital | 66.7^ (51-81) | 43.0 | 4.0 | 37.25 | - | 58.8 | - | 0.00 | fair |
| Izzi-Engbeaya et al. (2020) | Izzi-Engbeaya | 2020-08-11 | UK | 889 | Hospital | 65.8^ (48-83) | 40.0 | - | - | 21.26 | 33.2 | - | 45.56 | poor |
| Rizzo et al. (2020) | Rizzo | 2020-08-11 | USA | 76,819 | Hospital | 54 (38-67) | 55.2 | 6.7 | 20.78 | - | 50.4 | - | 22.05 | poor |
| Jehi et al. (2020) | Jehi | 2020-08-11 | USA | 4,536 | Community and Hospital | NA | - | 7.3 | 28.48 | - | 49.9 | - | 14.40 | fair |
| Holman et al. (2020) | Holman | 2020-08-13 | UK | 10,989 | Community and Hospital | NA | 38.8 | 5.5 | 42.62 | - | 49.0 | - | 2.82 | fair |
| Ouyang et al. (2020) | Ouyang | 2020-08-14 | China | 217 | Hospital | 46.5^ (30-62) | 53.5 | 16.6 | - | - | - | - | 83.41 | poor |
| Valenzuela et al. (2020) | Valenzuela | 2020-08-14 | Chile | 29 | Hospital | 56.9^ (43-70) | 6.9 | 17.2 | - | - | - | 83 | 0.00 | poor |
| Monteiro et al. (2020) | Monteiro | 2020-08-14 | USA | 112 | Hospital | 61 (45-74) | 34.0 | 6.2 | 17.86 | - | 68.8 | - | 7.14 | fair |
| Philipose et al. (2020) | Philipose | 2020-08-14 | UK | 466 | Hospital | 67 (6-97) | 41.8 | 6.0 | 73.18 | - | 16.5 | - | 4.29 | fair |
| Weerahandi et al. (2020) | Weerahandi | 2020-08-14 | USA | 394 | Community | 63 (55-70) | 37.0 | 5.3 | 25.89 | - | 55.8 | - | 12.94 | fair |
| Parra-Bracamonte et al. (2020) | Parra-Bracamonte | 2020-08-14 | Mexico | 331,298 | Community and Hospital | 44 (33-56) | 46.2 | - | - | 7.39 | - | - | 92.61 | poor |
| Peters et al. (2020) | Peters | 2020-08-15 | Netherlands | 1,893 | Hospital | 66.8^ (52-81) | 39.4 | 4.9 | - | - | - | - | 95.14 | poor |
| Islam et al. (2020) | Islam | 2020-08-18 | Bangladesh | 1,016 | Community and Hospital | 37 (28-49) | 35.9 | 18.2 | - | - | - | - | 77.85 | poor |
| Chand et al. (2020) | Chand | 2020-08-19 | USA | 300 | Hospital | 58.2^ (45-70) | 39.3 | 22.3 | - | - | - | - | 77.67 | poor |
| Aksu et al. (2020) | Aksu | 2020-08-19 | Turkey | 123 | Community and Hospital | 49.7^ (36-63) | 33.3 | 11.4 | - | - | - | 89 | 0.00 | poor |
| Alkurt et al. (2020) | Alkurt | 2020-08-20 | Turkey | 932 | Community and Hospital | 34.8^ (25-44) | 64.4 | 24.5 | - | - | - | - | 75.54 | poor |
| Ward et al. (2020) | Ward | 2020-08-21 | UK | 99,908 | Community | NA | 56.1 | 10.6 | - | - | - | 88 | 0.98 | poor |
| Salerno et al. (2020) | Salerno | 2020-08-22 | USA | 15,920 | Hospital | 49 (30-65) | 57.0 | - | - | 36.78 | 55.9 | - | 7.29 | poor |
| Rashid et al. (2020) | Rashid | 2020-08-22 | UK | 517 | Hospital | 72.8^ (59-86) | 31.9 | 9.9 | 29.01 | - | 29.4 | - | 31.72 | poor |
| Pan et al. (2020) | Pan | 2020-08-22 | USA | 12,084 | Community and Hospital | 45.5^ (27-63) | 54.3 | - | - | 17.51 | - | - | 82.49 | poor |
| Fillmore et al. (2020) | Fillmore | 2020-08-24 | USA | 22,914 | Community and Hospital | NA | - | 37.5 | 40.65 | - | 15.5 | - | 6.38 | fair |
| Zhou et al. (2020) | Zhou, Qin | 2020-08-25 | China | 51 | Hospital | 57.37^ (42-72) | 29.4 | - | - | 78.43 | 21.6 | - | 0.00 | poor |
| Ibrahim et al. (2020) | Ibrahim | 2020-08-27 | USA | 38 | Hospital | 63^ (51-75) | 47.0 | 10.5 | - | - | - | - | 89.47 | poor |
| Oliveira et al. (2020) | Oliveira | 2020-08-31 | USA | 131 | Hospital | 61 (49.5-71.5) | 64.9 | - | - | 17.56 | 26.7 | - | 55.73 | poor |
| Yoo et al. (2020) | Yoo | 2020-08-31 | USA | 4,840 | Hospital | 66.4 (54.9-77.8) | 43.5 | 4.4 | 21.38 | - | 53.3 | - | 20.89 | poor |
| Zhan et al. (2020) | Zhan, Liu | 2020-08-31 | China | 405 | Hospital | 56^ (17-95) | 54.1 | - | - | 11.36 | 88.6 | - | 0.00 | poor |
| Mohamed-Hussein et al. (2020) | Hussein, Galal | 2020-09-01 | Egypt | 444 | Community | 33.1^ (21-45) | 56.8 | 13.1 | 9.01 | - | 77.9 | - | 0.00 | fair |
| Villar-Garcia et al. (2020) | Vilar-Garcia | 2020-09-01 | Spain | 7,699,568 | Community and Hospital | 43 (24-59) | 50.9 | 17.1 | - | - | - | - | 82.93 | poor |
| Ibarra-Nava et al. (2020) | Ibarra-Nava | 2020-09-01 | Mexico | 416,546 | Community and Hospital | NA | 46.9 | 7.4 | - | - | - | - | 92.60 | poor |
| Rubio-Rivas et al. (2020) | Rubio-Rivas | 2020-09-01 | Spain | 186 | Hospital | 64.3^ (51-77) | 30.6 | 4.3 | 20.43 | - | 75.3 | - | 0.00 | fair |
| Mamtani et al. (2020) | Mamtani | 2020-09-02 | USA | 403 | Hospital | 55^ (41-68) | 32.3 | 9.7 | 12.66 | - | 68.5 | - | 9.18 | fair |
| Ren et al. (2020) | Ren | 2020-09-02 | China | 432 | Hospital | NA | 57.9 | 10.0 | - | - | 90.0 | - | 0.00 | poor |
| Mutambudzi et al. (2020) | Mutambudzi | 2020-09-03 | UK | 120,075 | Community and Hospital | NA | 54.2 | 11.7 | 26.39 | - | 61.9 | - | 0.00 | fair |
| Yan et al. (2020) | Yan | 2020-09-07 | China | 578 | Hospital | 49.2^ (35-63) | 49.3 | 9.2 | - | - | - | - | 90.83 | poor |
| Mancilla-Galindo et al. (2020) | Mancilla-Galindo | 2020-09-08 | Mexico | 183,779 | Community and Hospital | 45^ (28-61) | 46.0 | 7.6 | - | - | - | - | 92.44 | poor |
| Ullah et al. (2020) | Ullah | 2020-09-08 | UK | 212 | Community and Hospital | 66.7 (54.2-80.5) | 44.8 | 11.3 | 48.11 | - | 37.7 | - | 2.83 | fair |
| Hamadah et al. (2020) | Hamadah | 2020-09-10 | Kuwait | 1,123 | Hospital | 40 (1-93) | 18.7 | 3.9 | - | - | - | 96 | 0.00 | poor |
| Dashti et al. (2020) | Dashti | 2020-09-13 | USA | 12,347 | Community and Hospital | 47 (32-62) | 53.3 | 4.6 | 15.87 | - | 57.1 | - | 22.45 | poor |
| Sami et al. (2020) | Sami | 2020-09-14 | Iran | 490 | Community and Hospital | 56.6^ (41-71) | 39.0 | 14.1 | - | - | - | - | 85.92 | poor |
| Pongpirul et al. (2020) | Pongpirul | 2020-09-16 | Thailand | 193 | Community and Hospital | 37 (29-53) | 41.5 | - | - | 15.03 | 66.3 | - | 18.65 | poor |
| Burrell et al. (2020) | Burrell | 2020-09-16 | Australia | 204 | Hospital | 63.5 (53-72) | 31.4 | - | - | 13.24 | - | 83 | 3.92 | poor |
| Nicholson et al. (2020) | Nicholson | 2020-09-17 | USA | 1,042 | Hospital | 64 (53-75) | 43.2 | 8.3 | 22.17 | - | 37.1 | - | 32.44 | poor |
| Ariza et al. (2020) | Ariza | 2020-09-18 | Colombia | 351 | Community and Hospital | 30.5 (NA) | 54.0 | 6.8 | - | - | - | 93 | 0.00 | poor |
| Carrat et al. (2020) | Carrat | 2020-09-18 | France | 14,628 | Community | NA | 60.3 | 12.0 | 40.83 | - | 45.6 | - | 1.61 | good |
| Favara et al. (2020) | Favara | 2020-09-20 | UK | 434 | Community | 40 (19-66) | 82.0 | 8.5 | - | - | - | 91 | 0.00 | poor |
| Invernizzi et al. (2020) | Invernizzi | 2020-09-20 | Italy | 54 | Hospital | 49.9^ (34-65) | 29.7 | - | - | 24.07 | - | - | 75.93 | poor |
| Zhu et al. (2020) | Zhu | 2020-09-21 | China | 432 | Community and Hospital | 49 (35-60) | 47.9 | 14.4 | - | - | - | - | 85.65 | poor |
| O’Reilly et al. (2020) | O'Reilly | 2020-09-21 | Australia | 1,334 | Hospital | NA | - | - | - | 28.49 | - | - | 71.51 | poor |
| Meini et al. (n.d.) | Meini | 2020-09-23 | Italy | 461 | Hospital | NA | 51.2 | 10.4 | 25.81 | - | 63.8 | - | 0.00 | fair |
| Silva Neto et al. (2020) | da Silva Neto | 2020-09-23 | Brazil | 91 | Community and Hospital | 49^ (29-68) | 49.4 | - | - | 19.78 | - | 80 | 0.00 | poor |
| Ioannou et al. (2020) | Ioannou | 2020-09-23 | USA | 88,747 | Community and Hospital | NA | 9.0 | 20.6 | 37.55 | - | 29.3 | - | 12.60 | fair |
| Torres-Macho et al. (2020) | Torres-Macho | 2020-09-23 | Spain | 1,968 | Hospital | NA | 44.0 | - | - | 23.37 | - | - | 76.63 | poor |
| Li et al. (2020) | Li, Cai | 2020-09-28 | China | 98 | Hospital | 68.5 (63-75) | 58.2 | - | - | 11.22 | - | 89 | 0.00 | poor |
| Wang et al. (2020) | Wang | 2020-09-29 | USA | 1,078 | Hospital | NA | 38.2 | 3.7 | 24.86 | - | 49.0 | - | 22.45 | poor |
| Lopez-Medrano et al. (2020) | Lopez-Medrano | 2020-09-30 | Spain | 261 | Hospital | NA | 43.7 | - | - | 37.16 | - | 63 | 0.00 | poor |
| Collard et al. (2020) | Collard | 2020-10-01 | Netherlands | 1,604 | Hospital | 65.7^ (50-80) | 39.5 | 4.9 | - | - | - | - | 95.14 | poor |
| Makaronidis et al. (2020) | Makaronidis | 2020-10-01 | UK | 567 | Community | 39.4^ (27-51) | 69.1 | 9.3 | - | - | - | 91 | 0.00 | poor |
| Yadaw et al. (2020) | Yadaw | 2020-10-01 | USA | 5,051 | Community and Hospital | NA | - | 3.6 | 15.92 | - | 51.4 | - | 29.06 | poor |
| Talavera et al. (2020) | Talavera | 2020-10-01 | Spain | 576 | Hospital | 67.2^ (52-81) | 43.4 | - | - | 20.49 | - | - | 79.51 | poor |
| Jakob et al. (2020) | Jakob | 2020-10-01 | Multiple | 2,155 | Community and Hospital | NA | 40.3 | 6.6 | 7.29 | - | 34.3 | - | 51.74 | poor |
| Incerti et al. (2020) | Incerti | 2020-10-02 | USA | 13,658 | Hospital | 62 (49-75) | 48.1 | 6.3 | 22.64 | - | 45.4 | - | 25.57 | poor |
| Luo et al. (2020) | Luo, Rizvi | 2020-10-03 | USA | 102 | Hospital | 68 (61-75) | 52.0 | - | - | 26.47 | - | 74 | 0.00 | poor |
| Alharthy et al. (2020) | Alharthy | 2020-10-03 | Saudi Arabia | 352 | Hospital | 50.6^ (37-63) | 12.8 | 49.4 | - | - | - | 51 | 0.00 | poor |
| Robinson et al. (2021) | Robinson | 2020-10-05 | USA | 3,248 | Hospital | 51^ (34-68) | 72.0 | 4.0 | 17.64 | - | 61.8 | - | 16.56 | fair |
| Adrish et al. (2020) | Adrish | 2020-10-05 | USA | 1,173 | Hospital | NA | 38.6 | 14.0 | 14.66 | - | 71.4 | - | 0.00 | fair |
| Erber et al. (2020) | Erber | 2020-10-06 | Germany | 4,554 | Community | 38.5^ (NA) | 70.4 | - | - | 18.02 | - | 82 | 0.00 | poor |
| Chaudhary et al. (2020) | Chaudhary | 2020-10-06 | Nepal | 220 | Hospital | 31.5 (25-37) | 17.7 | 11.4 | 7.73 | - | 80.0 | - | 0.91 | fair |
| Raines et al. (2021) | Raines | 2020-10-07 | USA | 453 | Community and Hospital | 60.8^ (46-74) | 10.7 | - | - | 52.98 | 41.9 | - | 5.08 | poor |
| Roederer et al. (2021) | Roederer | 2020-10-09 | France | 818 | Community | NA | 20.4 | 36.9 | 8.80 | - | 53.9 | - | 0.37 | fair |
| Zinellu et al. (2021) | Zinellu | 2020-10-11 | Italy | 105 | Hospital | 72 (59.5-80) | 33.3 | 30.5 | 10.48 | - | 59.0 | - | 0.00 | fair |
| Ramachandran et al. (2020) | Ramachandran | 2020-10-12 | USA | 188 | Hospital | NA | - | 18.6 | - | - | - | - | 81.38 | poor |
| Lamure et al. (2020) | Lamure | 2020-10-12 | France | 89 | Hospital | 67 (19-92) | 34.0 | 5.6 | 32.58 | - | 48.3 | - | 13.48 | fair |
| Ghinai et al. (2020) | Ghinai | 2020-10-12 | USA | 1,435 | Homeless Shelters | NA | 27.6 | 36.6 | 17.49 | - | 33.2 | - | 12.75 | fair |
| Best et al. (2020) | Best | 2020-10-12 | USA | 3,471 | Hospital | 63.5^ (47-79) | 51.2 | - | - | 28.64 | - | 71 | 0.00 | poor |
| Savarraj et al. (n.d.) | Savarraj | 2020-10-18 | USA | 48 | Hospital | 50^ (33-67) | 48.0 | 10.4 | - | - | - | - | 89.58 | poor |
| Israel et al. (2020) | Israel, Schaffer | 2020-10-18 | Israel | 26,959 | Hospital | NA | 50.6 | 6.8 | 15.22 | - | 77.0 | - | 1.05 | fair |
| El-Solh et al. (2020) | El-Solh | 2020-10-20 | USA | 7,816 | Hospital | 69 (60-74) | 5.5 | - | - | 45.25 | - | 55 | 0.00 | poor |
| Perico et al. (2020) | Perico | 2020-10-22 | Italy | 423 | Community | 44.3^ (34-54) | 36.4 | 21.7 | 17.97 | - | 60.3 | - | 0.00 | fair |
| Zhou et al. (2020) | Zhou, Song | 2020-10-22 | China | 124 | Hospital | 67 (30-86) | 48.0 | 19.1 | - | - | - | - | 80.88 | poor |
| Chudasama et al. (2020) | Chudasama | 2020-10-23 | UK | 1,706 | Community and Hospital | 68 (48-85) | 42.5 | 13.8 | 40.97 | - | 45.3 | - | 0.00 | fair |
| Salama et al. (2021) | Salama | 2020-10-23 | Multiple | 377 | Hospital | 55.9^ (41-70) | 40.8 | 5.8 | 16.98 | - | 77.2 | - | 0.00 | fair |
| Wang et al. (2020) | Wang, Zheutlin | 2020-10-26 | USA | 3,273 | Hospital | 65 (53-77) | 42.7 | 3.5 | 20.68 | - | 53.2 | - | 22.61 | poor |
| Zhou et al. (2020) | Zhou, He, Yang | 2020-10-27 | China | 1,087 | Hospital | NA | 51.7 | - | - | 85.00 | 15.0 | - | 0.00 | poor |
| Hoertel et al. (2020) | Hoertel, Sanchez, Vernet | 2020-10-27 | France | 12,210 | Hospital | NA | 50.1 | 9.0 | - | - | - | - | 90.97 | poor |
| Arleo et al. (2020) | Arleo | 2020-10-27 | USA | 70 | Community and Hospital | 56.6^ (48-65) | 80.0 | 1.4 | 28.57 | - | 70.0 | - | 0.00 | fair |
| Bermejo-Martin et al. (2020) | Bermejo-Martin | 2020-10-27 | Spain | 250 | Community and Hospital | NA | 64.0 | 6.0 | - | - | - | - | 94.00 | poor |
| Joubert et al. (2020) | Joubert | 2020-10-29 | France | 74 | Community and Hospital | NA | - | 5.4 | - | - | - | - | 94.59 | poor |
| Kortela et al. (2020) | Kortela | 2020-11-01 | Finland | 3,008 | Community and Hospital | 51 (36-69) | 59.6 | 11.0 | 14.03 | - | 29.2 | - | 45.84 | poor |
| Gianfrancesco et al. (2020) | Gianfrancesco, Leykina | 2020-11-03 | USA | 1,324 | Community and Hospital | NA | 75.9 | - | - | 26.66 | 68.2 | - | 5.14 | poor |
| Gallichotte et al. (2020) | Gallichotte | 2020-11-05 | USA | 239 | Community | 41^ (16-76) | - | 20.1 | 16.74 | - | 57.3 | - | 0.00 | fair |
| Lin et al. (2020) | Lin | 2020-11-05 | USA | 2,821 | Hospital | 62.7^ (NA) | 45.0 | 2.9 | 12.51 | - | 3.3 | - | 81.28 | poor |
| Kim et al. (2020) | Kim, Han | 2020-11-09 | South Korea | 4,787 | Hospital | 55 (38-68) | 60.1 | 5.5 | 2.84 | - | 91.7 | - | 0.00 | fair |
| Galal et al. (2020) | Galal | 2020-11-12 | Egypt | 430 | Community | 37.4^ (24-50) | 63.7 | 6.0 | 7.67 | - | 86.3 | - | 0.00 | fair |
| Sourij et al. (2020) | Sourij | 2020-11-16 | Austria | 238 | Hospital | 71.1^ (58-83) | 36.1 | 1.7 | 15.97 | - | 82.4 | - | 0.00 | fair |
| Clavario et al. (2020) | Clavario | 2020-11-16 | Italy | 110 | Community | 61.7 (53.5-69.2) | 40.9 | 40.9 | - | - | - | - | 59.09 | poor |
| Saeed et al. (2020) | Saeed | 2020-11-16 | United Arab Emirates | 173 | Hospital | NA | 34.1 | 6.4 | - | - | - | - | 93.64 | poor |
| Mansour et al. (2020) | Mansour | 2020-11-16 | Iran | 353 | Hospital | 61.7^ (45-78) | 42.5 | 7.1 | - | - | - | - | 92.92 | poor |
| Cadegiani et al. (2020) | Cadegiani | 2020-11-18 | Brazil | 130 | Community | 42^ (NA) | 0.0 | 7.7 | - | - | - | - | 92.31 | poor |
| Ilic et al. (2021) | Ilic | 2020-11-19 | Serbia | 107 | Community and Hospital | 39.1^ (27-50) | - | 29.9 | - | - | - | - | 70.09 | poor |
| Benaim et al. (2020) | Benaim | 2020-11-19 | Israel | 693 | Hospital | 59.8 (NA) | 47.9 | - | - | 5.05 | - | - | 94.95 | poor |
| Ho et al. (2020) | Ho | 2020-11-19 | UK | 235,928 | Community and Hospital | NA | - | - | - | 45.38 | - | 55 | 0.00 | poor |
| Singh et al. (2020) | Singh | 2020-11-20 | UK | 930 | Hospital | 71.4^ (54-87) | 44.8 | - | - | 19.03 | - | 81 | 0.00 | poor |
| Márquez-Salinas et al. (2020) | Marquez-Salinas | 2020-11-24 | Mexico | 1,068 | Hospital | 53 (44-63) | 36.8 | - | - | 14.98 | - | - | 85.02 | poor |
| Díez-Manglano et al. (2020) | Diez-Manglanas | 2020-11-24 | Spain | 4,393 | Hospital | 53^ (NA) | 40.8 | 6.6 | - | - | - | - | 93.42 | poor |
| Bellan et al. (2020) | Bellan | 2020-11-26 | Italy | 1,697 | Hospital | 71 (58-80) | 41.0 | 3.2 | - | - | - | 15 | 81.61 | poor |
| Woolcott and Castilla-Bancayán (2020) | Woolcott | 2020-11-26 | Mexico | 1,636,050 | Community and Hospital | 42 (34-54) | 51.9 | - | - | 8.76 | - | - | 91.24 | poor |
| Yao et al. (2021) | Yao, Hasegawa | 2020-11-26 | Japan | 101 | Hospital | 60^ (17-97) | 39.6 | - | - | 28.71 | - | 71 | 0.00 | poor |
| Chen et al. (2020) | Chen, Varathraja | 2020-11-29 | USA | 10,123 | Community and Hospital | 40 (28-54) | 53.6 | 4.4 | 9.71 | - | 45.9 | - | 40.00 | poor |
| Serling-Boyd et al. (2020) | Serling-Boyd | 2020-11-30 | USA | 831 | Hospital | NA | 76.0 | 3.0 | 23.23 | - | 50.1 | - | 23.71 | poor |
| Simons et al. (2020) | Simons | 2020-11-30 | UK | 446 | Hospital | 64.9 (52.4-76.2) | 35.9 | 9.4 | 38.57 | - | 52.0 | - | 0.00 | fair |
| Dupraz et al. (2020) | Dupraz | 2020-11-30 | Switzerland | 219 | Community | NA | 54.8 | 11.0 | - | - | - | - | 89.04 | poor |
| Barasa et al. (2020) | Barasa | 2020-11-30 | USA | 394 | Hospital | NA | 47.7 | 14.7 | 36.04 | - | 41.6 | - | 7.61 | fair |
| Ren et al. (2020) | Ren, Guo | 2020-11-30 | China | 481 | Hospital | NA | 45.7 | 7.7 | 0.62 | - | 91.7 | - | 0.00 | fair |
| Martinez-Lacalzada et al. (2020) | Martinez-Lacalzada | 2020-12-01 | Spain | 10,433 | Hospital | 65.8^ (49-82) | 42.8 | 5.2 | 23.77 | - | 66.0 | - | 5.03 | fair |
| Li et al. (2020) | Li, Long, Zhang | 2020-12-03 | China | 954 | Hospital | NA | - | - | - | 5.87 | 94.1 | - | 0.00 | poor |
| Martini et al. (2020) | Martini | 2020-12-04 | Italy | 146 | Hospital | NA | 49.0 | - | - | 46.58 | 53.4 | - | 0.00 | poor |
| O’Gallagher et al. (2020) | O'Gallagher | 2020-12-04 | UK | 1,721 | Hospital | 71 (56-83) | 43.4 | 6.6 | 18.48 | - | 74.9 | - | 0.00 | fair |
| Alguwaihes et al. (2020) | Alguwaihes | 2020-12-05 | Saudi Arabia | 439 | Hospital | 55 (19-101) | 31.7 | 2.1 | - | - | - | 98 | 0.00 | poor |
| Zuo et al. (2020) | Zuo, Warnock | 2020-12-05 | USA | 118 | Hospital | 61^ (44-78) | 46.0 | - | - | 23.73 | - | - | 76.27 | poor |
| Zhang et al. (2020) | Zhang, Li | 2020-12-06 | UK | 1,746 | Community and Hospital | 68.8^ (59-78) | 47.1 | 10.1 | 35.09 | - | 44.2 | - | 10.54 | fair |
| Dai et al. (2020) | Dai | 2020-12-09 | China | 1,574 | Hospital | 57.3^ (41-73) | 48.2 | - | - | 9.21 | 90.8 | - | 0.00 | poor |
| Vila-Córcoles et al. (2020) | Vila-Corcoles | 2020-12-10 | Spain | 79,083 | Community | NA | 52.4 | - | - | 16.12 | - | - | 83.88 | poor |
| Bisso et al. (2020) | Bisso | 2020-12-11 | Argentina | 168 | Hospital | 67 (58-75) | 34.0 | 10.7 | - | - | - | - | 89.29 | poor |
| Rentsch et al. (2020) | Rentsch, Beckman | 2020-12-11 | USA | 4,297 | Hospital | 68 (58-75) | 6.6 | 36.8 | 39.31 | - | 1.9 | - | 22.06 | poor |
| Thiabaud et al. (2020) | Thiabaud | 2020-12-11 | Switzerland | 3,582 | Hospital | 68 (54-79) | 40.5 | - | - | 6.62 | - | 50 | 42.91 | poor |
| Vila-Corcoles et al. (2020) | Vila-Corcoles, Satue-Gracia | 2020-12-11 | Spain | 282 | Community and Hospital | 65.9^ (53-78) | 50.3 | 8.9 | - | - | - | - | 91.13 | poor |
| Lévy et al. (2020) | Levy | 2020-12-12 | France | 61 | Hospital | 60 (50-69) | 20.0 | 8.2 | - | - | - | - | 91.80 | poor |
| Kantele et al. (2020) | Kantele | 2020-12-13 | Finland | 1,095 | Community and Hospital | 38 (31-48) | 82.7 | 16.3 | 25.84 | - | 56.4 | - | 0.00 | fair |
| Iftime et al. (2020) | Iftimie | 2020-12-14 | Spain | 468 | Hospital | NA | 44.9 | - | - | 7.91 | - | - | 92.09 | poor |
| Ho et al. (2020) | Ho, Narasimhan | 2020-12-15 | USA | 9,991 | Community and Hospital | 58^ (39-76) | 45.9 | 4.1 | 18.08 | - | 77.9 | - | 0.00 | fair |
| Caliskan and Saylan (2020) | Caliskan | 2020-12-16 | Turkey | 565 | Hospital | 48 (38-58) | - | 20.9 | 13.98 | - | 65.1 | - | 0.00 | fair |
| Muñoz et al. (2020) | Munoz | 2020-12-16 | Spain | 314 | Community | 45 (40-53) | 52.5 | 6.7 | - | - | - | - | 93.31 | poor |
| Crooks et al. (2020) | Crooks | 2020-12-16 | UK | 2,964 | Hospital | NA | 52.6 | 11.7 | - | - | - | - | 83.20 | poor |
| Núñez-Gil et al. (2020) | Nunez-Gil | 2020-12-17 | Multiple | 2,798 | Hospital | 67 (53-78) | 40.0 | 6.2 | - | - | - | - | 93.82 | poor |
| Gori et al. (2020) | Gori | 2020-12-17 | Italy | 1,352 | Hospital | 68 (58-77) | 28.4 | 3.6 | 18.42 | - | 66.6 | - | 11.39 | fair |
| Rowlands et al. (2020) | Rowlands | 2020-12-18 | UK | 580 | Community | 63.8^ (56-70) | 52.2 | 10.2 | 38.10 | - | 51.7 | - | 0.00 | fair |
| Richard et al. (2020) | Richard | 2020-12-18 | Switzerland | 8,344 | Community | 46.9^ (NA) | 53.5 | 15.2 | 17.11 | - | 66.2 | - | 1.51 | good |
| Schubl et al. (2020) | Schuble\* | 2020-12-19 | USA | 1,557 | Community | NA | 68.9 | 2.4 | - | - | - | - | 97.62 | poor |
| Ugur Chousein et al. (2020) | Chousein | 2020-12-21 | Turkey | 114 | Hospital | 51.1^ (36-66) | 32.5 | 16.7 | 20.18 | - | 63.2 | - | 0.00 | fair |
| Modrák et al. (2020) | Modrak | 2020-12-22 | Czechia | 213 | Hospital | 69 (58-80) | 51.0 | - | - | 13.15 | - | - | 86.85 | poor |
| Kara Polat et al. (2020) | Polat | 2020-12-22 | Turkey | 1,322 | Community | NA | 47.6 | 35.6 | 15.58 | - | 48.8 | - | 0.00 | fair |
| Kjetland et al. (2020) | Kjetland | 2020-12-24 | Norway | 7,839 | Community and Hospital | 45.3^ (33-56) | 77.0 | - | - | 41.00 | - | - | 59.00 | poor |
| Lewnard et al. (2021) | Lewnard | 2021-01-02 | USA | 1,115 | Community | NA | 52.6 | 4.4 | 14.17 | - | 81.3 | - | 0.09 | fair |
| Nezhadmoghadam and Tamez-Peña (2021) | Nezhadmoghadam | 2021-01-04 | Mexico | 33,325 | Hospital | NA | - | 10.2 | - | - | - | - | 89.79 | poor |
| Covid-19 in pregnancy et al. (2021) | Vousden | 2021-01-05 | UK | 1,148 | Community and Hospital | NA | 100.0 | 8.6 | - | - | - | - | 91.38 | poor |
| Boyd and Martin-Loeches (2021) | Boyd | 2021-01-07 | Ireland | 38 | Hospital | NA | 26.3 | - | - | 5.26 | - | - | 94.74 | poor |
| Paleiron et al. (2021) | Paleiron | 2021-01-09 | France | 1,688 | Community | 28 (23-35) | 13.0 | 48.3 | 22.87 | - | 28.9 | - | 0.00 | fair |
| Ader et al. (2021) | Ader | 2021-01-09 | Multiple | 583 | Hospital | 63 (54-71) | 28.3 | 3.1 | - | - | - | - | 96.91 | poor |
| Giannini et al. (2021) | Giannini | 2021-01-10 | Italy | 91 | Hospital | 74^ (61-87) | 45.0 | 23.1 | - | - | - | - | 76.92 | poor |
| Shade et al. (2021) | Shade | 2021-01-10 | USA | 3,779 | Community and Hospital | NA | 47.2 | 3.3 | 15.74 | - | - | - | 80.92 | poor |
| Park et al. (2021) | Park | 2021-01-11 | South Korea | 2,269 | Hospital | 55.5^ (35-75) | 64.1 | 4.1 | - | - | - | - | 95.86 | poor |
| Ferrari et al. (2021) | Ferrari | 2021-01-12 | Brazil | 198 | Community | 61 (19-91) | 65.0 | - | - | 20.71 | 79.3 | - | 0.00 | poor |
| Zhang et al. (2021) | Zhang, Yang | 2021-01-12 | UK | 1,485 | Community and Hospital | 68.2^ (59-77) | 47.2 | 48.5 | 39.19 | - | 11.3 | - | 1.01 | fair |
| Ebrahimian et al. (2021) | Ebrahimian | 2021-01-13 | USA | 226 | Hospital | NA | - | - | - | 10.62 | - | 89 | 0.00 | poor |
| Vahidy et al. (2021) | Vahidy | 2021-01-13 | USA | 96,473 | Hospital | 51.2^ (32-69) | 59.6 | - | - | 26.18 | 73.8 | - | 0.00 | poor |
| Mendes et al. (2021) | Mendes | 2021-01-14 | Switzerland | 265 | Hospital | 85.9^ (79-92) | 57.0 | 5.7 | - | - | - | - | 94.34 | poor |
| Saurabh et al. (2021) | Saurabh | 2021-01-14 | India | 911 | Community | 43.1^ (23-62) | 35.2 | 8.1 | 0.66 | - | 91.2 | - | 0.00 | fair |
| Ayoubkhani et al. (2021) | Ayoubkhani | 2021-01-15 | UK | 47,780 | Hospital | NA | 45.1 | 8.4 | 40.94 | - | 42.5 | - | 8.21 | fair |
| Thakur et al. (2021) | Thakar | 2021-01-18 | India | 250 | Hospital | NA | 42.4 | - | - | 49.20 | - | 51 | 0.00 | poor |
| Zhong et al. (2021) | Zhong | 2021-01-18 | China | 91 | Hospital | 47.3^ (30-64) | 49.5 | - | - | 18.68 | - | - | 81.32 | poor |
| Cummins et al. (2021) | Cummins | 2021-01-20 | UK | 1,781 | Community and Hospital | NA | 44.8 | 10.2 | - | - | - | - | 89.84 | poor |
| Sun et al. (2021) | Sun | 2021-01-21 | USA | 323 | Community and Hospital | NA | 57.6 | - | - | 39.32 | - | 61 | 0.00 | poor |
| Lowe et al. (2021) | Lowe | 2021-01-25 | USA | 7,102 | Hospital | 50.3^ (NA) | 61.2 | 2.4 | 12.81 | - | 84.8 | - | 0.00 | fair |
| Caglar and Kacer (2021) | Caglar | 2021-01-25 | Turkey | 120 | Hospital | 57 (47-67) | 51.7 | - | - | 37.50 | - | 62 | 0.00 | poor |
| Quan et al. (2021) | Quan | 2021-01-27 | USA | 2,038 | Hospital | 64^ (47-80) | 50.4 | - | - | 39.74 | - | - | 60.26 | poor |
| Strangfeld et al. (2021) | Strangfeld | 2021-01-27 | Multiple | 3,729 | Community and Hospital | 57^ (41-72) | 68.0 | - | - | 20.81 | 64.0 | - | 15.15 | poor |
| Tardif et al. (2021) | Tardif | 2021-01-27 | Canada | 4,488 | Community and Hospital | NA | 53.9 | 9.6 | 33.60 | - | 56.8 | - | 0.04 | fair |
| Jafari et al. (2021) | Jafari | 2021-01-28 | USA | 1,979 | Hospital | 66 (57-74) | 32.0 | 12.1 | - | - | - | - | 87.87 | poor |
| Prats-Uribe et al. (2021) | Prats-Uribe | 2021-01-30 | Spain | 696 | Hospital | 63^ (52-73) | 30.9 | - | - | 16.09 | 74.6 | - | 9.34 | poor |
| Nuño et al. (2021) | Nuno | 2021-02-01 | USA | 4,730 | Hospital | 61 (46-73) | 43.6 | 10.1 | - | - | - | - | 89.85 | poor |
| Abajo et al. (2021) | de Abajo | 2021-02-03 | Spain | 625 | Hospital | NA | 39.4 | 4.6 | 29.28 | - | 39.2 | - | 26.88 | poor |
| Mora et al. (2021) | Mora | 2021-02-03 | USA | 1,058 | Community | 39.7^ (27-52) | 52.5 | 4.5 | 14.56 | - | 80.8 | - | 0.09 | fair |
| Molenaar et al. (2021) | Molenaar | 2021-02-03 | USA | 696 | Community and Hospital | 33.1^ (NA) | 100.0 | 4.5 | - | - | - | - | 95.55 | poor |
| Leister et al. (2021) | Leister | 2021-02-03 | Austria | 3,301 | Community and Hospital | 43.6^ (33-54) | 68.0 | 23.3 | - | - | - | - | 76.70 | poor |
| Didikoglu et al. (2021) | Didikoglu | 2021-02-04 | UK | 384,816 | Community and Hospital | 68.3^ (60-76) | 54.9 | 9.8 | 35.19 | - | 55.0 | - | 0.00 | fair |
| Estiri et al. (2021) | Estiri | 2021-02-04 | USA | 16,709 | Hospital | NA | 57.2 | - | - | 8.62 | - | - | 91.38 | poor |
| Tavakol et al. (2021) | Tavakol | 2021-02-04 | Iran | 206 | Community and Hospital | 40.9^ (29-52) | 57.8 | - | - | 12.62 | - | 87 | 0.00 | poor |
| Cai et al. (2021) | Cai, Yang | 2021-02-05 | China | 455 | Hospital | NA | 52.6 | 7.5 | - | - | - | - | 92.53 | poor |
| Lohia et al. (2021) | Lohia | 2021-02-05 | USA | 1,871 | Hospital | 64.1^ (48-80) | 48.4 | - | - | 37.63 | - | - | 62.37 | poor |
| Vila-Corcoles et al. (2021) | Vila-Corcoles, Satue-Gracia, Vila-Rovira | 2021-02-05 | Spain | 79,083 | Community | 65.8^ (54-77) | 52.4 | 16.1 | - | - | - | - | 83.88 | poor |
| International Severe Acute Respiratory and emerging Infections Consortium et al. (2020) | ISARIC | 2021-02-11 | Multiple | 240,149 | Hospital | 60 (NA) | 49.0 | - | - | 3.63 | 21.5 | - | 74.90 | poor |
| Gégout petit et al. (2021) | Gegout Petit | 2021-02-12 | France | 2,006 | Community | NA | 55.0 | 16.8 | - | - | - | 79 | 4.24 | poor |
| Zhang et al. (2021) | Zhang, Wang | 2021-02-13 | China | 172 | Hospital | 47.9^ (29-66) | 46.5 | 7.0 | 1.16 | 91.86 | - | - | 0.00 | poor |

### Smoking prevalence by country

Unadjusted smoking prevalence compared with overall estimates for national adult smoking prevalence split by country and study setting is presented in [Figure 2a](#fig-2a) and [2b](#fig-2b). Lower than expected current smoking prevalence was generally observed, especially in studies with hospitalised samples. Former smoking prevalence was more similar to expected prevalence when reported; however, study-based prevalence was typically higher than national estimates. National smoking prevalence estimates used for comparison are presented in [Supplementary table 3](#supplementary-t3).



*Figure 2a.* Weighted mean prevalence of current smoking in included studies, split by country (solid lines). The circles represent individual studies, with colour corresponding to study setting (i.e. community, community and hospital, hospital) and size corresponding to relative study sample size. For comparison, national current smoking prevalence is shown by the dashed red lines. Countries with three or more eligible studies are shown.



*Figure 2b.* Prevalence of former smoking in included studies, split by country (solid lines). The circles represent individual studies, with colour corresponding to study setting (i.e. community, community and hospital, hospital) and size corresponding to relative study sample size. For comparison, national former smoking prevalence is shown by dashed red lines. Countries with three or more eligible studies are shown.

### SARS-CoV-2 testing by smoking status

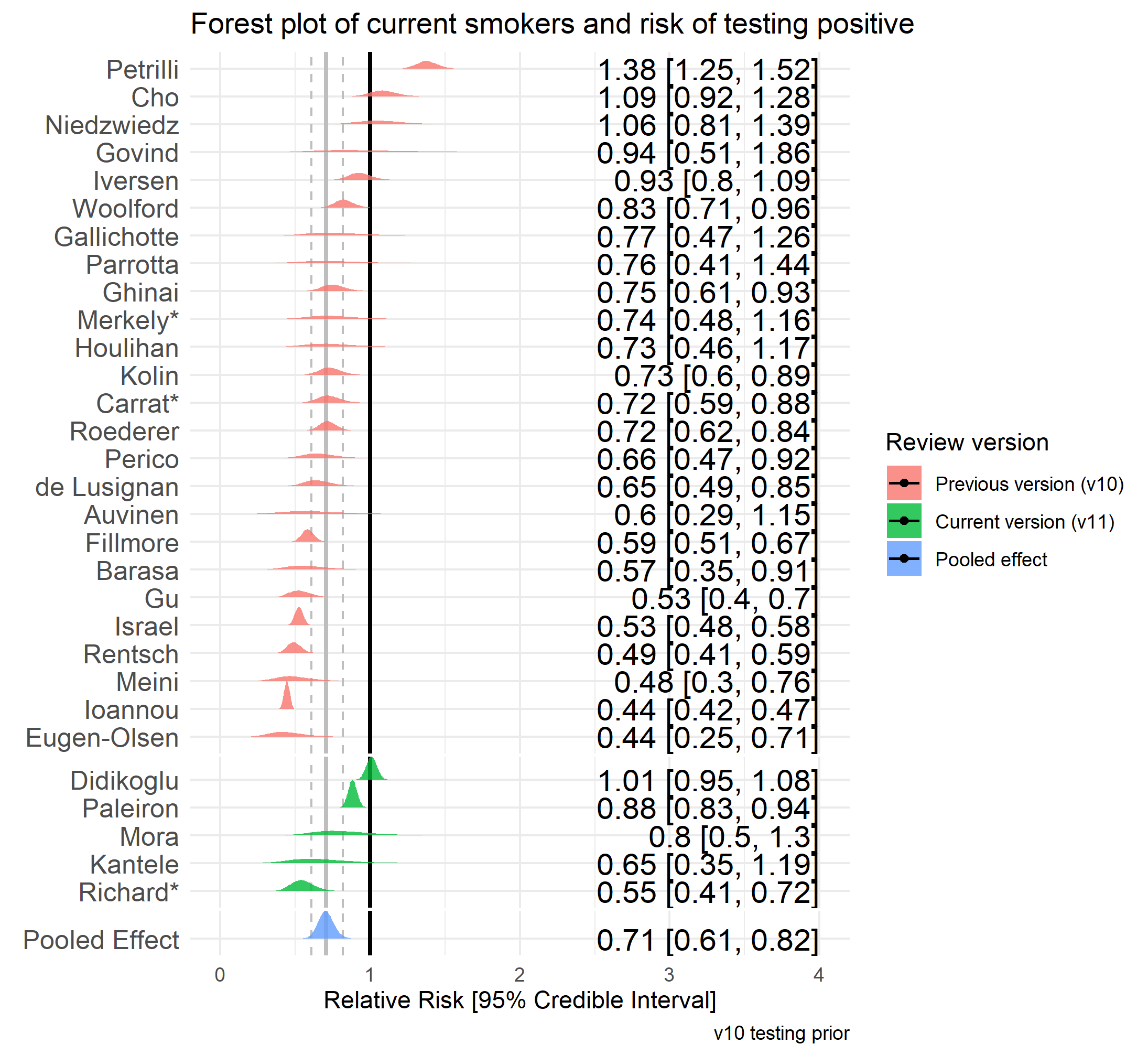
Four studies provided data on access to SARS-CoV-2 diagnostic testing for those meeting local testing criteria by smoking status. In a cohort study of US military veterans aged 54-75 (Christopher T. Rentsch et al., 2020), current smokers were more likely to receive a test: 42.3% (1,603/3,789) of the sample were current smokers compared with 23.8% of all veterans aged 50+ years using any tobacco product between 2010-2015 (Odani, 2018). In the UK Biobank cohort (Niedzwiedz et al., 2020), a multivariable analysis showed former (RR = 1.29, 95% CI = 1.14-1.45, *p* < .001) and current (RR = 1.44, 95% CI = 1.20-1.71, *p* < .001) compared with never smokers to be more likely to receive a test. In an Australian rapid assessment screening clinic for COVID-19 (Trubiano et al., 2020), 9.4% (397/4,226) of the self-referred sample (subsequently assessed by a healthcare professional to decide on testing) were current smokers. Of these self-referrals, healthcare professionals decided that current compared with former or never smokers were less likely to require a test (RR = 0.93, 95% CI = 0.86-1.0, *p* = 0.045). In a further study using the UK Biobank cohort (Didikoglu et al., 2021), current (RR = 1.23, 95% CI = 1.19-1.26, *p* < 0.001) and former smokers (RR = 1.20, 95% CI = 1.18-1.23, *p* < 0.001) were more likely to receive a test compared with never smokers.

### SARS-CoV-2 infection by smoking status

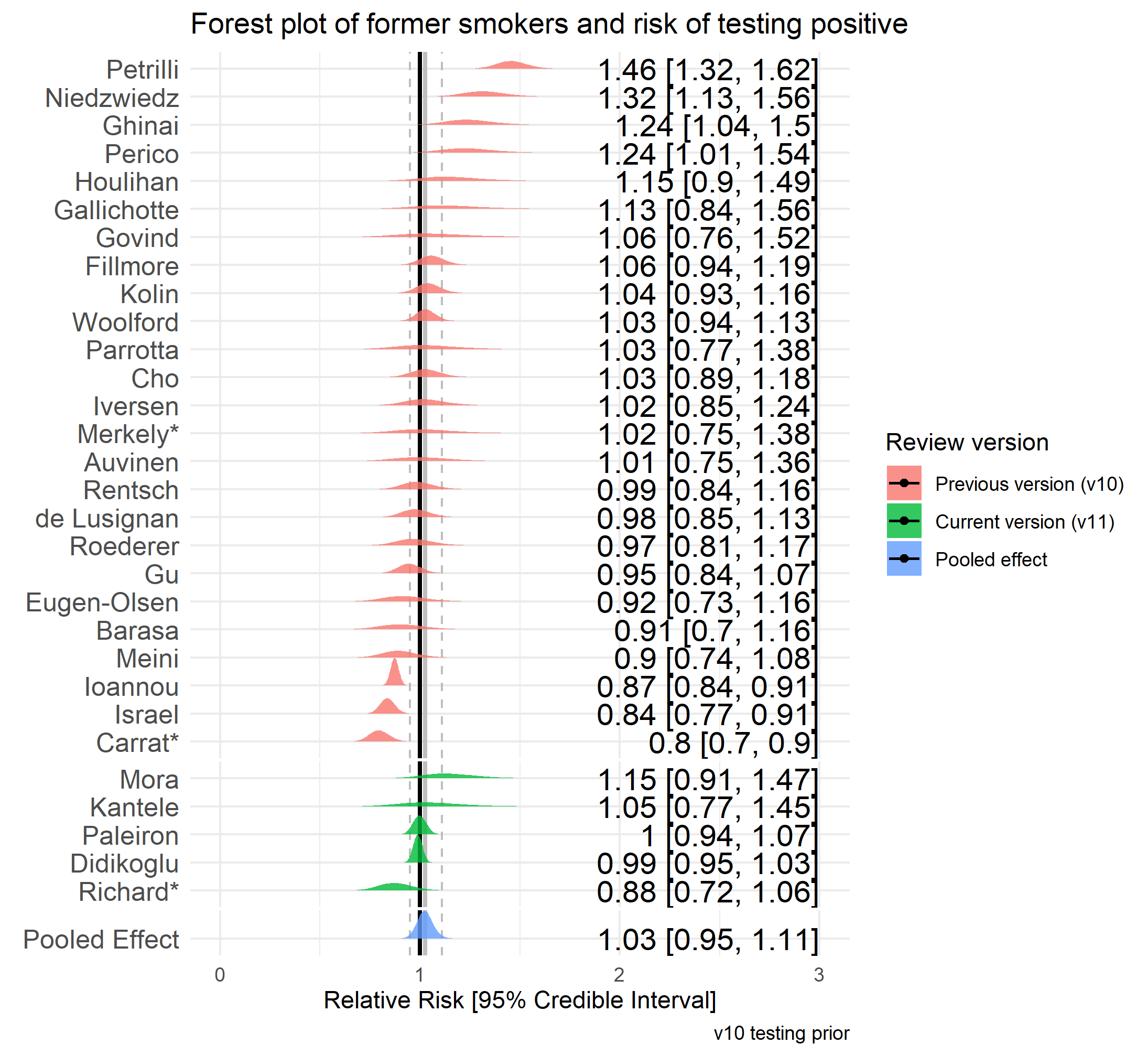
76 studies provided data on SARS-CoV-2 infection for people meeting local testing criteria by smoking status (see [Table 2](#table-2)). Meta-analyses were performed for 3 ‘good’ and 27 ‘fair’ quality studies (see [Figure 3](#fig-3) and [4](#fig-4)). Current smokers were at reduced risk of testing positive for SARS-CoV-2 compared with never smokers (RR = 0.71, 95% Credible Interval (CrI) = 0.61-0.82, τ = 0.34). The three good quality studies each reported point estimates less than 1, although the CrI for one of the three studies crossed 1. The probability of current smokers being at reduced risk of infection compared with never smokers (RR ≤0.9) was >99%. Former compared with never smokers were at increased risk of testing positive, but data were inconclusive (RR = 1.03, 95% CrI = 0.95-1.11, τ = 0.17) and favoured there being no important association. The probability of former smokers being at increased risk of infection (RR ≥1.1) compared with never smokers was 4%. Results were materially unchanged in sensitivity analyses.

#### *Table 2* SARS-CoV-2 infection by smoking status

|  | | SARS-CoV-2 negative | | | | | | SARS-CoV-2 positive | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Total population tested | N (%) | Current smoker (%) | Former smoker (%) | Current/former smoker (%) | Never smoker (%) | Not stated (%) | N (%) | Current smoker (%) | Former smoker (%) | Current/former smoker (%) | Never smoker (%) | Not stated (%) |
| Rentsch | 3,528 | 2974 (84.30%) | 1444 (48.55%) | 704 (23.67%) | - | 826 (27.77%) | - | 554 (15.70%) | 159 (28.70%) | 179 (32.31%) | - | 216 (38.99%) | - |
| Fontanet | 661 | 490 (74.13%) | 64 (13.06%) | - | - | 426 (86.94%) | - | 171 (25.87%) | 5 (2.92%) | - | - | 166 (97.08%) | - |
| Cho | 1,331 | 793 (59.58%) | 142 (17.91%) | 214 (26.99%) | - | 437 (55.11%) | - | 538 (40.42%) | 111 (20.63%) | 145 (26.95%) | - | 282 (52.42%) | - |
| Shah | 243 | 212 (87.24%) | 52 (24.53%) | 47 (22.17%) | - | 113 (53.30%) | - | 29 (11.93%) | 0 (0.00%) | 9 (31.03%) | - | 20 (68.97%) | - |
| Kolin | 1,474 | 805 (54.61%) | 141 (17.52%) | 307 (38.14%) | - | 354 (43.98%) | 3 (0.37%) | 669 (45.39%) | 72 (10.76%) | 285 (42.60%) | - | 303 (45.29%) | 9 (1.35%) |
| de Lusignan | 3,291 | 2740 (83.26%) | 366 (13.36%) | 1450 (52.92%) | - | 924 (33.72%) | - | 551 (16.74%) | 47 (8.53%) | 303 (54.99%) | - | 201 (36.48%) | - |
| Valenti | 789 | 689 (87.33%) | 197 (28.59%) | - | - | - | 492 (71.41%) | 40 (5.07%) | 7 (17.50%) | - | - | - | 33 (82.50%) |
| Parrotta | 76 | 39 (51.32%) | 1 (2.56%) | 10 (25.64%) | - | 27 (69.23%) | 1 (2.56%) | 37 (48.68%) | 1 (2.70%) | 10 (27.03%) | - | 25 (67.57%) | 1 (2.70%) |
| Berumen | 102,875 | 71353 (69.36%) | - | - | 7173 (10.05%) | 64180 (89.95%) | - | 31522 (30.64%) | - | - | 2748 (8.72%) | 28774 (91.28%) | - |
| Israel | 24,906 | 20755 (83.33%) | 3783 (18.23%) | 2671 (12.87%) | - | 14301 (68.90%) | - | 4151 (16.67%) | 406 (9.78%) | 483 (11.64%) | - | 3262 (78.58%) | - |
| del Valle | 1,108 | 143 (12.91%) | 27 (18.88%) | 53 (37.06%) | - | - | 63 (44.06%) | 965 (87.09%) | 55 (5.70%) | 293 (30.36%) | - | - | 617 (63.94%) |
| Romao | 34 | 20 (58.82%) | - | - | 5 (25.00%) | - | 15 (75.00%) | 14 (41.18%) | - | - | 4 (28.57%) | - | 10 (71.43%) |
| Ramlall | 11,116 | 4723 (42.49%) | - | - | - | - | - | 6393 (57.51%) | - | - | 1643.001 (25.70%) | 4749.999 (74.30%) | - |
| Sharma | 501 | 267 (53.29%) | - | - | 1 (0.37%) | - | 266 (99.63%) | 234 (46.71%) | - | - | 20 (8.55%) | - | 214 (91.45%) |
| Eugen-Olsen | 407 | 290 (71.25%) | 76 (26.21%) | 104 (35.86%) | - | 102 (35.17%) | - | 117 (28.75%) | 8 (6.84%) | 46 (39.32%) | - | 59 (50.43%) | - |
| Raisi-Estabragh | 4,510 | 3184 (70.60%) | - | - | 1653 (51.92%) | - | 1531 (48.08%) | 1326 (29.40%) | - | - | 683 (51.51%) | - | 643 (48.49%) |
| Houlihan | 177 | 97 (54.80%) | 14 (14.43%) | 14 (14.43%) | - | 69 (71.13%) | - | 80 (45.20%) | 7 (8.75%) | 19 (23.75%) | - | 54 (67.50%) | - |
| McQueenie | 428,199 | 424355 (99.10%) | - | - | 189299 (44.61%) | 235056 (55.39%) | - | 1311 (0.31%) | - | - | 669 (51.03%) | 642 (48.97%) | - |
| Woolford | 4,474 | 3161 (70.65%) | 441 (13.95%) | 1194 (37.77%) | - | 1526 (48.28%) | - | 1313 (29.35%) | 145 (11.04%) | 525 (39.98%) | - | 643 (48.97%) | - |
| Lan | 104 | 83 (79.81%) | - | - | 24 (28.92%) | - | 59 (71.08%) | 21 (20.19%) | - | - | 1 (4.76%) | - | 20 (95.24%) |
| Hernandez, Garduno | 32,583 | 20279 (62.24%) | - | - | 2399 (11.83%) | 17861 (88.08%) | - | 12304 (37.76%) | - | - | 1191 (9.68%) | 11083 (90.08%) | - |
| Govind | 6,215 | 6207 (99.87%) | 4104 (66.12%) | 1669 (26.89%) | - | 342 (5.51%) | - | 102 (1.64%) | 78 (76.47%) | 20 (19.61%) | - | 2 (1.96%) | - |
| Gu | 4,699 | 3815 (81.19%) | 360 (9.44%) | 1142 (29.93%) | - | 2313 (60.63%) | - | 884 (18.81%) | 40 (4.52%) | 264 (29.86%) | - | 580 (65.61%) | - |
| Kibler | 702 | 680 (96.87%) | 25 (3.68%) | - | - | - | 655 (96.32%) | 22 (3.13%) | 1 (4.55%) | - | - | - | 21 (95.45%) |
| Auvinen | 61 | 33 (54.10%) | 10 (30.30%) | 8 (24.24%) | - | 15 (45.45%) | - | 28 (45.90%) | 1 (3.57%) | 9 (32.14%) | - | 18 (64.29%) | - |
| Antonio-Villa | 34,263 | 23338 (68.11%) | 2293 (9.83%) | - | - | - | 21045 (90.17%) | 10925 (31.89%) | 1023 (9.36%) | - | - | - | 9902 (90.64%) |
| Merzon | 7,807 | 7025 (89.98%) | - | - | 1136 (16.17%) | - | 5889 (83.83%) | 782 (10.02%) | - | - | 127 (16.24%) | - | 655 (83.76%) |
| Trubiano | 2,935 | 2827 (96.32%) | - | - | 256 (9.06%) | - | 2586 (91.48%) | 108 (3.68%) | - | - | 3 (2.78%) | - | 105 (97.22%) |
| Shi, Resurreccion | 1,521 | 1265 (83.17%) | - | - | 681 (53.83%) | - | 584 (46.17%) | 256 (16.83%) | - | - | 154 (60.16%) | - | 102 (39.84%) |
| Riley | 120,620 | 120461 (99.87%) | 2594 (2.15%) | - | - | 19914 (16.53%) | 97953 (81.32%) | 159 (0.13%) | 3 (1.89%) | - | - | 17 (10.69%) | 139 (87.42%) |
| Alizadehsani | 319 | 196 (61.44%) | - | - | - | - | 196 (100.00%) | 123 (38.56%) | - | - | 1 (0.81%) | - | 122 (99.19%) |
| Merkely | 10,474 | 10336 (98.68%) | 2904 (28.10%) | 2107 (20.39%) | - | 5310 (51.37%) | 15 (0.15%) | 70 (0.67%) | 16 (22.86%) | 15 (21.43%) | - | 38 (54.29%) | 1 (1.43%) |
| Edwards | 209 | 118 (56.46%) | - | - | 31 (26.27%) | - | 87 (73.73%) | 91 (43.54%) | - | - | 8 (8.79%) | - | 83 (91.21%) |
| Reiter | 235 | 175 (74.47%) | - | - | 93 (53.14%) | 82 (46.86%) | - | 60 (25.53%) | - | - | 13 (21.67%) | 47 (78.33%) | - |
| Izquierdo | 71,192 | NA ( NA%) | - | - | - | - | - | 1006 (1.41%) | 111 (11.03%) | - | - | - | 895 (88.97%) |
| Ward | 99,908 | 94416 (94.50%) | 10202 (10.81%) | - | - | - | 84214 (89.19%) | 5492 (5.50%) | 433 (7.88%) | - | - | - | 5059 (92.12%) |
| Ebinger | 6,062 | 5850 (96.50%) | 99 (1.69%) | - | - | - | 5668 (96.89%) | 212 (3.50%) | 3 (1.42%) | - | - | - | 205 (96.70%) |
| Salerno | 15,920 | 14753 (92.67%) | - | - | 5517 (37.40%) | 8278 (56.11%) | 958 (6.49%) | 1167 (7.33%) | - | - | 339 (29.05%) | 626 (53.64%) | 202 (17.31%) |
| Iversen | 28,792 | 27629 (95.96%) | 4430 (16.03%) | 1799 (6.51%) | - | 21217 (76.79%) | 246 (0.89%) | 1163 (4.04%) | 177 (15.22%) | 78 (6.71%) | - | 898 (77.21%) | 10 (0.86%) |
| Hippisley-Cox | 8,275,949 | NA ( NA%) | - | - | - | - | - | 19486 (0.24%) | 1354 (6.95%) | 5715 (29.33%) | - | 12036 (61.77%) | 381 (1.96%) |
| Fillmore | 22,914 | 21120 (92.17%) | 8137 (38.53%) | 8416 (39.85%) | - | 3227 (15.28%) | 1340 (6.34%) | 1794 (7.83%) | 452 (25.20%) | 899 (50.11%) | - | 322 (17.95%) | 121 (6.74%) |
| Alkurt | 119 | NA ( NA%) | - | - | - | - | - | 119 (100.00%) | 14 (11.76%) | - | - | - | 105 (88.24%) |
| Petrilli | 10,620 | 5341 (50.29%) | 3454 (64.67%) | 816 (15.28%) | - | 541 (10.13%) | 530 (9.92%) | 5279 (49.71%) | 3268 (61.91%) | 902 (17.09%) | - | 288 (5.46%) | 821 (15.55%) |
| Bello-Chavolla | 150,200 | 98567 (65.62%) | - | - | 9624 (9.76%) | - | 88943 (90.24%) | 51633 (34.38%) | - | - | 4366 (8.46%) | - | 47267 (91.54%) |
| Ariza | 351 | 322 (91.74%) | 21 (6.52%) | - | - | - | 301 (93.48%) | 29 (8.26%) | 3 (10.34%) | - | - | - | 26 (89.66%) |
| Carrat | 14,393 | 13426 (93.28%) | 1652 (12.30%) | 5620 (41.86%) | - | 6154 (45.84%) | - | 967 (6.72%) | 98 (10.13%) | 353 (36.50%) | - | 516 (53.36%) | - |
| Meini | 461 | 243 (52.71%) | 39 (16.05%) | 66 (27.16%) | - | 138 (56.79%) | - | 218 (47.29%) | 9 (4.13%) | 53 (24.31%) | - | 156 (71.56%) | - |
| Favara | 434 | 354 (81.57%) | 28 (7.91%) | - | - | - | 326 (92.09%) | 80 (18.43%) | 9 (11.25%) | - | - | - | 71 (88.75%) |
| Erber | 4,554 | 4446 (97.63%) | - | - | 806 (18.13%) | - | 3640 (81.87%) | 108 (2.37%) | - | - | 11 (10.19%) | - | 97 (89.81%) |
| Roederer | 815 | 390 (47.85%) | 175 (44.87%) | 32 (8.21%) | - | 183 (46.92%) | - | 425 (52.15%) | 127 (29.88%) | 40 (9.41%) | - | 258 (60.71%) | - |
| Makaronidis | 567 | 127 (22.40%) | 16 (12.60%) | - | - | - | 111 (87.40%) | 440 (77.60%) | 37 (8.41%) | - | - | - | 403 (91.59%) |
| Ioannou | 88,747 | 78616 (88.58%) | 17138 (21.80%) | 29245 (37.20%) | - | 22327 (28.40%) | 9906 (12.60%) | 10131 (11.42%) | 1135 (11.20%) | 4073 (40.20%) | - | 3647 (36.00%) | 1277 (12.60%) |
| Perico | 423 | 260 (61.47%) | 69 (26.54%) | 35 (13.46%) | - | 156 (60.00%) | - | 163 (38.53%) | 23 (14.11%) | 41 (25.15%) | - | 99 (60.74%) | - |
| Vila-Corcoles | 2,324 | 1944 (83.65%) | - | - | - | - | - | 380 (16.35%) | - | - | 27 (7.11%) | - | 353 (92.89%) |
| O'Reilly | 1,334 | 1284 (96.25%) | - | - | 376 (29.28%) | - | 908 (70.72%) | 50 (3.75%) | - | - | 4 (8.00%) | - | 46 (92.00%) |
| Ghinai | 1,435 | 1004 (69.97%) | 412 (41.04%) | 155 (15.44%) | - | 341 (33.96%) | 96 (9.56%) | 431 (30.03%) | 113 (26.22%) | 96 (22.27%) | - | 135 (31.32%) | 87 (20.19%) |
| Kortela | 2,993 | 2419 (80.82%) | 300 (12.40%) | 340 (14.06%) | - | 636 (26.29%) | 1143 (47.25%) | 574 (19.18%) | 26 (4.53%) | 80 (13.94%) | - | 232 (40.42%) | 236 (41.11%) |
| Gallichotte | 239 | 190 (79.50%) | 40 (21.05%) | 28 (14.74%) | - | 110 (57.89%) | - | 49 (20.50%) | 8 (16.33%) | 12 (24.49%) | - | 27 (55.10%) | - |
| Saeed | 173 | 69 (39.88%) | 2 (2.90%) | - | - | - | 67 (97.10%) | 104 (60.12%) | 9 (8.65%) | - | - | - | 95 (91.35%) |
| Woolcott | 1,636,050 | 878840 (53.72%) | - | - | 85816 (9.76%) | - | 793024 (90.24%) | 757210 (46.28%) | - | - | 57451 (7.59%) | - | 699759 (92.41%) |
| Barasa | 394 | 277 (70.30%) | 49 (17.69%) | 105 (37.91%) | - | 110 (39.71%) | 13 (4.69%) | 117 (29.70%) | 9 (7.69%) | 37 (31.62%) | - | 54 (46.15%) | 17 (14.53%) |
| Paleiron | 1,688 | 409 (24.23%) | 236 (57.70%) | 77 (18.83%) | - | 96 (23.47%) | - | 1279 (75.77%) | 579 (45.27%) | 309 (24.16%) | - | 391 (30.57%) | - |
| Didikoglu | 43,428 | 35695 (82.19%) | 3919 (10.98%) | 13841 (38.78%) | - | 17939 (50.26%) | - | 7733 (17.81%) | 867 (11.21%) | 2966 (38.36%) | - | 3901 (50.45%) | - |
| Kantele | 1,095 | 1059 (96.71%) | 176 (16.62%) | 272 (25.68%) | - | 611 (57.70%) | - | 36 (3.29%) | 3 (8.33%) | 11 (30.56%) | - | 21 (58.33%) | 1 (2.78%) |
| Polat | 1,322 | NA ( NA%) | - | - | - | - | - | 23 (1.74%) | 4 (17.39%) | 2 (8.70%) | - | 17 (73.91%) | - |
| Richard | 8,344 | 6798 (81.47%) | 1065 (15.67%) | 1171 (17.23%) | - | 4456 (65.55%) | 106 (1.56%) | 531 (6.36%) | 47 (8.85%) | 83 (15.63%) | - | 396 (74.58%) | 5 (0.94%) |
| Schubl | 1,557 | 1392 (89.40%) | 33 (2.37%) | - | - | - | 1359 (97.63%) | 165 (10.60%) | 4 (2.42%) | - | - | - | 161 (97.58%) |
| Nezhadmoghadam | 33,325 | 19958 (59.89%) | 2151 (10.78%) | - | - | - | 17807 (89.22%) | 13367 (40.11%) | 1251 (9.36%) | - | - | - | 12116 (90.64%) |
| Mora | 1,058 | 857 (81.00%) | 40 (4.67%) | 118 (13.77%) | - | 698 (81.45%) | 1 (0.12%) | 201 (19.00%) | 8 (3.98%) | 36 (17.91%) | - | 157 (78.11%) | - |
| Molenaar | 696 | 591 (84.91%) | 29 (4.91%) | - | - | - | 562 (95.09%) | 105 (15.09%) | 2 (1.90%) | - | - | - | 103 (98.10%) |
| Vila-Corcoles, Satue-Gracia, Vila-Rovira | 4,113 | 3577 (86.97%) | 591 (16.52%) | - | - | - | 2986 (83.48%) | 536 (13.03%) | 41 (7.65%) | - | - | - | 495 (92.35%) |
| Gegout Petit | 2,006 | 1964 (97.91%) | 334 (17.01%) | - | - | 1545 (78.67%) | 85 (4.33%) | 42 (2.09%) | 4 (9.52%) | - | - | 38 (90.48%) | - |
| Leister | 3,301 | 3269 (99.03%) | 764 (23.37%) | - | - | - | 2505 (76.63%) | 32 (0.97%) | 5 (15.62%) | - | - | - | 27 (84.38%) |



*Figure 3.* Forest plot for risk of testing positive for SARS-CoV-2 in current vs. never smokers. \* Indicates ‘good’ quality studies. The prior from the previous review version (v10) was RR = 0.69.



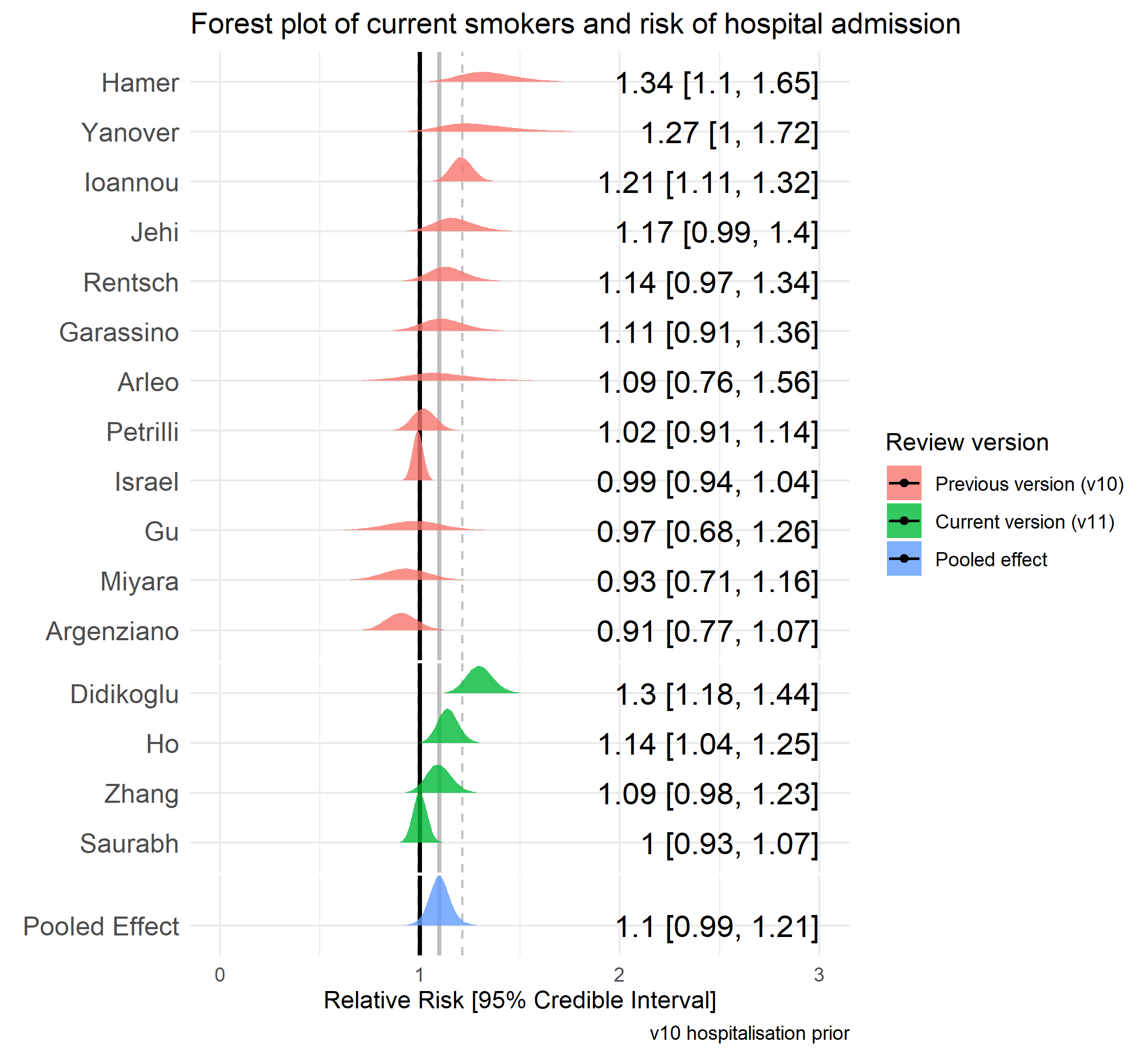
*Figure 4.* Forest plot for risk of testing positive for SARS-CoV-2 in former vs. never smokers. \* Indicates ‘good’ quality studies. The prior from the previous review version (v10) was RR = 1.02.

### Hospitalisation for COVID-19 by smoking status

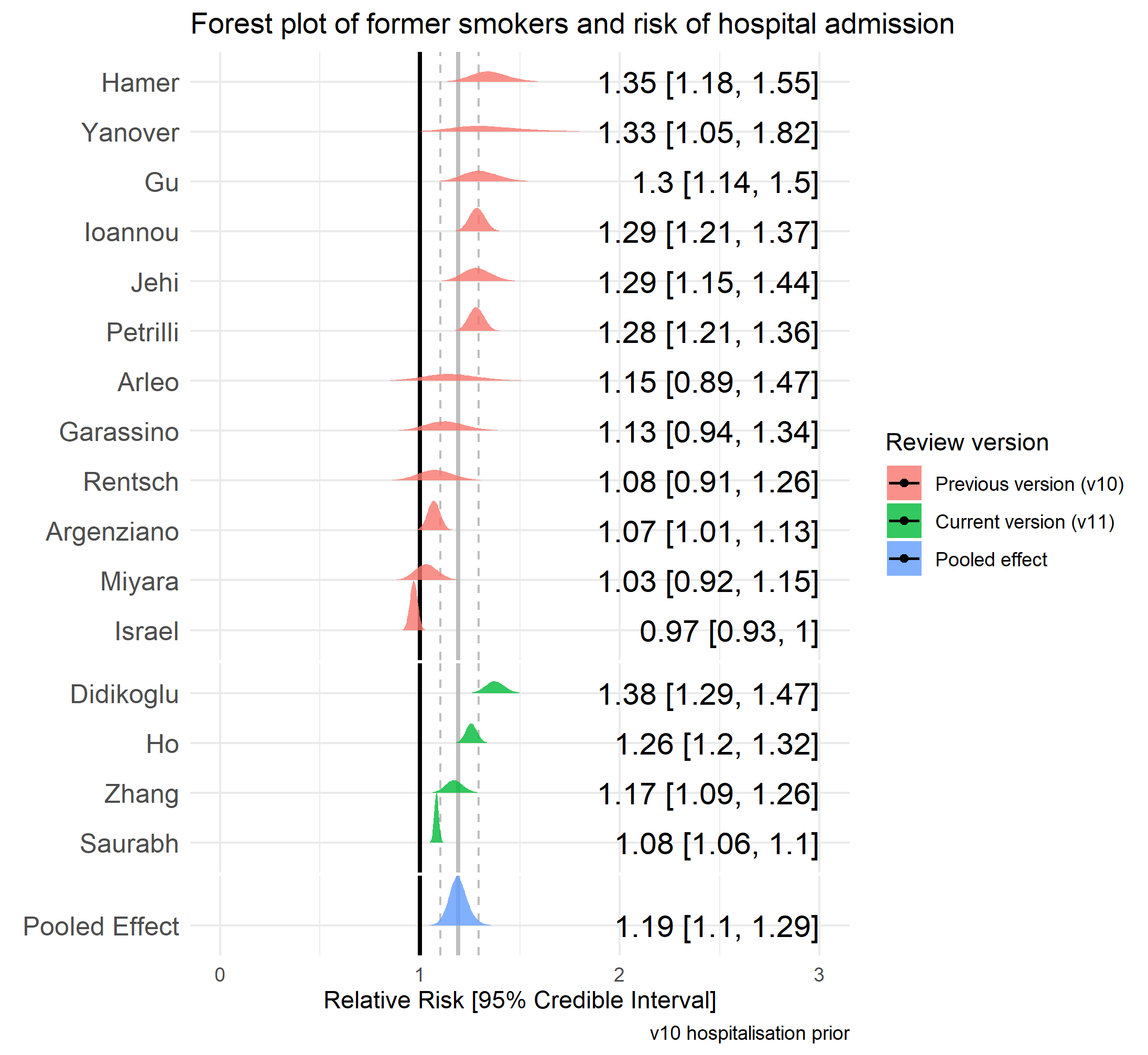
48 studies examined hospitalisation for COVID-19 disease, stratified by smoking status (see [Table 3](#table-3)). Meta-analyses were performed for 17 ‘fair’ quality studies (see [Figure 5](#fig-5) and [6](#fig-6)). Current (RR = 1.1, 95% CrI = 0.99-1.21, τ = 0.15) and former (RR = 1.19, CrI = 1.1-1.29, τ = 0.13) compared with never smokers were at increased risk of hospitalisation with COVID-19. However, data for current smokers were inconclusive and favoured there being no important association. The probability of current and former smokers being at increased risk of hospitalisation (RR ≥1.1) compared with never smokers was 49% and 98%, respectively. Results were materially unchanged in two sensitivity analyses.

#### *Table 3* COVID-19 hospitalsation by smoking status

|  | | Community | | | | | | | Hospitalised | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Population with outcome | N (%) | Current smoker (%) | Former smoker (%) | Current/former smoker (%) | Never smoker (%) | Never/unknown smoker (%) | Not stated (%) | N (%) | Current smoker (%) | Former smoker (%) | Current/former smoker (%) | Never smoker (%) | Never/unknown smoker (%) | Not stated (%) |
| Rentsch | 554 | 269 (48%) | 69 (25.65%) | 90 (33.46%) | - | 110 (40.89%) | - | - | 285 (51%) | 90 (31.58%) | 89 (31.23%) | - | 106 (37.19%) | - | - |
| Chow (US CDC) | 6,637 | 5143 (77%) | 61 (1.19%) | 80 (1.56%) | - | - | - | 5002 (97.26%) | 1494 (22%) | 27 (1.81%) | 78 (5.22%) | - | - | - | 1389 (92.97%) |
| Argenziano | 1,000 | 151 (15%) | 14 (9.27%) | 18 (11.92%) | - | 119 (78.81%) | - | - | 849 (84%) | 35 (4.12%) | 161 (18.96%) | - | 653 (76.91%) | - | - |
| Lubetzky | 54 | 15 (27%) | - | - | 4 (26.67%) | - | - | 11 (73.33%) | 39 (72%) | - | - | 8 (20.51%) | - | - | 31 (79.49%) |
| Carillo-Vega | 9,946 | 3922 (39%) | 408 (10.40%) | - | - | - | - | 3514 (89.60%) | 6024 (60%) | 486 (8.07%) | - | - | - | - | 5538 (91.93%) |
| Yanover | 4,353 | 4180 (96%) | 484 (11.58%) | 118 (2.82%) | - | 3578 (85.60%) | - | - | 173 (3%) | 30 (17.34%) | 11 (6.36%) | - | 132 (76.30%) | - | - |
| Hamer | 387,109 | 386349 (99%) | 37333 (9.66%) | 134542 (34.82%) | - | 214474 (55.51%) | - | - | 760 (0%) | 93 (12.24%) | 313 (41.18%) | - | 354 (46.58%) | - | - |
| Heili-Frades | 4,712 | 1973 (41%) | 121 (6.13%) | 222 (11.25%) | - | - | 1630 (82.62%) | 1630 (82.62%) | 2739 (58%) | 112 (4.09%) | 598 (21.83%) | - | - | 2029 (74.08%) | - |
| Freites | 123 | 69 (56%) | 1 (1.45%) | - | - | - | - | 68 (98.55%) | 54 (43%) | 3 (5.56%) | - | - | - | - | 51 (94.44%) |
| Berumen | 102,875 | 18832 (18%) | - | - | 1546 (8.21%) | - | 17286 (91.79%) | - | 12690 (12%) | - | - | 1202 (9.47%) | - | 11488 (90.53%) | - |
| Gianfrancesco | 600 | 323 (53%) | - | - | 61 (18.89%) | - | - | 262 (81.11%) | 277 (46%) | - | - | 68 (24.55%) | - | - | 209 (75.45%) |
| Chaudhry | 40 | 19 (47%) | - | - | 0 (0.00%) | - | - | 19 (100.00%) | 21 (52%) | - | - | 6 (28.57%) | - | - | 15 (71.43%) |
| Giannouchos | 89,756 | 58485 (65%) | 4679 (8.00%) | - | - | - | 53806 (92.00%) | - | 31271 (34%) | 2721 (8.70%) | - | - | - | 28550 (91.30%) | - |
| Wang, Oekelen | 57 | 22 (38%) | - | - | 6 (27.27%) | - | - | 16 (72.73%) | 36 (63%) | - | - | 15 (41.67%) | - | - | 20 (55.56%) |
| Miyara | 470 | 132 (28%) | 14 (10.61%) | 41 (31.06%) | - | 77 (58.33%) | - | - | 338 (71%) | 18 (5.33%) | 111 (32.84%) | - | 209 (61.83%) | - | - |
| Suleyman | 463 | 108 (23%) | - | - | 23 (21.30%) | - | - | 85 (78.70%) | 355 (76%) | - | - | 137 (38.59%) | - | - | 218 (61.41%) |
| Garassino | 196 | 48 (24%) | 10 (20.83%) | 27 (56.25%) | - | 11 (22.92%) | - | - | 152 (77%) | 38 (25.00%) | 84 (55.26%) | - | 26 (17.11%) | - | - |
| Siso-Almirall | 260 | 119 (45%) | - | - | 31 (26.05%) | - | - | 88 (73.95%) | 141 (54%) | - | - | 50 (35.46%) | - | - | 91 (64.54%) |
| Gu | 884 | 511 (57%) | 30 (5.87%) | 126 (24.66%) | - | 355 (69.47%) | - | - | 373 (42%) | 10 (2.68%) | 138 (37.00%) | - | 225 (60.32%) | - | - |
| Killerby | 531 | 311 (58%) | - | - | 37 (11.90%) | 222 (71.38%) | - | 52 (16.72%) | 220 (41%) | - | - | 54 (24.55%) | 157 (71.36%) | - | 9 (4.09%) |
| Nguyen | 689 | 333 (48%) | - | - | 57 (17.12%) | - | - | 276 (82.88%) | 356 (51%) | - | - | 114 (32.02%) | - | - | 242 (67.98%) |
| Mendy | 689 | 473 (68%) | - | - | 84 (17.76%) | - | - | 389 (82.24%) | 216 (31%) | - | - | 86 (39.81%) | - | - | 130 (60.19%) |
| Soares | 10,713 | 9561 (89%) | 132 (1.38%) | - | - | - | 9429 (98.62%) | - | 1152 (10%) | 77 (6.68%) | - | - | - | 1075 (93.32%) | - |
| Zobairy | 203 | 65 (32%) | 1 (1.54%) | - | - | - | 64 (98.46%) | - | 138 (67%) | 11 (7.97%) | - | - | - | 127 (92.03%) | - |
| Izquierdo | 1,006 | 743 (73%) | 52 (7.00%) | - | - | - | 691 (93.00%) | - | 263 (26%) | 16 (6.08%) | - | - | - | 247 (93.92%) | - |
| Rizzo | 76,819 | 60039 (78%) | 3931 (6.55%) | 11379 (18.95%) | - | 30042 (50.04%) | - | 14687 (24.46%) | 16780 (21%) | 1254 (7.47%) | 4585 (27.32%) | - | 8693 (51.81%) | - | 2248 (13.40%) |
| Pan | 12,084 | 8548 (70%) | - | - | 1263 (14.78%) | - | - | 7285 (85.22%) | 3536 (29%) | - | - | 874 (24.72%) | - | - | 2662 (75.28%) |
| Petrilli | 5,279 | 2538 (48%) | 147 (5.79%) | 337 (13.28%) | - | 1678 (66.12%) | - | 376 (14.81%) | 2741 (51%) | 141 (5.14%) | 565 (20.61%) | - | 1590 (58.01%) | - | 445 (16.23%) |
| Vilar-Garcia | 328,892 | 291254 (88%) | 64792 (22.25%) | - | - | - | - | 226462 (77.75%) | 37638 (11%) | 9526 (25.31%) | - | - | - | - | 28112 (74.69%) |
| Ibarra-Nava | 416,546 | 302693 (72%) | 26773 (8.84%) | - | - | - | - | 275920 (91.16%) | 113853 (27%) | 8875 (7.80%) | - | - | - | - | 104978 (92.20%) |
| Dashti | 12,347 | 8946 (72%) | 353 (3.95%) | 1099 (12.28%) | - | 5133 (57.38%) | - | 2361 (26.39%) | 3401 (27%) | 210 (6.17%) | 860 (25.29%) | - | 1920 (56.45%) | - | 411 (12.08%) |
| da Silva Neto | 91 | 44 (48%) | - | - | 4 (9.09%) | - | 40 (90.91%) | - | 47 (51%) | - | - | 14 (29.79%) | - | 33 (70.21%) | - |
| Israel, Schaffer | 26,676 | 13706 (51%) | 944 (6.89%) | 2166 (15.80%) | - | 10596 (77.31%) | - | - | 12970 (48%) | 880 (6.78%) | 1936 (14.93%) | - | 10154 (78.29%) | - | - |
| Ioannou | 10,131 | 6624 (65%) | 716 (10.81%) | 2484 (37.50%) | - | 2542 (38.38%) | - | 882 (13.32%) | 3507 (34%) | 419 (11.95%) | 1593 (45.42%) | - | 1102 (31.42%) | - | 393 (11.21%) |
| Zhang, Li | 1,596 | 576 (36%) | 63 (10.94%) | 190 (32.99%) | - | 318 (55.21%) | - | 5 (0.87%) | 1020 (63%) | 116 (11.37%) | 429 (42.06%) | - | 462 (45.29%) | - | 13 (1.27%) |
| Parra-Bracamonte | 331,298 | 235840 (71%) | - | - | 16676 (7.07%) | - | - | 219164 (92.93%) | 95458 (28%) | - | - | 7517 (7.87%) | - | - | 87941 (92.13%) |
| Jehi | 4,536 | 3578 (78%) | 247 (6.90%) | 943 (26.36%) | - | 1795 (50.17%) | - | 593 (16.57%) | 958 (21%) | 82 (8.56%) | 349 (36.43%) | - | 467 (48.75%) | - | 60 (6.26%) |
| Arleo | 70 | 36 (51%) | 1 (2.78%) | 10 (27.78%) | - | 25 (69.44%) | - | - | 34 (48%) | 0 (0.00%) | 10 (29.41%) | - | 24 (70.59%) | - | - |
| Kortela | 604 | 246 (40%) | 12 (4.88%) | 14 (5.69%) | - | 55 (22.36%) | - | 165 (67.07%) | 328 (54%) | 14 (4.27%) | 66 (20.12%) | - | 177 (53.96%) | - | 71 (21.65%) |
| Didikoglu | 7,733 | 5239 (67%) | 554 (10.57%) | 1845 (35.22%) | - | 2841 (54.23%) | - | - | 2494 (32%) | 313 (12.55%) | 1121 (44.95%) | - | 1060 (42.50%) | - | - |
| Ho, Narasimhan | 9,991 | 5082 (50%) | 189 (3.72%) | 744 (14.64%) | - | 4148 (81.62%) | - | - | 4909 (49%) | 217 (4.42%) | 1062 (21.63%) | - | 3630 (73.95%) | - | - |
| Saurabh | 911 | 69 (7%) | 6 (8.70%) | 0 (0.00%) | - | 63 (91.30%) | - | - | 842 (92%) | 68 (8.08%) | 6 (0.71%) | - | 768 (91.21%) | - | - |
| Munoz | 314 | 294 (93%) | 20 (6.80%) | - | - | - | - | 274 (93.20%) | 20 (6%) | 1 (5.00%) | - | - | - | - | 19 (95.00%) |
| Cummins | 1,781 | 586 (32%) | 77 (13.14%) | - | - | - | - | 509 (86.86%) | 1195 (67%) | 104 (8.70%) | - | - | - | - | 1091 (91.30%) |



*Figure 5.* Forest plot for risk of hospitalisation in current vs. never smokers. The prior from the previous review version (v10) was RR = 1.08.



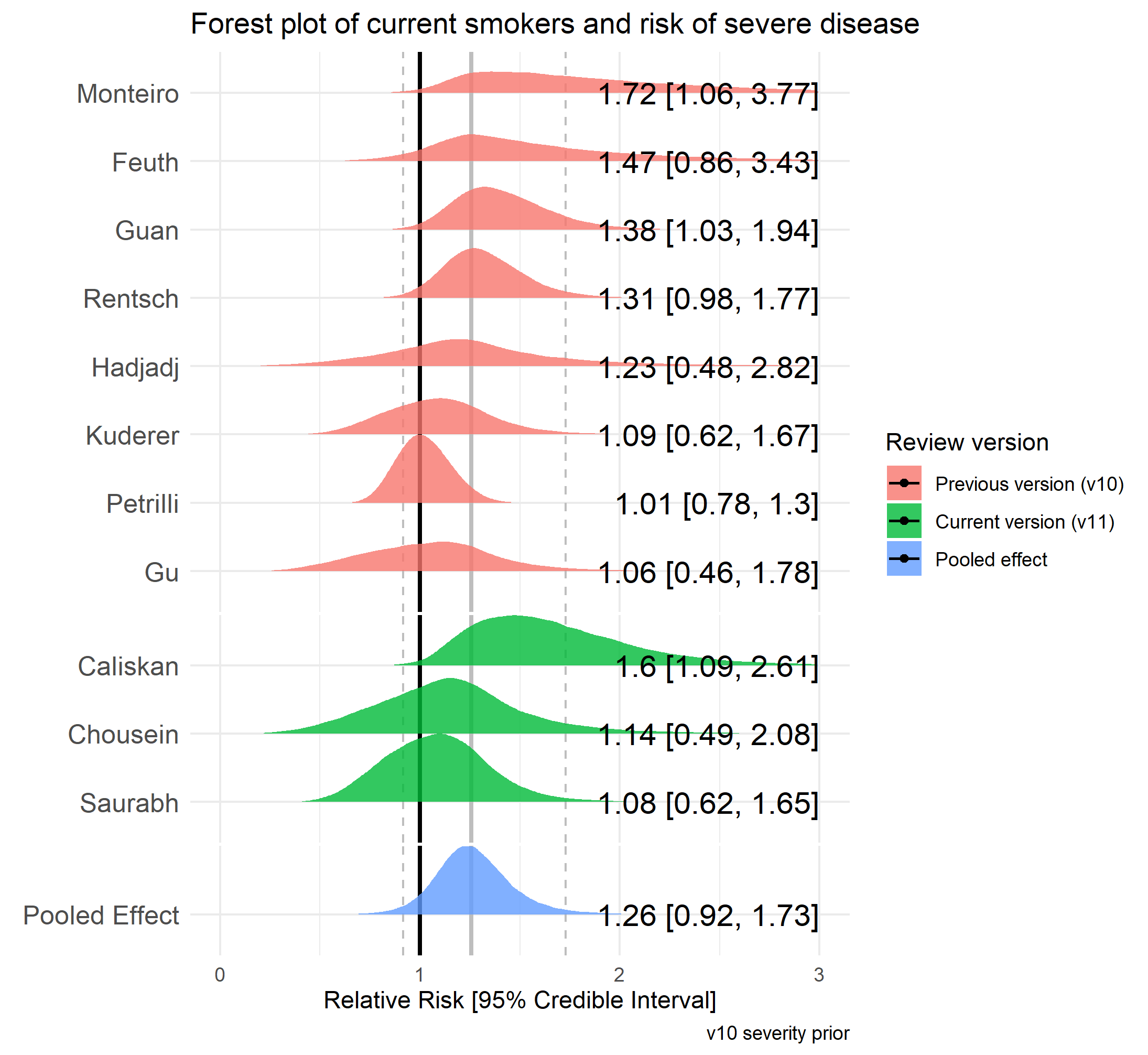
*Figure 6.* Forest plot for risk of hospitalisation in former vs. never smokers. The prior from the previous version (v10) was RR = 1.18.

### Disease severity by smoking status

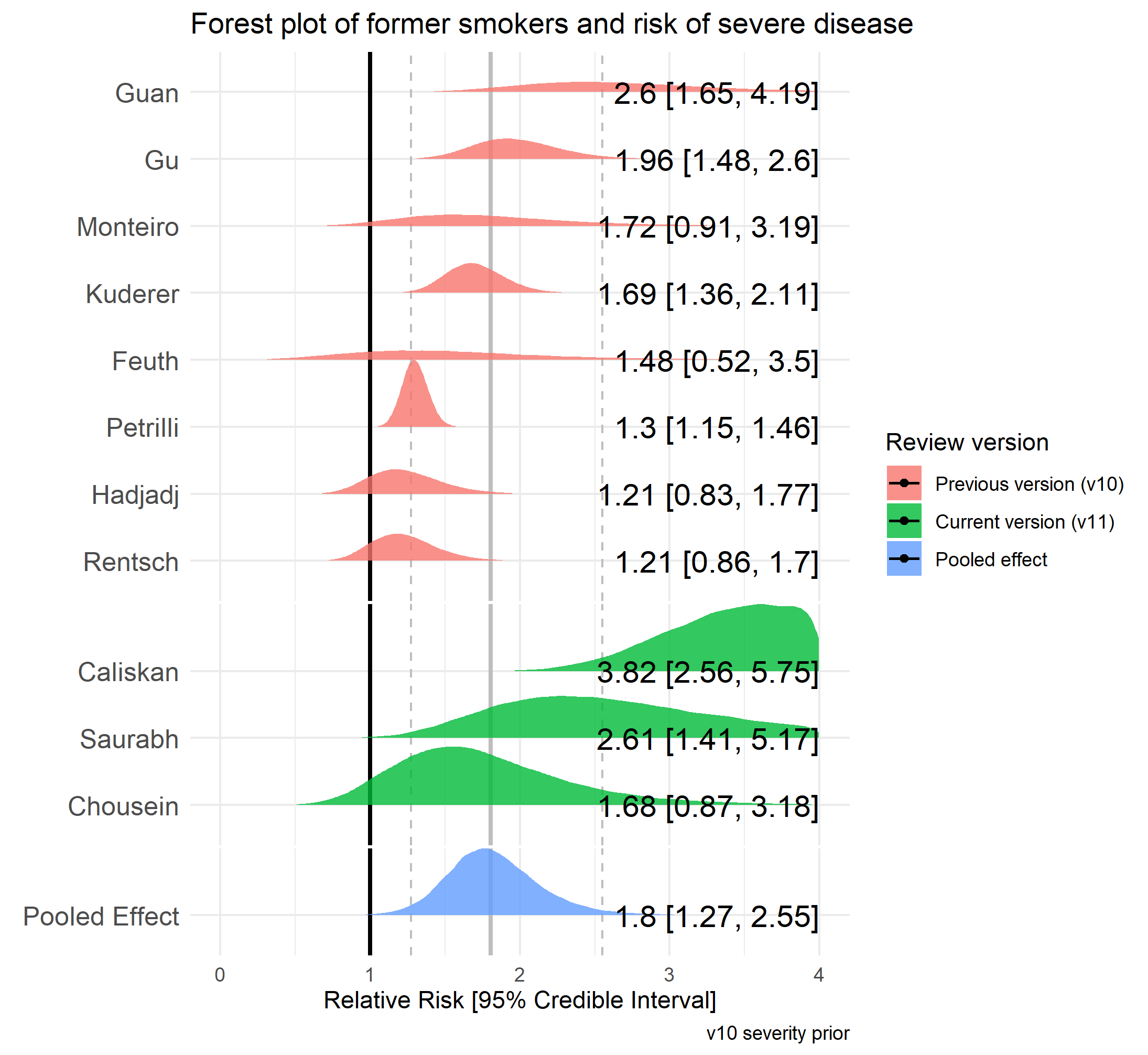
85 studies reported disease severity in hospitalised patients stratified by smoking status (see [Table 4](#table-4)). Severe (as opposed to non-severe) disease was broadly defined as requiring intensive treatment unit (ITU) admission, requiring oxygen as a hospital inpatient or in-hospital death. Meta-analyses were performed for 16 ‘fair’ quality studies (see [Figure 7](#fig-7) and [8](#fig-8)). Current (RR = 1.26, 95% CrI = 0.92-1.73, τ = 0.32) and former (RR = 1.8, 95% CrI = 1.27-2.55, τ = 0.46) compared with never smokers were at increased risk of greater disease severity. However, while data for current smokers only were inconclusive, they favoured there being a small but important association. The probability of current and former smokers having increased risk of greater disease severity (RR ≥1.1) compared with never smokers was 80% and 100%, respectively. Results were materially unchanged in two sensitivity analyses.

#### *Table 4* COVID-19 disease severity by smoking status

|  | | Non severe disease | | | | | | | Severe disease | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Population with severity | N (%) | Current smoker (%) | Former smoker (%) | Current/former smoker (%) | Never smoker (%) | Never/unknown smoker (%) | Not stated (%) | N (%) | Current smoker (%) | Former smoker (%) | Current/former smoker (%) | Never smoker (%) | Never/unknown smoker (%) | Not stated (%) |
| Guan, Ni | 1,085 | 913 (84%) | 108 (11.83%) | 12 (1.31%) | - | 793 (86.86%) | - | - | 172 (15%) | 29 (16.86%) | 9 (5.23%) | - | 134 (77.91%) | - | - |
| Zhang, Dong | 9 | 3 (33%) | 0 (0.00%) | 3 (100.00%) | - | 0 (0.00%) | - | - | 6 (66%) | 2 (33.33%) | 4 (66.67%) | - | 0 (0.00%) | - | - |
| Wan | 9 | 8 (88%) | 8 (100.00%) | 0 (0.00%) | - | 0 (0.00%) | - | - | 1 (11%) | 1 (100.00%) | 0 (0.00%) | - | 0 (0.00%) | - | - |
| Huang, Wang | 3 | 3 (100%) | 3 (100.00%) | 0 (0.00%) | - | 0 (0.00%) | - | - | 0 (0%) | 0 (NaN%) | 0 (NaN%) | - | 0 (NaN%) | - | - |
| Rentsch | 285 | 168 (58%) | 47 (27.98%) | 53 (31.55%) | - | 68 (40.48%) | - | - | 117 (41%) | 43 (36.75%) | 36 (30.77%) | - | 38 (32.48%) | - | - |
| Hu | 323 | 151 (46%) | - | - | 12 (7.95%) | - | 139 (92.05%) | - | 172 (53%) | - | - | 26 (15.12%) | - | 146 (84.88%) | - |
| Wang, Pan | 125 | 100 (80%) | - | - | 9 (9.00%) | - | 91 (91.00%) | - | 25 (20%) | - | - | 7 (28.00%) | - | 18 (72.00%) | - |
| Kim | 27 | 21 (77%) | 3 (14.29%) | - | - | - | 18 (85.71%) | - | 6 (22%) | 2 (33.33%) | 0 (0.00%) | - | - | 4 (66.67%) | - |
| Shi, Yu | 474 | 425 (89%) | - | - | 34 (8.00%) | - | 391 (92.00%) | - | 49 (10%) | - | - | 6 (12.24%) | - | 43 (87.76%) | - |
| Liao, Feng | 148 | 92 (62%) | - | - | 5 (5.43%) | - | - | 87 (94.57%) | 56 (37%) | 3 (5.36%) | - | - | - | - | 53 (94.64%) |
| Shi, Ren | 134 | 88 (65%) | - | - | 8 (9.09%) | - | - | 80 (90.91%) | 46 (34%) | - | - | 6 (13.04%) | - | - | 40 (86.96%) |
| Hadjadj | 50 | 15 (30%) | 1 (6.67%) | 2 (13.33%) | - | 12 (80.00%) | - | - | 35 (70%) | 0 (0.00%) | 7 (20.00%) | - | 28 (80.00%) | - | - |
| Zheng, Xiong | 73 | 43 (58%) | - | - | 6 (13.95%) | 37 (86.05%) | - | - | 30 (41%) | - | - | 2 (6.67%) | 28 (93.33%) | - | - |
| de la Rica | 48 | 26 (54%) | - | - | 6 (23.08%) | - | - | 20 (76.92%) | 20 (41%) | - | - | 4 (20.00%) | - | - | 16 (80.00%) |
| Yin, Yang | 106 | 47 (44%) | - | - | 6 (12.77%) | - | - | 41 (87.23%) | 59 (55%) | - | - | 12 (20.34%) | - | - | 47 (79.66%) |
| Allenbach | 147 | 100 (68%) | - | - | 9 (9.00%) | - | - | 91 (91.00%) | 47 (31%) | - | - | 0 (0.00%) | - | - | 47 (100.00%) |
| Goyal | 393 | 263 (66%) | 14 (5.32%) | - | - | - | - | 249 (94.68%) | 130 (33%) | 6 (4.62%) | - | - | - | - | 124 (95.38%) |
| Feng | 454 | 333 (73%) | 27 (8.11%) | - | - | - | - | 306 (91.89%) | 121 (26%) | 17 (14.05%) | - | - | - | - | 104 (85.95%) |
| Yao | 108 | 83 (76%) | 1 (1.20%) | - | - | - | - | 82 (98.80%) | 25 (23%) | 3 (12.00%) | - | - | - | - | 22 (88.00%) |
| Regina | 200 | 163 (81%) | 9 (5.52%) | - | - | - | - | 154 (94.48%) | 37 (18%) | 0 (0.00%) | - | - | - | - | 37 (100.00%) |
| Feuth | 28 | 21 (75%) | 1 (4.76%) | 7 (33.33%) | - | 13 (61.90%) | - | - | 7 (25%) | 2 (28.57%) | 1 (14.29%) | - | 4 (57.14%) | - | - |
| Mejia-Vilet | 329 | 214 (65%) | - | - | 13 (6.07%) | - | - | 201 (93.93%) | 115 (34%) | - | - | 10 (8.70%) | - | - | 105 (91.30%) |
| Chen, Jiang | 135 | 54 (40%) | - | - | 4 (7.41%) | - | - | 50 (92.59%) | 81 (60%) | - | - | 9 (11.11%) | - | - | 72 (88.89%) |
| Vaquero-Roncero | 146 | 75 (51%) | - | - | 4 (5.33%) | - | - | 71 (94.67%) | 71 (48%) | - | - | 6 (8.45%) | - | - | 65 (91.55%) |
| Kim, Garg | 2,490 | 1692 (67%) | 112 (6.62%) | 395 (23.35%) | - | - | 1185 (70.04%) | - | 798 (32%) | 38 (4.76%) | 247 (30.95%) | - | - | 512 (64.16%) | - |
| Wu | 174 | 92 (52%) | - | - | 47 (51.09%) | - | 45 (48.91%) | - | 82 (47%) | 11 (13.41%) | - | - | - | 71 (86.59%) | - |
| Chaudhry | 40 | 34 (85%) | - | - | 5 (14.71%) | - | - | 29 (85.29%) | 6 (15%) | - | - | 1 (16.67%) | - | - | 5 (83.33%) |
| Garibaldi | 832 | 532 (63%) | 25 (4.70%) | 107 (20.11%) | - | - | - | 400 (75.19%) | 300 (36%) | 21 (7.00%) | 81 (27.00%) | - | - | - | 198 (66.00%) |
| Kuderer | 928 | 686 (73%) | 35 (5.10%) | 210 (30.61%) | - | 370 (53.94%) | - | 29 (4.23%) | 242 (26%) | 8 (3.31%) | 116 (47.93%) | - | 99 (40.91%) | 15 (6.20%) | 4 (1.65%) |
| Romao | 14 | 14 (100%) | - | - | 4 (28.57%) | - | - | 10 (71.43%) | 0 (0%) | - | - | - | - | - | - |
| Giannouchos | 89,756 | 78050 (86%) | 6322 (8.10%) | - | - | - | 71728 (91.90%) | - | 11706 (13%) | 1089 (9.30%) | - | - | - | 10617 (90.70%) | - |
| Cen | 1,007 | 720 (71%) | - | - | 70 (9.72%) | - | - | 650 (90.28%) | 287 (28%) | - | - | 18 (6.27%) | - | - | 269 (93.73%) |
| Maraschini | 132 | 89 (67%) | - | 11 (12.36%) | - | 78 (87.64%) | - | - | 43 (32%) | - | 3 (6.98%) | - | 40 (93.02%) | - | - |
| Russell | 156 | 128 (82%) | 9 (7.03%) | 31 (24.22%) | - | 51 (39.84%) | - | 37 (28.91%) | 28 (17%) | 2 (7.14%) | 8 (28.57%) | - | 8 (28.57%) | - | 10 (35.71%) |
| Siso-Almirall | 260 | 212 (81%) | - | - | 60 (28.30%) | - | - | 152 (71.70%) | 48 (18%) | - | - | 21 (43.75%) | - | - | 27 (56.25%) |
| Gu | 884 | 511 (57%) | 30 (5.87%) | 126 (24.66%) | - | 355 (69.47%) | - | - | 134 (15%) | 3 (2.24%) | 61 (45.52%) | - | 70 (52.24%) | - | - |
| Mendy | 689 | 598 (86%) | - | - | 133 (22.24%) | - | - | 465 (77.76%) | 91 (13%) | - | - | 37 (40.66%) | - | - | 54 (59.34%) |
| Jin, Gu | 6 | 2 (33%) | - | - | 0 (0.00%) | - | - | 2 (100.00%) | 4 (66%) | - | - | 2 (50.00%) | - | - | 2 (50.00%) |
| Senkal | 611 | 446 (73%) | 48 (10.76%) | - | - | - | - | 398 (89.24%) | 165 (27%) | 21 (12.73%) | - | - | - | - | 144 (87.27%) |
| Patel | 129 | 89 (68%) | 26 (29.21%) | - | - | - | 58 (65.17%) | 5 (5.62%) | 40 (31%) | 22 (55.00%) | - | - | - | 14 (35.00%) | 4 (10.00%) |
| Maucourant | 27 | 10 (37%) | 1 (10.00%) | 2 (20.00%) | - | 2 (20.00%) | - | 5 (50.00%) | 17 (62%) | 2 (11.76%) | 5 (29.41%) | - | 9 (52.94%) | - | 1 (5.88%) |
| Xie | 619 | 469 (75%) | - | - | 32 (6.82%) | - | - | 437 (93.18%) | 150 (24%) | - | - | 19 (12.67%) | - | - | 131 (87.33%) |
| Fox | 55 | 30 (54%) | 1 (3.33%) | 4 (13.33%) | - | 17 (56.67%) | - | 8 (26.67%) | 25 (45%) | 0 (0.00%) | 2 (8.00%) | - | 14 (56.00%) | - | 9 (36.00%) |
| Zhang, Cao | 240 | 162 (67%) | 2 (1.23%) | 6 (3.70%) | - | - | - | 154 (95.06%) | 78 (32%) | 4 (5.13%) | 4 (5.13%) | - | - | - | 70 (89.74%) |
| Kurashima | 53 | 10 (18%) | - | - | 3 (30.00%) | - | - | 7 (70.00%) | 43 (81%) | - | - | 24 (55.81%) | - | - | 19 (44.19%) |
| Zhan | 75 | NA (NA%) | - | - | - | - | - | - | 75 (100%) | - | - | 9 (12.00%) | - | - | 66 (88.00%) |
| Omrani | 858 | 806 (93%) | - | - | 121 (15.01%) | - | - | 685 (84.99%) | 52 (6%) | - | - | 9 (17.31%) | - | - | 43 (82.69%) |
| Marcos | 918 | 555 (60%) | 38 (6.85%) | - | 69 (12.43%) | - | - | 448 (80.72%) | 363 (39%) | 18 (4.96%) | - | 71 (19.56%) | - | - | 292 (80.44%) |
| Hoertel, Sanchez, Rico | 7,345 | 6014 (81%) | 433 (7.20%) | - | - | - | - | 5581 (92.80%) | 1331 (18%) | 190 (14.27%) | - | - | - | - | 1141 (85.73%) |
| Qi | 267 | 217 (81%) | 22 (10.14%) | - | - | - | 195 (89.86%) | - | 50 (18%) | 31 (62.00%) | - | - | - | 19 (38.00%) | - |
| Monteiro | 112 | 84 (75%) | 3 (3.57%) | 14 (16.67%) | - | 63 (75.00%) | - | 4 (4.76%) | 28 (25%) | 4 (14.29%) | 6 (21.43%) | - | 14 (50.00%) | - | 4 (14.29%) |
| Morshed | 103 | 87 (84%) | 28 (32.18%) | - | - | - | 59 (67.82%) | - | 16 (15%) | 4 (25.00%) | - | - | - | 12 (75.00%) | - |
| Zhou, Sun | 144 | 108 (75%) | 11 (10.19%) | - | - | - | - | 97 (89.81%) | 36 (25%) | 2 (5.56%) | - | - | - | - | 34 (94.44%) |
| Hippisley-Cox | - | NA (NA%) | - | - | - | - | - | - | 1286 (NA%) | 56 (4.35%) | 427 (33.20%) | - | 791 (61.51%) | - | 12 (0.93%) |
| Zhao, Chen | 641 | 398 (62%) | 87 (21.86%) | - | - | - | - | 311 (78.14%) | 195 (30%) | 52 (26.67%) | - | - | - | - | 143 (73.33%) |
| Qu | 246 | 226 (91%) | 90 (39.82%) | - | - | - | - | 136 (60.18%) | 20 (8%) | 14 (70.00%) | - | - | - | - | 6 (30.00%) |
| Petrilli | 2,729 | 1739 (63%) | 97 (5.58%) | 325 (18.69%) | - | 1067 (61.36%) | - | 250 (14.38%) | 990 (36%) | 44 (4.44%) | 236 (23.84%) | - | 517 (52.22%) | - | 193 (19.49%) |
| Ren | 432 | 314 (72%) | 26 (8.28%) | - | - | 288 (91.72%) | - | - | 118 (27%) | 17 (14.41%) | - | - | 101 (85.59%) | - | - |
| Yan | 578 | 450 (77%) | 31 (6.89%) | - | - | - | - | 419 (93.11%) | 128 (22%) | 20 (15.62%) | - | - | - | - | 108 (84.38%) |
| Nicholson | 1,042 | 550 (52%) | 37 (6.73%) | 106 (19.27%) | - | 211 (38.36%) | - | 196 (35.64%) | 401 (38%) | 41 (10.22%) | 92 (22.94%) | - | 155 (38.65%) | - | 113 (28.18%) |
| Zhu | 432 | 285 (65%) | 46 (16.14%) | - | - | - | - | 239 (83.86%) | 147 (34%) | 16 (10.88%) | - | - | - | - | 147 (100.00%) |
| Kalan | 193 | 122 (63%) | 9 (7.38%) | - | - | 102 (83.61%) | - | 11 (9.02%) | 71 (36%) | 5 (7.04%) | - | - | 62 (87.32%) | - | 4 (5.63%) |
| Burrell | 204 | 85 (41%) | - | - | 7 (8.24%) | - | 75 (88.24%) | 3 (3.53%) | 119 (58%) | - | - | 20 (16.81%) | - | 94 (78.99%) | 5 (4.20%) |
| Chudasama | 1,706 | NA (NA%) | - | - | - | - | - | - | 1706 (100%) | 235 (13.77%) | 699 (40.97%) | - | 772 (45.25%) | - | - |
| Lamure | 89 | NA (NA%) | - | - | - | - | - | - | 25 (28%) | 1 (4.00%) | 5 (20.00%) | - | 15 (60.00%) | - | 4 (16.00%) |
| Zhou, He, Yang | 1,087 | 990 (91%) | - | - | 849 (85.76%) | 141 (14.24%) | - | - | 97 (8%) | - | - | 75 (77.32%) | 22 (22.68%) | - | - |
| Zhou, Qin | 51 | NA (NA%) | - | - | - | - | - | - | 51 (100%) | - | - | 40 (78.43%) | 11 (21.57%) | - | - |
| Zhan, Liu | 405 | 257 (63%) | - | - | 21 (8.17%) | 236 (91.83%) | - | - | 148 (36%) | - | - | 25 (16.89%) | 123 (83.11%) | - | - |
| Li, Long, Zhang | 954 | 838 (87%) | - | - | 34 (4.06%) | 804 (95.94%) | - | - | 116 (12%) | - | - | 22 (18.97%) | 94 (81.03%) | - | - |
| Jakob | 2,155 | 1400 (64%) | - | - | 92 (6.57%) | 99 (7.07%) | - | 669 (47.79%) | 755 (35%) | 51 (6.75%) | 58 (7.68%) | - | 200 (26.49%) | - | 446 (59.07%) |
| Aksu | 123 | 34 (27%) | 3 (8.82%) | - | - | - | 31 (91.18%) | - | 89 (72%) | 11 (12.36%) | - | - | - | 78 (87.64%) | - |
| Adrish | 1,173 | 162 (13%) | - | - | 36 (22.22%) | - | 126 (77.78%) | - | 1011 (86%) | - | - | 300 (29.67%) | 711 (70.33%) | - | - |
| Hoertel, Sanchez, Vernet | 12,210 | 11018 (90%) | 921 (8.36%) | - | - | - | - | 10097 (91.64%) | 1192 (9%) | 181 (15.18%) | - | - | - | - | 1011 (84.82%) |
| Vila-Corcoles, Satue-Gracia | 282 | 218 (77%) | - | - | 21 (9.63%) | - | - | 197 (90.37%) | 64 (22%) | - | - | 4 (6.25%) | - | - | 60 (93.75%) |
| Boyd | 38 | 0 (0%) | - | - | - | - | - | - | 38 (100%) | - | - | 2 (5.26%) | - | - | 36 (94.74%) |
| Caliskan | 565 | 474 (83%) | 96 (20.25%) | 45 (9.49%) | - | 333 (70.25%) | - | - | 91 (16%) | 22 (24.18%) | 34 (37.36%) | - | 35 (38.46%) | - | - |
| Ebrahimian | 226 | 134 (59%) | - | - | 12 (8.96%) | - | 122 (91.04%) | - | 92 (40%) | - | - | 12 (13.04%) | - | 80 (86.96%) | - |
| Ho, Narasimhan | 4,909 | 3859 (78%) | 169 (4.38%) | 833 (21.59%) | - | - | 2857 (74.03%) | - | 1050 (21%) | 48 (4.57%) | 229 (21.81%) | - | 773 (73.62%) | - | - |
| Quan | 2,038 | 1452 (71%) | - | 549 (37.81%) | - | - | - | 903 (62.19%) | 586 (28%) | - | - | 261 (44.54%) | - | - | 325 (55.46%) |
| Saurabh | 911 | 783 (85%) | 65 (8.30%) | 3 (0.38%) | - | 715 (91.32%) | - | - | 128 (14%) | 9 (7.03%) | 3 (2.34%) | - | 116 (90.62%) | - | - |
| Chousein | 114 | 94 (82%) | 17 (18.09%) | 17 (18.09%) | - | 60 (63.83%) | - | - | 20 (17%) | 2 (10.00%) | 6 (30.00%) | - | 12 (60.00%) | - | - |
| Tavakol | 206 | 182 (88%) | - | - | 24 (13.19%) | - | 158 (86.81%) | - | 24 (11%) | - | - | 2 (8.33%) | - | 22 (91.67%) | - |
| Yao, Hasegawa | 101 | 78 (77%) | - | - | 17 (21.79%) | - | 71 (91.03%) | - | 23 (22%) | - | - | 12 (52.17%) | - | 11 (47.83%) | - |
| Cummins | 1,195 | 1043 (87%) | 96 (9.20%) | - | - | - | - | 947 (90.80%) | 152 (12%) | 9 (5.92%) | - | - | - | - | 143 (94.08%) |
| Nuno | 4,730 | 3536 (74%) | 333 (9.42%) | - | - | - | - | 3203 (90.58%) | 1194 (25%) | 147 (12.31%) | - | - | - | - | 1047 (87.69%) |



*Figure 7.* Forest plot for the risk of severe disease in current vs. never smokers. The prior from the previous review version (v10) was RR = 1.26.



*Figure 8.* Forest plot for the risk of severe disease in former vs. never smokers. The prior from the previous review version (v10) was RR = 1.52.

### Mortality by smoking status

89 studies reported mortality from COVID-19 by smoking status (see [Table 5](#table-5)), with 21 ‘fair’ quality studies included in meta-analyses (see [Figure 9](#fig-9) and [10](#fig-10)). Current (RR = 1.12, 95% CrI = 0.84-1.47, τ = 0.42) and former (RR = 1.56, 95% CrI = 1.23-2, τ = 0.43) compared with never smokers were at increased risk of in-hospital mortality from COVID-19. However, data for current smokers were inconclusive and favoured there being no important association. The probability of current and former smokers being at greater risk of in-hospital mortality (RR ≥1.1) compared with never smokers was 60% and >99%, respectively. Results were materially unchanged in two sensitivity analyses.

#### *Table 5* COVID-19 attributed mortality by smoking status

|  | | Recovered | | | | | | | Died | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Author | Population with mortality | N (%) | Current smoker (%) | Former smoker (%) | Current/former smoker (%) | Never smoker (%) | Never/unknown smoker (%) | Not stated (%) | N (%) | Current smoker (%) | Former smoker (%) | Current/former smoker (%) | Never smoker (%) | Never/unknown smoker (%) | Not stated (%) |
| Chen | 274 | 161 (58%) | 5 (3.11%) | 5 (3.11%) | - | - | - | 151 (93.79%) | 113 (41%) | 7 (6.19%) | 2 (1.77%) | - | - | - | 104 (92.04%) |
| Zhou, Yu | 191 | 137 (71%) | 6 (4.38%) | - | - | - | - | 131 (95.62%) | 54 (28%) | 5 (9.26%) | - | - | - | - | 49 (90.74%) |
| Yang, Yu | 52 | 20 (38%) | 2 (10.00%) | - | - | - | 18 (90.00%) | - | 32 (61%) | - | - | - | - | 32 (100.00%) | - |
| Borobia | 2,226 | 1766 (79%) | 113 (6.40%) | - | - | - | - | 1653 (93.60%) | 460 (20%) | 44 (9.57%) | - | - | - | - | 416 (90.43%) |
| Giacomelli | 233 | 185 (79%) | - | - | 53 (28.65%) | 132 (71.35%) | - | - | 48 (20%) | - | - | 17 (35.42%) | 31 (64.58%) | - | 0 (0.00%) |
| Yao | 108 | 96 (88%) | 1 (1.04%) | - | - | - | - | 95 (98.96%) | 12 (11%) | 3 (25.00%) | - | - | - | - | 9 (75.00%) |
| Carillo-Vega | 9,946 | 8983 (90%) | 795 (8.85%) | - | - | - | - | 8188 (91.15%) | 963 (9%) | 99 (10.28%) | - | - | - | - | 864 (89.72%) |
| Ge | 51 | 39 (76%) | 6 (15.38%) | - | - | - | - | 33 (84.62%) | 12 (23%) | 1 (8.33%) | - | - | - | - | 11 (91.67%) |
| Chen, Jiang | 135 | NA (NA%) | - | - | - | - | - | - | 31 (22%) | - | - | 4 (12.90%) | - | - | 27 (87.10%) |
| Heili-Frades | 4,712 | 4086 (86%) | 210 (5.14%) | 659 (16.13%) | - | - | 3217 (78.73%) | - | 626 (13%) | 23 (3.67%) | 161 (25.72%) | - | - | 442 (70.61%) | - |
| Kim, Garg | 2,490 | 2070 (83%) | 128 (6.18%) | 481 (23.24%) | - | - | 1461 (70.58%) | - | 420 (16%) | 22 (5.24%) | 161 (38.33%) | - | - | 236 (56.19%) | - |
| Al-Hindawi | 31 | 15 (48%) | 0 (0.00%) | 10 (66.67%) | - | 5 (33.33%) | - | - | 16 (51%) | 1 (6.25%) | 12 (75.00%) | - | 3 (18.75%) | - | - |
| Louis | 22 | 16 (72%) | - | - | 7 (43.75%) | - | - | 9 (56.25%) | 6 (27%) | - | - | 3 (50.00%) | - | - | 3 (50.00%) |
| Soto-Mota | 400 | 200 (50%) | - | - | 23 (11.50%) | - | - | 177 (88.50%) | 200 (50%) | - | - | 25 (12.50%) | - | - | 175 (87.50%) |
| Garibaldi | 747 | 634 (84%) | 36 (5.68%) | 129 (20.35%) | - | - | - | 469 (73.97%) | 113 (15%) | 6 (5.31%) | 36 (31.86%) | - | - | - | 71 (62.83%) |
| Docherty | 13,364 | 8199 (61%) | 370 (4.51%) | 1832 (22.34%) | - | 4179 (50.97%) | - | 1818 (22.17%) | 5165 (38%) | 214 (4.14%) | 1350 (26.14%) | - | 2105 (40.76%) | - | 1496 (28.96%) |
| Kuderer | 928 | 807 (86%) | 38 (4.71%) | 262 (32.47%) | - | 425 (52.66%) | - | 31 (3.84%) | 121 (13%) | 5 (4.13%) | 64 (52.89%) | - | 44 (36.36%) | - | 2 (1.65%) |
| Ramlall | 11,116 | 10498 (94%) | - | - | 2771 (26.40%) | 7727 (73.60%) | - | - | 618 (5%) | - | - | 208 (33.66%) | 410 (66.34%) | - | - |
| Wang, Oekelen | 57 | 43 (75%) | - | - | 14 (32.56%) | - | - | 29 (67.44%) | 14 (24%) | - | - | 7 (50.00%) | - | - | 7 (50.00%) |
| Martinez-Portilla | 224 | 217 (96%) | - | - | 7 (3.23%) | - | - | 210 (96.77%) | 7 (3%) | - | - | 0 (0.00%) | - | - | 7 (100.00%) |
| Cen | 1,007 | 964 (95%) | - | - | 87 (9.02%) | - | - | 877 (90.98%) | 43 (4%) | - | - | 1 (2.33%) | - | - | 42 (97.67%) |
| Klang | 3,406 | 2270 (66%) | - | - | 492 (21.67%) | - | - | 1778 (78.33%) | 1136 (33%) | - | - | 301 (26.50%) | - | - | 835 (73.50%) |
| Wang, Zhong | 5,510 | 4874 (88%) | 247 (5.07%) | 1083 (22.22%) | - | 3544 (72.71%) | - | - | 636 (11%) | 28 (4.40%) | 214 (33.65%) | - | 394 (61.95%) | - | - |
| Miyara | 338 | 211 (62%) | 13 (6.16%) | 58 (27.49%) | - | 141 (66.82%) | - | - | 46 (13%) | 1 (2.17%) | 23 (50.00%) | - | 21 (45.65%) | - | - |
| Rajter | 255 | 209 (81%) | - | - | 28 (13.40%) | 181 (86.60%) | - | - | 53 (20%) | - | - | 18 (33.96%) | 28 (52.83%) | - | - |
| Zeng | 1,031 | 866 (84%) | - | - | 69 (7.97%) | - | - | 797 (92.03%) | 165 (16%) | - | - | 36 (21.82%) | - | - | 129 (78.18%) |
| Chen, Yu | 1,859 | 1651 (88%) | 32 (1.94%) | 54 (3.27%) | - | 1565 (94.79%) | - | - | 208 (11%) | 13 (6.25%) | 12 (5.77%) | - | 183 (87.98%) | - | - |
| Garassino | 190 | 124 (65%) | - | - | 92 (74.19%) | 32 (25.81%) | - | - | 66 (34%) | - | 61 (92.42%) | - | 5 (7.58%) | - | - |
| Gu | 884 | 864 (97%) | 40 (4.63%) | 250 (28.94%) | - | 219 (25.35%) | - | - | 20 (2%) | 0 (0.00%) | 14 (70.00%) | - | 6 (30.00%) | - | - |
| Zhou, He | - | NA (NA%) | - | - | - | - | - | - | NA (NA%) | - | - | - | - | - | - |
| Sigel | 88 | 70 (79%) | - | - | 37 (52.86%) | - | - | 33 (47.14%) | 18 (20%) | - | - | 11 (61.11%) | - | - | 7 (38.89%) |
| Nguyen | 356 | 308 (86%) | - | - | 91 (29.55%) | - | - | 217 (70.45%) | 45 (12%) | - | - | 23 (51.11%) | - | - | 22 (48.89%) |
| de Souza | 8,443 | 7826 (92%) | - | - | 95 (1.21%) | - | 7571 (96.74%) | 160 (2.04%) | 617 (7%) | - | - | 47 (7.62%) | - | 560 (90.76%) | 10 (1.62%) |
| Mendy | 532 | 663 (124%) | - | - | 160 (24.13%) | - | - | 503 (75.87%) | 26 (4%) | - | - | 10 (38.46%) | - | - | 16 (61.54%) |
| Shi, Resurreccion | 256 | 210 (82%) | - | - | 128 (60.95%) | - | - | 82 (39.05%) | 46 (17%) | - | - | 26 (56.52%) | - | - | 20 (43.48%) |
| Xie | 619 | 591 (95%) | - | - | 43 (7.28%) | - | - | 548 (92.72%) | 28 (4%) | - | - | 8 (28.57%) | - | - | 20 (71.43%) |
| Fox | 54 | 35 (64%) | 1 (2.86%) | 4 (11.43%) | - | 18 (51.43%) | - | 12 (34.29%) | 19 (35%) | 0 (0.00%) | 2 (10.53%) | - | 12 (63.16%) | - | 5 (26.32%) |
| Zhang, Cao | 289 | 240 (83%) | 10 (4.17%) | 6 (2.50%) | - | - | - | 224 (93.33%) | 49 (16%) | 4 (8.16%) | 8 (16.33%) | - | - | - | 37 (75.51%) |
| Gupta | 496 | 255 (51%) | - | - | 15 (5.88%) | - | 80 (31.37%) | 160 (62.75%) | 241 (48%) | - | - | 21 (8.71%) | 77 (31.95%) | - | 143 (59.34%) |
| Soares | 1,152 | 696 (60%) | 38 (5.46%) | - | - | - | 658 (94.54%) | - | 456 (39%) | 39 (8.55%) | - | - | - | 417 (91.45%) | - |
| Thompson | 470 | 301 (64%) | 39 (12.96%) | 79 (26.25%) | - | 183 (60.80%) | - | - | 169 (35%) | 27 (15.98%) | 49 (28.99%) | - | 93 (55.03%) | - | - |
| Bernaola | 1,645 | 1382 (84%) | 35 (2.53%) | 146 (10.56%) | - | 1201 (86.90%) | - | - | 263 (15%) | 6 (2.28%) | 33 (12.55%) | - | 218 (82.89%) | - | - |
| Islam | 654 | 631 (96%) | 103 (16.32%) | - | - | - | - | 507 (80.35%) | 23 (3%) | 3 (13.04%) | - | - | - | - | - |
| Philipose | 466 | 267 (57%) | 19 (7.12%) | 204 (76.40%) | - | 44 (16.48%) | - | - | 199 (42%) | 9 (4.52%) | 137 (68.84%) | - | 33 (16.58%) | - | 20 (10.05%) |
| Fillmore | 1,794 | 1566 (87%) | 408 (26.05%) | 758 (48.40%) | - | 279 (17.82%) | - | 98 (6.26%) | 228 (12%) | 44 (19.30%) | 141 (61.84%) | - | 43 (18.86%) | - | 23 (10.09%) |
| Pan | 3,536 | 3302 (93%) | - | - | 862 (26.11%) | - | - | 2440 (73.89%) | 234 (6%) | - | - | 82 (35.04%) | - | - | 152 (64.96%) |
| Zhao, Chen | 474 | 398 (83%) | 87 (21.86%) | - | - | - | - | 311 (78.14%) | 82 (17%) | 36 (43.90%) | - | - | - | - | 46 (56.10%) |
| Holman | 10,989 | NA (NA%) | - | - | - | - | - | - | 10989 (100%) | 609 (5.54%) | 4684 (42.62%) | - | 5386 (49.01%) | - | 310 (2.82%) |
| Chand | 300 | 143 (47%) | 23 (16.08%) | - | - | - | - | 120 (83.92%) | 157 (52%) | 44 (28.03%) | - | - | - | - | 113 (71.97%) |
| Oliveira | 131 | 105 (80%) | - | - | 16 (15.24%) | - | 83 (79.05%) | 6 (5.71%) | 26 (19%) | - | - | 7 (26.92%) | - | 17 (65.38%) | - |
| Vilar-Garcia | 328,892 | 316605 (96%) | 71215 (22.49%) | - | - | - | - | 245390 (77.51%) | 12287 (3%) | 3103 (25.25%) | - | - | - | - | 9184 (74.75%) |
| Ibarra-Nava | 416,546 | 370038 (88%) | 27001 (7.30%) | - | - | - | - | 343037 (92.70%) | 46508 (11%) | 3817 (8.21%) | - | - | - | - | 42691 (91.79%) |
| Rubio-Rivas | 186 | 147 (79%) | 7 (4.76%) | 32 (21.77%) | - | 108 (73.47%) | - | - | 39 (20%) | 1 (2.56%) | 6 (15.38%) | - | 32 (82.05%) | - | - |
| Ren | 432 | 289 (66%) | 25 (8.65%) | - | - | 264 (91.35%) | - | - | 143 (33%) | 18 (12.59%) | - | 125 (87.41%) | - | - | - |
| Ullah | 212 | 158 (74%) | 22 (13.92%) | 67 (42.41%) | - | 63 (39.87%) | - | 6 (3.80%) | 54 (25%) | 2 (3.70%) | 35 (64.81%) | - | 17 (31.48%) | - | 0 (0.00%) |
| Dashti | 3,401 | 2892 (85%) | 190 (6.57%) | 689 (23.82%) | - | 1756 (60.72%) | - | 257 (8.89%) | 509 (14%) | 20 (3.93%) | 171 (33.60%) | - | 164 (32.22%) | - | 154 (30.26%) |
| Nicholson | 1,040 | 829 (79%) | 70 (8.44%) | 163 (19.66%) | - | 320 (38.60%) | - | 276 (33.29%) | 211 (20%) | 16 (7.58%) | 68 (32.23%) | - | 65 (30.81%) | - | 62 (29.38%) |
| Kalan | 193 | 188 (97%) | 14 (7.45%) | - | - | 162 (86.17%) | - | 12 (6.38%) | 5 (2%) | 0 (0.00%) | - | - | 2 (40.00%) | - | 3 (60.00%) |
| Incerti | 13,658 | 11495 (84%) | 785 (6.83%) | 2450 (21.31%) | - | 5450 (47.41%) | 2810 (24.45%) | - | 2163 (15%) | 81 (3.74%) | 642 (29.68%) | - | 757 (35.00%) | 683 (31.58%) | - |
| Ioannou | 10,131 | 9033 (89%) | 1054 (11.67%) | 3549 (39.29%) | - | 3339 (36.96%) | - | 1091 (12.08%) | 1098 (10%) | 81 (7.38%) | 528 (48.09%) | - | 305 (27.78%) | - | 184 (16.76%) |
| Lamure | 89 | 59 (66%) | 4 (6.78%) | 16 (27.12%) | - | 31 (52.54%) | - | 8 (13.56%) | 30 (33%) | 1 (3.33%) | 13 (43.33%) | - | 12 (40.00%) | - | 4 (13.33%) |
| Yadaw | 5,051 | 4635 (91%) | 162 (3.50%) | 709 (15.30%) | - | 2394 (51.65%) | - | 1370 (29.56%) | 416 (8%) | 17 (4.09%) | 105 (25.24%) | - | 196 (47.12%) | - | 98 (23.56%) |
| Zinellu | 105 | 77 (73%) | 24 (31.17%) | 8 (10.39%) | - | 45 (58.44%) | - | - | 28 (26%) | 8 (28.57%) | 3 (10.71%) | - | 17 (60.71%) | - | - |
| Zhang, Li | 399 | NA (NA%) | - | - | - | - | - | - | 399 (100%) | 60 (15.04%) | 186 (46.62%) | - | 148 (37.09%) | - | - |
| Wang, Shu | 59 | 18 (30%) | - | - | 0 (0.00%) | - | - | 18 (100.00%) | 41 (69%) | - | - | 9 (21.95%) | - | - | 32 (78.05%) |
| Wang, Zheutlin | 2,448 | 1706 (69%) | 57 (3.34%) | 315 (18.46%) | - | 954 (55.92%) | - | 380 (22.27%) | 742 (30%) | 25 (3.37%) | 197 (26.55%) | - | 354 (47.71%) | - | 166 (22.37%) |
| Torres-Macho | 1,968 | 1643 (83%) | - | - | 335 (20.39%) | - | - | 1308 (79.61%) | 325 (16%) | - | - | 125 (38.46%) | - | - | 200 (61.54%) |
| Raines | 440 | 408 (92%) | - | - | 222 (54.41%) | 186 (45.59%) | - | - | 32 (7%) | - | - | 28 (87.50%) | 4 (12.50%) | - | - |
| Parra-Bracamonte | 331,298 | 292988 (88%) | - | - | 21269 (7.26%) | - | - | 271719 (92.74%) | 38310 (11%) | - | - | 3215 (8.39%) | - | - | 35095 (91.61%) |
| Li, Long, Zhang | 954 | 876 (91%) | - | - | 48 (5.48%) | 828 (94.52%) | - | - | 78 (8%) | - | - | 8 (10.26%) | 70 (89.74%) | - | - |
| Bellan | 407 | 285 (70%) | 30 (10.53%) | - | - | - | 191 (67.02%) | 64 (22.46%) | 122 (29%) | 24 (19.67%) | - | - | - | 67 (54.92%) | 31 (25.41%) |
| Alharthy | 352 | 239 (67%) | 109 (45.61%) | - | - | - | 130 (54.39%) | - | 113 (32%) | 65 (57.52%) | - | - | - | 48 (42.48%) | - |
| Adrish | 1,173 | 783 (66%) | - | - | 205 (26.18%) | 578 (73.82%) | - | - | 390 (33%) | - | - | 131 (33.59%) | 259 (66.41%) | - | - |
| Hoertel, Sanchez, Vernet | 12,210 | 12210 (100%) | 898 (7.35%) | - | - | - | - | 9904 (81.11%) | 1408 (11%) | 204 (14.49%) | - | - | - | - | 1204 (85.51%) |
| Sourij | 238 | 180 (75%) | 4 (2.22%) | 26 (14.44%) | - | 150 (83.33%) | - | - | 58 (24%) | 0 (0.00%) | 12 (20.69%) | - | 46 (79.31%) | - | - |
| Simons | 446 | 318 (71%) | 30 (9.43%) | 109 (34.28%) | - | 179 (56.29%) | - | - | 128 (28%) | 12 (9.38%) | 63 (49.22%) | - | 53 (41.41%) | - | - |
| Bisso | 168 | 122 (72%) | 13 (10.66%) | - | - | - | - | 109 (89.34%) | 46 (27%) | 5 (10.87%) | - | - | - | - | 39 (84.78%) |
| Caliskan | 565 | 490 (86%) | 97 (19.80%) | 48 (9.80%) | - | 345 (70.41%) | - | - | 75 (13%) | 21 (28.00%) | 31 (41.33%) | - | 23 (30.67%) | - | - |
| Ebrahimian | 226 | 128 (56%) | - | - | 9 (7.03%) | - | 119 (92.97%) | - | 98 (43%) | - | - | 15 (15.31%) | - | 83 (84.69%) | - |
| Estiri | 16,709 | 15879 (95%) | - | - | 1304 (8.21%) | - | - | 14575 (91.79%) | 830 (4%) | - | - | 137 (16.51%) | - | - | 693 (83.49%) |
| Ferrari | 198 | 165 (83%) | - | - | 27 (16.36%) | 138 (83.64%) | - | - | 33 (16%) | - | - | 14 (42.42%) | 19 (57.58%) | - | - |
| Ho, Narasimhan | 4,909 | 3553 (72%) | 163 (4.59%) | 743 (20.91%) | - | 2647 (74.50%) | - | - | 1356 (27%) | 54 (3.98%) | 319 (23.53%) | - | 983 (72.49%) | - | - |
| Mansour | 111 | 83 (74%) | 5 (6.02%) | - | - | - | - | 78 (93.98%) | 28 (25%) | 6 (21.43%) | - | - | - | - | 22 (78.57%) |
| Park | 2,269 | 2105 (92%) | 92 (4.37%) | - | - | - | - | 2013 (95.63%) | 164 (7%) | 2 (1.22%) | - | - | - | - | 162 (98.78%) |
| Quan | 2,038 | 1587 (77%) | - | - | 589 (37.11%) | - | - | 998 (62.89%) | 442 (21%) | - | - | 218 (49.32%) | - | - | 224 (50.68%) |
| Saurabh | 911 | 870 (95%) | 70 (8.05%) | 4 (0.46%) | - | 796 (91.49%) | - | - | 41 (4%) | 4 (9.76%) | 2 (4.88%) | - | 35 (85.37%) | - | - |
| Strangfeld | 3,729 | 3339 (89%) | - | - | 664 (19.89%) | 2190 (65.59%) | - | 485 (14.53%) | 390 (10%) | - | - | 112 (28.72%) | 198 (50.77%) | - | 80 (20.51%) |
| Nezhadmoghadam | 13,367 | 7757 (58%) | 686 (8.84%) | - | - | - | - | 7071 (91.16%) | 5610 (41%) | 565 (10.07%) | - | - | - | - | 5045 (89.93%) |
| Nuno | 4,730 | 4401 (93%) | 427 (9.70%) | - | - | - | - | 3974 (90.30%) | 329 (6%) | 53 (16.11%) | - | - | - | - | 276 (83.89%) |

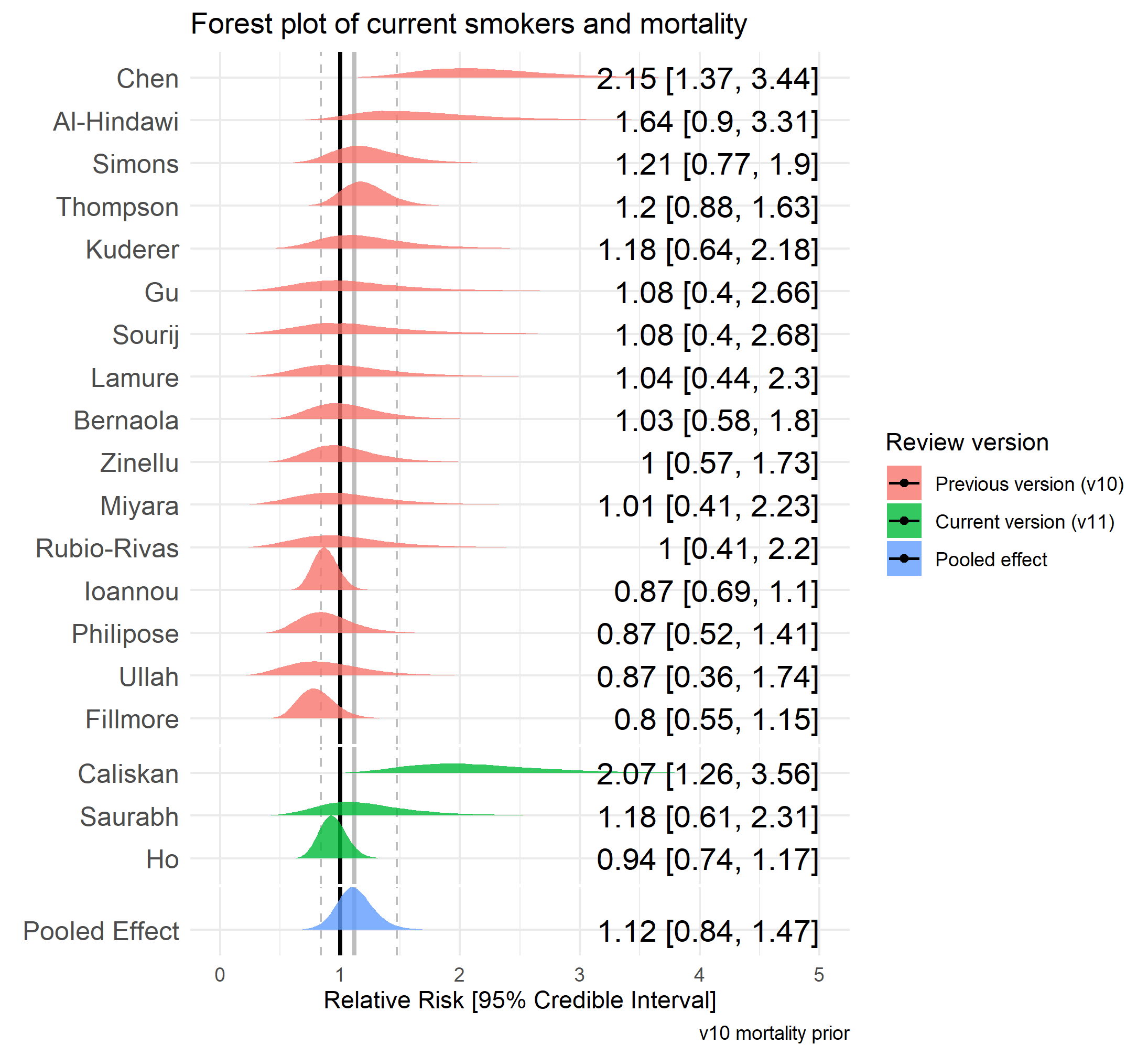


Figure 9. Forest plot for the risk of mortality in current vs. never smokers. The prior from the previous review version (v10) was RR = 1.05.

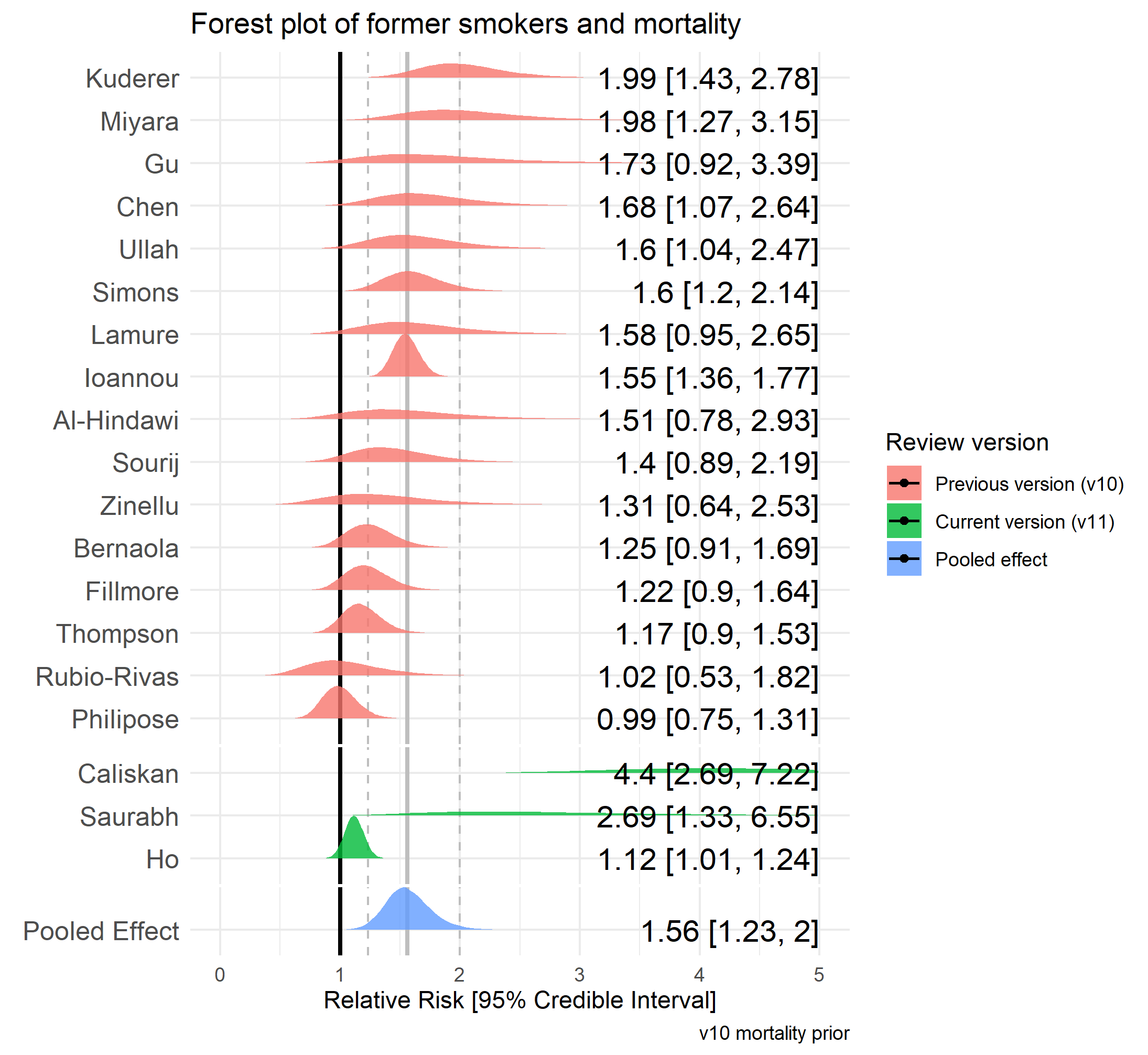


Figure 10. Forest plot for the risk of mortality in former smokers vs. never smokers. The prior from the previous version (v10) was RR = 1.40.

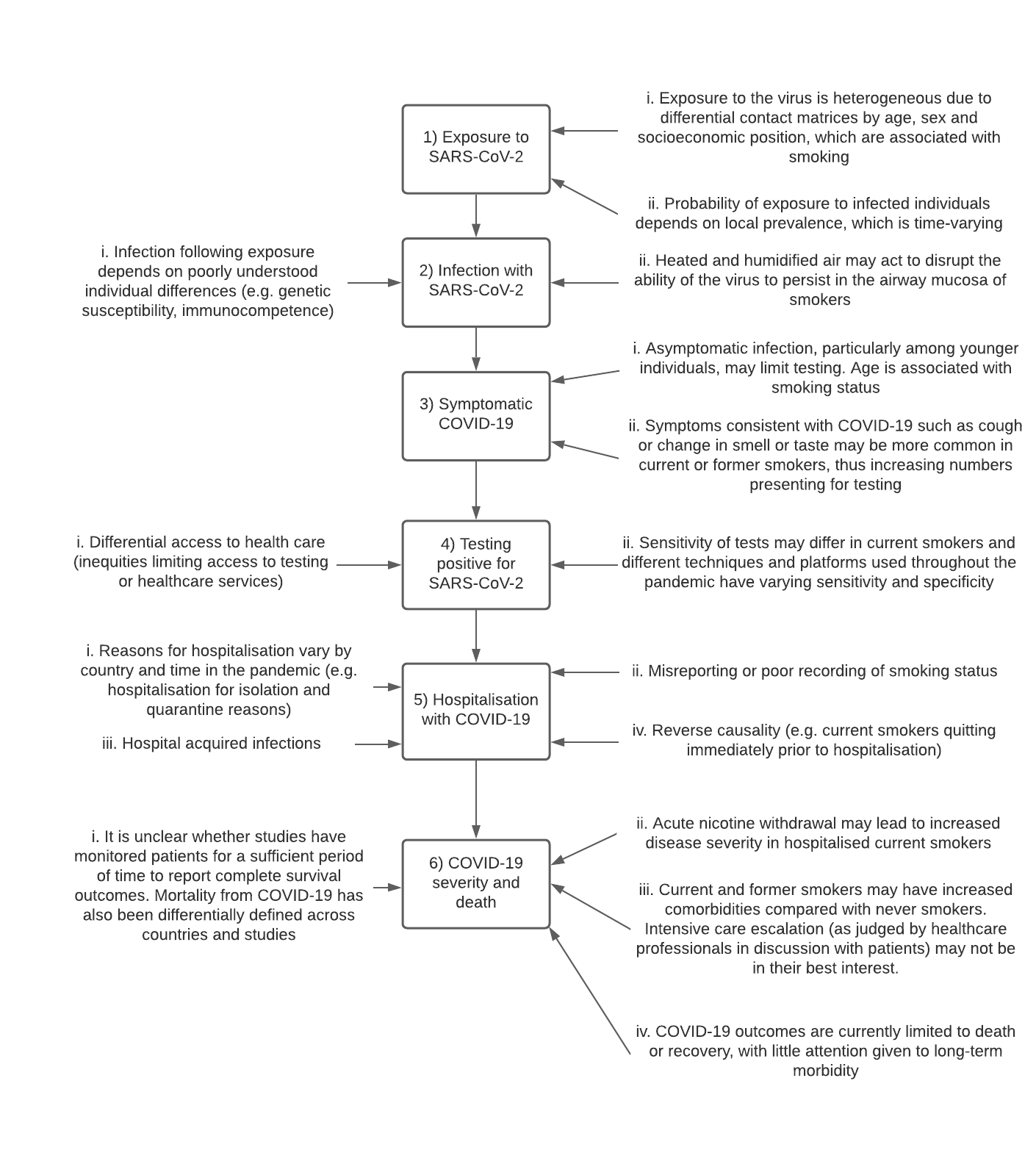
## Discussion

This living rapid review found uncertainty in the majority of 405 studies arising from the recording of smoking status. Notwithstanding this uncertainty, compared with overall adult national prevalence estimates, recorded current smoking rates in most studies were lower than expected. In a subset of good and fair quality studies (n = 30), current but not former smokers had a reduced risk of testing positive for SARS-CoV-2 but current smokers appeared somewhat more likely to present for testing and/or receive a test. Data for current smokers on the risk of hospitalisation, disease severity and mortality were inconclusive, and favoured there being no important associations with hospitalisation and mortality and a small but important increase in the risk of severe disease. Former smokers were at increased risk of hospitalisation, disease severity and mortality compared with never smokers.

### Issues complicating interpretation

Interpretation of results from studies conducted during the first phase of the SARS-CoV-2 pandemic is complicated by several factors (see [Figure 11](#fig-11)):

1. *Exposure to SARS-CoV-2*  
   1. Exposure to the SARS-CoV-2 virus is heterogeneous with different subgroups at heightened risk of infection at different stages of the pandemic, at least partly due to differential contact matrices by age, sex and socioeconomic position (CMMID COVID-19 working group et al., 2020), which are associated with smoking status.  
   2. The probability of viral exposure depends largely on local prevalence, which varies over time. This likely introduces bias in studies assessing the rate of infection by smoking status conducted in the early phase of the pandemic.
2. *Infection with SARS-CoV-2*  
   1. Infection following viral exposure depends on individual differences in, for example, genetic susceptibility or immunocompetence, which are poorly understood at present and may be confounded with smoking. For example, the household secondary attack rate for COVID-19 is estimated at 17% (Fung et al., 2020).  
   2. Heated and humidified air may act to disrupt the ability of the virus to persist in the airway mucosa of smokers. There is some evidence that transient localised hyperthermia can inhibit replication of rhinoviruses, a non-enveloped virus that causes the common cold (Conti et al., 1999). However, as SARS-CoV-2 is an enveloped virus (Schoeman and Fielding, 2019), it is unclear whether a similar protective effect against viral replication or invasion by heated and humidified air may occur.
3. *Symptomatic COVID-19*  
   1. An estimated 20% (95% CI = 17-25%) of COVID-19 cases are asymptomatic (Buitrago-Garcia et al., 2020), with some evidence suggesting younger people are more likely to be asymptomatic (Kronbichler et al., 2020). Testing is hence likely limited in some subgroups, with the potential for these groups to include an overrepresentation of current smokers.  
   2. On the other hand, current and former smokers may be more likely to meet local criteria for community testing due to increased prevalence of symptoms consistent with SARS-CoV-2 infection, such as cough, increased sputum production or altered sense of smell or taste (Hopkinson et al., 2020). Evidence from a small number of studies indicates that current smokers may be more likely to present for testing, hence increasing the denominator in comparisons with never smokers and potentially inflating the rate of negative tests in current smokers. Infection positivity rates estimated among random samples are more informative. We identified one population study conducted in Hungary reporting on seroprevalence and smoking status (Merkely et al., 2020); however, the response rate was only 58.8% and the current smoking rate was 10 percentage points below national prevalence estimates, which raises some doubt about representativeness of the final sample. Similarly, two further representative population surveys (Carrat et al., 2020; Richard et al., 2020) reported a current smoking rate of more than 10 percentage points below national prevalence (12% vs. 25% and 15% vs. 27% daily smoking prevalence, respectively) (Andler, 2019; statistique, 2020).
4. *Testing positive for SARS-CoV-2*  
   1. Smokers with COVID-19 may be less likely to receive a SARS-CoV-2 test or present to hospital due to lack of access to healthcare and may be more likely to die in the community from sudden complications (i.e. self-selection bias) and thus not be recorded (Brown, 2020).  
   2. Diagnostic criteria for SARS-CoV-2 infection and COVID-19 have changed during the course of the pandemic (Organisation, n.d.). It was not possible to extract details on the specific RT-PCR or antibody-based techniques or platforms used across the included studies due to reporting gaps. Different platforms have varying sensitivity and specificity to detect SARS-CoV-2 infection. In addition, testing for acute infection requires swabbing of the mucosal epithelium, which may be disrupted in current smokers, potentially altering the sensitivity of assays (Lusignan et al., 2020).
5. *Hospitalisation with COVID-19*  
   1. Reasons for hospitalisation vary by country and time in the pandemic. For example, early cases may have been hospitalised for isolation and quarantine reasons and not due to medical necessity. It is plausible this may have skewed early data towards less severe cases. In addition, the observed association between former smoking and greater disease severity may be explained by collider bias (Griffith et al., 2020), where conditioning on a collider (e.g. testing or hospitalisation) by design or analysis may introduce a spurious association between current or former smoking (a potential cause of testing or hospitalisation) and SARS-CoV-2 infection/adverse outcomes from COVID-19 (potentially exacerbated by smoking) (Murray, 2020).  
   2. The majority of included studies relied on EHRs as the source of information on smoking status. Research shows large discrepancies between EHRs and actual behaviour (Polubriaginof et al., 2018). Known failings of EHRs include implausible longitudinal changes, such as former smokers being recorded as never smokers at subsequent hospital visits (Polubriaginof et al., 2018). Misreporting on the part of the patient (perhaps due to perceived stigma) has also been observed, with biochemical measures showing higher rates of smoking compared with self-report in hospitalised patients in the US (Benowitz et al., 2009). It is hence possible that under-reporting of current and former smoking status in hospitals occurred across the included studies.  
   3. The majority of included studies were conducted in hospital settings. It is plausible that a non-trivial proportion of patients were infected with SARS-CoV-2 while being an inpatient for a different medical reason. If so, this may have biased the hospitalised populations towards older and more frail groups, who are less likely to be smokers (Mangera et al., 2017).  
   4. Individuals with severe COVID-19 symptoms may have stopped smoking immediately before admission to hospital and may therefore not have been recorded as current smokers (i.e. reverse causality).
6. *COVID-19 disease severity and death*  
   1. Given lack of knowledge of the disease progression and long-term outcomes of COVID-19, it is unclear whether studies conducted thus far in the pandemic have monitored patients for a sufficient time period to report complete survival outcomes or whether they are subject to early censoring. Adding to this, COVID-19 related mortality has been differentially defined across countries and epidemic phases. For example, in some UK reporting, death within 28 days of a COVID-19 diagnosis is required for attributing the cause of death to the virus. However, according to the UK Office for National Statistics, COVID-19 deaths are recorded only if this was stated on the death certificate.  
   2. If there is a protective effect of nicotine on COVID-19 disease outcomes, abrupt nicotine withdrawal upon hospitalisation may lead to worse disease outcomes including death (Farsalinos, Niaura, et al., 2020).  
   3. During periods of heightened demand of limited healthcare resources, current and former smokers with extensive comorbidities may have reduced priority for intensive care admission, thus leading to higher in-hospital mortality.  
   4. COVID-19 outcomes are currently limited to in-hospital death or survival to discharge. This binary outcome does not capture potential long-term morbidity attributed to COVID-19, such as stroke, amputation or acute cardiac events, which may be moderated by smoking status.



*Figure 11.* A schematic of some of the interpretation issues for the association of smoking status and COVID-19 infection, hospitalisation, disease severity and mortality. Numbers refer to the issues listed in-text in the above section. Issues presented on the right-hand side relate directly to smoking status.

### Limitations

This living rapid evidence review was limited by having a single reviewer extracting data with a second independently verifying the data extracted to minimise errors, restricting the search to one electronic database and one pre-print server and by not including at least three large population surveys due to their reliance on self-reported suspected or confirmed SARS-CoV-2 infection (which means they do not meet our eligibility criteria) (Bowyer et al., 2020; Hopkinson et al., 2020; Jackson et al., 2020). We also did not include a large, UK-based, representative seroprevalence study (Ward et al., 2020) in our meta-analyses as the odds of testing positive in former smokers was not reported. However, the odds of infection for current smokers (OR = 0.64, 95% CI = 0.58-0.71) was in concordance with the pooled estimate in our meta-analysis. Population surveys – particularly with linked data on confirmed infection or antibodies – will be included in future review versions to help mitigate some of the limitations of healthcare based observational studies. The comparisons of current and former smoking prevalence in the included studies with national prevalence estimates did not adjust observed prevalence for the demographic profile of those tested/admitted to hospital. Other reviews focused on this comparison have applied adjustments for sex and age, and continue to find lower than expected prevalence – notwithstanding the issues complicating interpretation described above (Farsalinos, Barbouni, et al., 2020).

### Implications for research, policy and practice

Further scientific research is needed to resolve the mixed findings summarised in our review. First, clinical trials of the posited therapeutic effect of nicotine could have important implications both for smokers and for improved understanding of how the SARS-CoV-2 virus causes disease in humans. Such trials should focus on medicinal nicotine (as smoked tobacco is a dirty delivery mechanism that could mask beneficial effects) and potentially differentiate between different modes of delivery (i.e. inhaled vs. ingested) since this can affect pharmacokinetics (Shahab et al., 2013) and potential therapeutic effects. A second research priority would be a large, representative (randomly sampled) population survey with a validated assessment of smoking status which distinguishes between recent and long-term ex-smokers – ideally biochemically verified – and assesses seroprevalence and links to health records.

In the meantime, public-facing messages about the possible protective effect of smoking or nicotine are premature. In our view, until there is further research, the quality of the evidence does not justify the huge risk associated with a message likely to reach millions of people that a lethal activity, such as smoking, may protect against COVID-19. It continues to be appropriate to recommend smoking cessation and emphasise the role of alternative nicotine products to support smokers to stop as part of public health efforts during COVID-19. At the very least, smoking cessation reduces acute risks from cardiovascular disease and could reduce demands on the healthcare system (Stead et al., 2013). GPs and other healthcare providers can play a crucial role – brief, high-quality and free online training is available at [National Centre for Smoking Cessation and Training](https://www.ncsct.co.uk/).

## Conclusion

Across 405 studies, recorded current but not past smoking prevalence was generally lower than national prevalence estimates. Current smokers were at reduced risk of testing positive for SARS-CoV-2 and former smokers were at increased risk of hospitalisation, disease severity and mortality compared with never smokers.

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## Declaration of conflicts of interest

DS and OP have no conflicts of interest to declare. LS has received a research grant and honoraria for a talk and travel expenses from manufacturers of smoking cessation medications (Pfizer and Johnson & Johnson). JB has received unrestricted research funding to study smoking cessation from companies who manufacture smoking cessation medications. All authors declare no financial links with tobacco companies or e-cigarette manufacturers or their representatives.

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## Review versions

The most up-to-date review version is available [here](https://www.qeios.com/read/latest-UJR2AW)

### Previous review versions

* [Version 1](https://doi.org/10.32388/UJR2AW)
* [Version 2](https://doi.org/10.32388/UJR2AW.3)
* [Version 3](https://doi.org/10.32388/UJR2AW.4)
* [Version 4](https://doi.org/10.32388/UJR2AW.5)
* [Version 5](https://doi.org/10.32388/UJR2AW.6)
* [Version 6](https://doi.org/10.32388/UJR2AW.7)
* [Version 7](https://doi.org/10.1111/add.15276)
* [Version 8](https://doi.org/10.32388/UJR2AW.9)
* [Version 9](https://doi.org/10.32388/UJR2AW.10)
* [Version 10](https://doi.org/10.32388/UJR2AW.11)

## Data availability

All data contributing to the current and future review versions are available [here](https://doi.org/10.6084/m9.figshare.12756020)

All code required to reproduce the current and future analyses are available [here](https://doi.org/10.5281/zenodo.4002046)

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