Use of Traditional, Complementary and Integrative Medicine During the COVID-19 Pandemic: A Systematic Review and Meta-Analysis

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Background: Traditional, Complementary and Integrative Medicine (TCIM) has been reported to use for symptom management of coronavirus disease 2019 (COVID-19). The objective of this review was to identify the overall usage prevalence of TCIM interventions for COVID-19.

Methods: Surveys on the general population and observational studies on the COVID-19 patient chart review were located in the search of PubMed, EMBASE and Cochrane Central Register of Controlled Trials databases in September 2021. Observational studies, such as cross-sectional studies, surveys, cohort studies and hospital-based patient case reviews, published in any language, reporting the usage of TCIM in the patients with COVID-19 or the general population during the COVID-19 pandemic were included in this review. Data screening and extraction were performed independently by two reviewers. The reporting quality of the included studies was assessed with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) statement. To conduct a meta-analysis of the usage prevalence of various TCIM interventions, the effect size of the proportion for each intervention was calculated with the inverse variance method. The main outcome was usage prevalence of TCIM interventions among patients with COVID-19 or the general population during the COVID-19 pandemic.

Results: A total of 62 studies were included in this review. The overall TCIM usage prevalence was estimated to be 0.64 (95% CI 0.54–0.73). The overall prevalence did not differ between the population-based survey (0.65, 95% CI 0.48–0.81) and the hospital-based patient case review (0.63, 95% CI 0.52–0.73). Statistical heterogeneity and comparatively low quality in reporting were observed, which should be cautiously considered when interpreting the results.

Conclusion: Various TCIM interventions were reported to be used with comparatively high frequency. Future international collaborative research might overcome the main limitation of this study, i.e., the heterogeneity of the included data.
INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an acute upper respiratory tract infection which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) newly identified in 2019 (1). Since the World Health Organization (WHO) declared a pandemic in March 2020, several variants have been appearing, and the pandemic continues. Treatment strategies have been gradually established based on accumulated clinical evidence for the acute treatment of COVID-19. In addition to the basic management principle that prioritizes the prevention of complications such as thrombosis, along with adequate oxygenation and hemodynamic support, antiviral agents such as remdesivir, antibody therapy and drug treatments such as dexamethasone are being used in clinical practice (2, 3). However, since knowledge about this disease is still incomplete and new mutated viruses continue to emerge, uncertainty is rising about the basis of treatment from a medical point of view. Additionally, symptoms that persist after the acute manifestation of COVID-19, called long COVID-19, should not be overlooked (4). Patients with severe clinical presentation of COVID-19 are likely to experience long-term respiratory system dysfunction or sequelae of complications, but the real problem is that a significant number of mild infections or asymptomatic COVID-19 patients have been presenting with long COVID symptoms for a long time (5). In addition, long COVID patients complain of symptoms of various spectra, such as fatigue, cognitive decline, respiratory difficulty, joint pain, loss of taste/smell and hair loss (4). From this perspective, a multidisciplinary approach is required for the prevention and management of COVID-19 from the acute stage through long COVID (3, 4).

Since the outbreak of COVID, Traditional, Complementary and Alternative Medicine (TCIM) has been adopted as an alternative strategy for the prevention and treatment of COVID-19 as the entire medical capacity of a country is mobilized at a national level to promote immunity and to protect against viral infection at both the national and individual levels. Clinical practice guidelines (CPGs) or therapeutic protocols for the management of COVID-19 have been published in various fields of TCIM, such as Traditional Chinese Medicine (TCM) (6, 7), Korean Medicine (8), and Ayurveda (9). In addition, according to a survey conducted on patients in quarantine in India, 25% of patients responded that they had experiences with TCIM-related products or home remedies (10). Judging from these data and recently published bibliometric studies (11–13), TCIM interventions are being used quite actively for the management of COVID-19 worldwide, although usage status might variations across countries might depending on the country’s medical system. Considering each country’s situation, reviewing the utilization prevalence of overall TCIM interventions by country and the utilization status of each intervention may provide insight into the impact of TCIM on global health in the COVID-19 pandemic period.

Therefore, we investigated the prevalence of TCIM use to prevent and treat COVID-19 around the world, identified the most frequently used specific TCIM treatments per country and suggested the overall proportion of CAM use worldwide to treat COVID-19 using systematic review methods.

METHODS

This was a systematic review (SR) for observational studies that assessed the usage status of TCIM interventions worldwide. We located surveys of the general population to assess the usage status of TCIM interventions and hospital-based COVID patients’ case review studies through electronic database searches. Overall and individual usage prevalence of diverse TCIM interventions were estimated through meta-analysis. This review protocol was registered in PROSPERO (https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=278452).

Review questions
1. How frequent are TCIM interventions used in the general population and COVID-19 patients worldwide?
2. How much is the difference in usage prevalence between different TCIM interventions?

Inclusion Criteria

Population

We did not impose any limitations on the population if the study assessed the usage prevalence of TCIM interventions during the COVID-19 pandemic. Both healthy individuals and COVID-19 patients were included in this review.

Intervention

In this review, we allowed any type of TCIM intervention based on the definition of the U.S. National Center for Complementary and Integrative Health (14). Interventions included nutrition (e.g., special diets, dietary supplements, herbs, probiotics, microbial-based therapies and botanical drugs), psychological treatment (e.g., meditation, hypnosis, music therapies, relaxation therapies, qigong, hypnotherapy, Feldenkrais method, Alexander technique, Pilates, Rolfing Structural Integration, and Trager psychophysical integration), physical therapies (e.g., acupuncture, massage and spinal manipulation), combinations such as psychological and physical methods (e.g., yoga, tai chi, dance therapies and some forms of art therapy), psychological and nutritional
combinations (e.g., mindful eating), chiropractic and osteopathic manipulation or traditional medicine (e.g., Ayurvedic Medicine, Traditional Chinese Medicine, homeopathy, naturopathy and functional medicine).

**Comparator**
We included observational studies, so most studies were not expected to have comparator groups. However, any kind of comparator intervention was allowed.

**Outcome**
Usage prevalence of TCIM interventions among patients with COVID-19 or the general population during the COVID-19 pandemic was included.

**Design**
Observational studies, such as cross-sectional studies, surveys, cohort studies and hospital-based patient case reviews, were included in this review.

**Literature Search and Data Extraction**
Core databases, including PubMed, EMBASE and Cochrane Central Register of Controlled Trials (CENTRAL), were searched in September 2021. The search strategy was developed with COVID-19-related terms and keywords for TCIM for each database, and the PubMed search strategy was listed in the Supplementary Table 1.

Screening and selection of the studies for inclusion in this review were conducted manually by two authors (THK and SRI) independently. Any disagreement was arbitrated by the third author (JWK). EndNote 20 (Philadelphia, PA) was used for the screening stage of this review. We uploaded a list of located publications and conducted a screening process with this software. The predefined extraction form included data regarding the type of study, population (healthy individuals or COVID-19 patients), type of TCIM interventions, country, time point for acquiring study data, information on the study population (age and sex), purpose of the usage of TCIM interventions and numbers of patients in hospital-based case reviews and survey respondents (numbers in the total population and those who used TCIM interventions).

**Quality Assessment**
For this review, observational patient case reviews for COVID-19 patients and surveys for the general population or COVID-19 patients were included. Therefore, items from the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) statement were selectively used for assessing the reporting quality of the included studies. We evaluated appropriateness of reporting for items including title and abstract, objectives, participants, variable, data sources, bias, study size, statistical methods, number of participants in each stage of the result section, result analysis, key results, limitations and funding (including conflicts of interest). Each item was evaluated with “A” if all the necessary points were appropriately suggested in the publication of the study and “T” if not. Two authors (THK and SRI) independently assessed STROBE items and discussed them until they reached agreement.

**Data Synthesis**
To conduct a meta-analysis of the usage prevalence of various TCIM interventions, the effect size of the proportion for each intervention was calculated with the inverse variance method. When calculating the estimated proportion of TCIM usage, we used double arcsine transformation and back transformation methods, because some studies showed extreme proportions, such as close 0 or 1, which meant that the dataset was skewed and not normally distributed (15). A random effects model was adopted to calculate summary effect estimates of usage prevalence, because there could be potential clinical heterogeneity in the study methods and study population. Based on the study types (survey vs. hospital-based COVID patient case review), intervention types, study population (general population vs. hospitalized patients) and the country where the intervention was used, subgroup analysis was conducted. $I^2$ statistics were used to assess statistical heterogeneity. In the subgroup analysis, the $R^2$ index was calculated to quantify the amount of variance or how much of the total variance in the meta-analysis could be explained by the suspicious effect modifier (16). Publication bias was assessed through visual evaluation of funnel plots and Egger's test. The package “meta” and the function “metaprop” in R (ver 4.0.2) were used for meta-analysis of proportions in this study. The overall usage prevalence of TCIM interventions in each country was presented in the form of a world map using the “ggplot2” package.

**RESULTS**

**Summary of the Included Studies**
From the electronic database search, a total of 62 studies were enrolled in this review (Figure 1) (10, 17–77). Thirty-nine studies were population-based surveys, and twenty-three studies were hospital-based COVID-19 patient case reviews. One study was a survey that included patient data from two regions, Hong Kong and mainland China, separately, so we analyzed the data separately (71). Twenty-two studies were conducted in China (27, 31–34, 37, 39, 40, 44, 47, 55, 62–65, 67, 69–73, 75–77), six in Saudi Arabia (18, 21–23, 25, 26), five in India (10, 41, 46, 60, 61), three in the United States (35, 42, 45) and three in Turkey (38, 49, 66), and these were the most frequent countries included in this review. Among the population-based survey studies, thirty-one were conducted through online surveys only (17, 18, 20, 22, 23, 25, 26, 28–31, 35, 42, 43, 45, 48–54, 57–62, 66, 68, 74), one was an in-person interview (56), three were telephone interviews (10, 21, 38), and two were both in-person and online surveys (19, 36). Among the included studies, usage status of the interventions, including TCM ($n = 22$) (27, 32–34, 37, 39, 40, 44, 47, 55, 63–65, 67, 69–73, 75–77), functional food (supplements) or herbs ($n = 20$) (17–24, 29, 36, 38, 43, 49–52, 57–59), mind-body practice or spiritual practice ($n = 9$) (28, 35, 42, 45, 48, 54, 60, 61, 74), Ayurveda ($n = 2$) (10, 41), homeopathy ($n = 1$) (46) and Ethiopian traditional medicine ($n = 1$) (56) was suggested. Only one study was conducted in 2021 (57). Most of the data for surveys or patient chart reviews were collected during 2020. In approximately half of the studies, TCIM interventions were used for prophylactic
purposes ($n = 28$) (17–20, 22, 23, 25, 26, 28, 31, 35, 36, 38, 41, 42, 45, 48–54, 59, 61, 62, 66, 74), and the other half were used for therapeutic purposes ($n = 27$) (21, 24, 27, 32–34, 37, 39, 40, 44, 46, 47, 55, 58, 63–65, 67, 69–73, 75–77) (Table 1).

**Reporting Quality of the Included Studies**

When assessing reporting quality with STROBE statement items, most studies did not appropriately address all the necessary contents in the publications. The most poorly reported items are variables (including effect modifiers and confounders), potential
| Study ID            | Type of study | Study population                        | Method for data acquisition                                                                 | Type of TCIM intervention             | Country         | Time points for data acquisition | Sex (male) | Sex (female) | Age (mean or median with SD or ranges, years) | Purpose of TCIM usage |
|---------------------|---------------|-----------------------------------------|---------------------------------------------------------------------------------------------|--------------------------------------|-----------------|-------------------------------|-------------|-------------|---------------------------------------------|-----------------------|
| Abdulateef et al.   | Survey        | Recovered patients                      | Online survey for patients recovered from COVID-19                                            | Dietary supplements                  | Iraq            | July 1st, 2020                | 190         | 238         | Median 33 (15–80)                          | Prophylactic           |
| Abdullah and Naif Al-Harbi | Survey          | General population who used herbal medicine and dietary supplements | Online survey for general population                                                        | Herbs and natural products          | Saudi Arabia   | May–Jul, 2020                 | 235         | 819         | Average 35.1 (18–70)                       | Prophylactic           |
| Ahmed et al.        | Survey        | General population                      | Online Survey or in-person interview on the recovered patients                                | Herbal food and dietary supplements  | Bangladesh      | Jun–Jul, 2020                 | 750         | 466         | Mean 30.77 (SD 12.1)                       | Prophylactic           |
| Al-Samydai et al.   | Survey        | General population                      | Online survey for general population                                                        | Herbs                                | Jordan          | Sep–Oct 2020                 | 128         | 159         | Not reported                              | Prophylactic           |
| Aldwile et al.      | Survey        | Recovered patients                      | Telephone survey interview on the recovered patients                                          | Herbs and dietary supplements       | Saudi Arabia   | Aug–Oct 2020                 | 418         | 320         | Average 36.5 (11.9)                       | Therapeutic            |
| Alfawaz et al.      | Survey        | General population                      | Online survey for general population                                                        | Dietary supplements                 | Saudi Arabia   | May–Jun 2020                 | 450         | 508         | Average 36.7 (13.8)                       | Prophylactic           |
| Alnajrany et al.    | Survey        | General population                      | Online survey for general population                                                        | Natural products                    | Saudi Arabia   | Mar–Aug 2020                 | 605         | 868         | Not reported                              | Prophylactic           |
| Alonso-Castro et al.| Survey        | General population with anxiety and depression in adults                                   | Not reported                                                                             | Herbal products                     | Mexico          | Mar–Jun 2020                 | 893         | 1,207        | Average 32.08 (13.57)                     | Therapeutic            |
| Alqahiani et al.    | Survey        | General population                      | Online survey for general population                                                        | Vitamins, herbs, and traditional medicine | Saudi Arabia   | Nov 2020                     | 3,278       | 2204        | Not reported                              | Prophylactic           |
| Alyami et al.       | Survey        | General population                      | Online survey for general population                                                        | Herbal product and food supplements | Saudi Arabia   | May–Jun 2020                 | 2,258       | 3,000        | Not reported                              | Prophylactic           |
| An et al.           | Cross sectional study | Convalescents of COVID-19              | Hospital-based COVID-19 patient case reviews                                                | TCM decoctions                      | China           | Feb–May 2020                  | Not reported | Not reported | Not reported                              | Therapeutic            |
| Ashiq et al.        | Survey        | General population                      | Online survey for general population                                                        | Exercise, yoga or walk              | Pakistan        | Mar–Apr 2020                 | 147         | 169         | Not reported                              | Prophylactic           |
| Azhar et al.        | Survey        | General population                      | Online survey for general population                                                        | Herbal medication and dietary supplements | Pakistan     | 2020                        | 91          | 179         | Not reported                              | Not reported           |
| Barnes et al.       | Survey        | Patients with irritable bowel syndrome  | Online survey for irritable bowel syndrome                                                   | Exercise, probiotics, meditation, mindfulness, acupuncture, prayer, TCM and Homeopathy | Australia     | May–Jul 2020                 | 101         | 143         | Median 46 (IQR 35–57)                     | Prophylactic or therapeutic |

(Continued)
| Study ID       | Type of study | Study population                          | Method for data acquisition                                                                 | Type of TCIM intervention                      | Country | Time points for data acquisition | Sex (male) | Sex (female) | Age (mean or median with SD or ranges, years) | Purpose of TCIM usage     |
|---------------|---------------|-------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------|---------|----------------------------------|------------|-------------|-----------------------------------------------|---------------------------|
| Ben-Ezra et al. (31) | Survey | General population under quarantine due to COVID-19 | Online survey for general population                                                        | Vitamins and TCM medicines                    | China   | Apr 2020                         | 527        | 607         | Average 30.99 (6.82)                         | Prophylactic              |
| Cen et al. (32) | Cross sectional study | COVID patients                            | Hospital-based COVID-19 patient case reviews                                                  | TCM medication (Lianhua Qingwen)              | China   | Feb 2020                         | 493        | 514         | Not reported                                  | Therapeutic               |
| Charan et al. (10) | Survey | COVID-19 patients without symptoms        | Telephone survey interview in isolation center                                               | Ayurveda, herbal products                    | India   | 2020                             | Not reported | Not reported | Not reported                                  | Prophylactic or therapeutic |
| Chen et al. (33) | Cross sectional study | Severe COVID-19 patient                   | Hospital-based COVID-19 patient case reviews                                                  | TCM patient medications                      | China   | 2020                             | 296        | 366         | Average 60 (47–70)                            | Therapeutic               |
| Cheng et al. (34) | Survey | COVID patients                            | Survey not detailed information in shelter hospital                                          | TCM medications                               | China   | Feb–Mar 2020                     | 67         | 49          | Average 44 (22–57)                            | Therapeutic               |
| Chrisinger et al. (35) | Survey | General population                        | Online Survey for general population in a community-based cohort                             | Contemplative practice behaviors (mindfulness, compassion practices) | United States | Apr 2020                         | 176        | 724         | Not reported                                  | Prophylactic               |
| de los Angeles et al. (36) | Survey | General population                        | Online Survey or in-person interview on general population                                   | Herbal products                               | Ecuador | Jan–Mar 2020                     | 350        | 479         | Not reported                                  | Prophylactic               |
| Du et al. (37) | Cross sectional study | Pediatric COVID patients                 | Hospital-based COVID-19 patient case reviews                                                  | TCM medication                                | China   | Jan–Feb 2020                     | 120        | 62          | Median 6 (0.01–15)                            | Therapeutic               |
| Erdem et al. (38) | Survey | Cancer patients                           | Telephone survey interview on outpatient community-based oncology clinic                    | Dietary supplement                            | Turkey  | Apr 2020                         | 101        | 199         | Average 57.39 (19–92)                         | Prophylactic               |
| Feng 2020a et al. (39) | Cross sectional study | COVID patients                            | Hospital-based COVID-19 patient case reviews                                                  | TCM medication                                | China   | Feb–Mar 2020                     | 65         | 69          | Median 45 (33–56)                             | Therapeutic               |
| Feng 2020b et al. (40) | Cross sectional study | COVID patients with severe symptom        | Hospital-based COVID-19 patient case reviews                                                  | TCM medication                                | China   | Jan–Feb 2020                     | 71         | 43          | Average 63.96 (13.41)                         | Therapeutic               |

(Continued)
| Study ID | Type of study | Study population | Method for data acquisition | Type of TCIM intervention | Country | Time points for data acquisition | Sex (male) | Sex (female) | Age (mean or median with SD or ranges, years) | Purpose of TCIM usage |
|----------|---------------|------------------|-----------------------------|---------------------------|---------|-------------------------------|------------|-------------|-------------------------------------------|----------------------|
| Francis et al. (41) | Survey | Students | Not reported | Ayurvedic foods | India | Not reported | 416 | 409 | Not reported | Prophylactic |
| Green et al. (42) | Survey | General population using meditation app | Online survey for general population using meditation online app | Meditation | United States | Apr-May 2020 | 1,147 | 6,129 | Average 47 (13.8) | Prophylactic |
| Hamdani et al. (43) | Survey | General population | Online survey for general population | Herbal medication | Algeria | Not reported | 230 | 370 | Average 36 | Prophylactic or therapeutic |
| He et al. (44) | Cross sectional study | COVID patients (children) | Hospital-based COVID-19 patient case reviews | TCM | China | Jan-Jun 2020 | 18 | 17 | Average 7.1 (4.2) | Therapeutic |
| Hellem et al. (45) | Survey | General population | Online survey with email and social media for general population | Mind-body practice, physical exercise | United States | Apr-Jun 2020 | 29 | 304 | Average 49.7 (16.1) | Prophylactic |
| Jethani et al. (46) | Cross sectional study | COVID patients | Hospital-based COVID-19 patient case reviews | Homeopathy | India | Apr-Jun 2020 | 142 | 54 | Average 38.9 (16.3) | Therapeutic |
| Ji et al. (47) | Cross sectional study | COVID patients with stroke | Hospital-based COVID-19 patient case reviews | TCM | China | Feb-May 2020 | 17 | 10 | Average 66.4 (12.1) | Therapeutic |
| Jimenez et al. (48) | Survey | General population | Online survey for general population | Mind-body practice | Spain | Not reported | 61 | 348 | Not reported | Prophylactic |
| Kamarli et al. (49) | Survey | General population | Online survey for dietitians | Dietary supplements, functional foods, herbal medicine | Turkey | May-Jun 2020 | 65 | 485 | Average 30.6 (9.1) | Prophylactic |
| Karbownik et al. (50) | Survey | General population | Online survey for general population | Dietary supplements | Poland | Mar-May 2020 | 65 | 369 | Average 36.4 (13.9) | Prophylactic |
| Khadka et al. (51) | Survey | General population | Online survey for general population | Medicinal plants | Nepal | Jun-Jul 2020 | 471 | 303 | Not reported | Prophylactic |
| Kristian et al. (52) | Survey | General population (undergraduate student) | Online survey for undergraduate student | Dietary supplements | Indonesia | Jun 2020 | 845 | 5,079 | Not reported | Prophylactic |
| Lam et al. (53) | Survey | General population | Online survey for general population | Dietary supplement, TCM medication, acupuncture, massage, aromatherapy, yoga, qigong and moxibustion | China | Nov-Dec 2020 | 233 | 399 | Not reported | Prophylactic |
| Study ID          | Type of study | Study population | Method for data acquisition | Type of TCIM intervention | Country        | Time points for data acquisition | Sex (male) | Sex (female) | Age (mean or median with SD or ranges, years) | Purpose of TCIM usage |
|------------------|---------------|------------------|-----------------------------|---------------------------|----------------|---------------------------------|------------|-------------|-----------------------------------------------|----------------------|
| Lenaerts et al.  | Survey        | General population | Online survey for general population | Nature visits       | Belgium        | Not reported                    | 3,568      | 7,742       | Not reported                                | Prophylactic          |
| Ma et al. (55)   | Cross sectional study | COVID patients after acute admission treatments | Hospital-based COVID-19 patient case reviews | TCM             | China          | Feb 2020                        | 348        | 361         | Average 45.15 (12.64)                        | Therapeutic           |
| Mamo et al. (56) | Survey        | General population | In-person survey interview on general population | Traditional medicine | Ethiopia       | May–Jun 2020                    | 547        | 307         | Average 34.12 (18–89)                        | Prophylactic or therapeutic |
| Mohsen et al. (57) | Survey        | General population | Online survey for general population | Dietary supplement | Lebanon        | Jan–Feb 2021                    | 1,449      | 1,522       | Average 29.47 (11.4)                        | Prophylactic or therapeutic |
| Nguyen et al. (58) | Survey        | General population | Online survey for general population | Herbal medicine | Vietnam        | Sep–Oct 2020                    | 180        | 328         | Average 26.8 years (18–68)                  | Therapeutic           |
| Panagiotakos et al. (59) | Survey        | General population | Online survey for general population | Dietary supplement | Greece         | Dec 2020                        | 912        | 1,346       | Median 35 years (31–45)                    | Prophylactic           |
| Parmila et al. (60) | Survey        | General population | Online survey for general population | Yoga              | India          | Mar–May 2020                    | Not reported | Not reported | Average 42.99 years (16–81)                | Not reported          |
| Sahni et al. (61) | Survey        | General population | Online survey for general population | Yoga and spiritual practice | India          | Apr–Jun 2020                    | 416        | 223         | Not reported                                | Prophylactic          |
| Shi et al. (62)  | Survey        | General population | Online survey for general population | TCM herbs, Physical exercise | China          | Feb 2020                        | 569        | 2,082       | Average 35.91 year (10.95)                 | Prophylactic           |
| Shu et al. (63)  | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 patient case reviews | TCM herbal prescriptions | China          | Jan–Mar 2020                    | 135        | 158         | Average 57.1 year (15.6)                   | Therapeutic           |
| Sun et al. (64)  | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 patient case reviews | TCM             | China          | Jan–Apr 2020                    | 84         | 81          | Average 55 years (42–66)                   | Therapeutic           |
| Sun et al. (65)  | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 patient case reviews | TCM patent medications | China          | Jan–Mar 2020                    | 148        | 134         | Average 67 years (59–74)                   | Therapeutic           |
| Teke et al. (66) | Survey        | Healthcare professionals | Online survey for healthcare professionals | TCM, dietary supplements, religious practice | Turkey         | Apr 2020                        | 462        | 98          | Average 30.88 years (7.68)                 | Prophylactic           |
| Tian et al. (67) | Cross sectional study | Severe COVID-19 patient | Hospital-based COVID-19 patient case reviews | TCM             | China          | Not reported                    | 17         | 20          | Average 44.3 years (1.67)                  | Therapeutic           |
| Study ID | Type of study | Study population | Method for data acquisition | Type of TCIM intervention | Country | Time points for data acquisition | Sex (male) | Sex (female) | Age (mean or median with SD or ranges, years) | Purpose of TCIM usage |
|----------|---------------|------------------|-----------------------------|---------------------------|---------|-------------------------------|------------|-------------|------------------------------------------|-----------------------|
| Van der Werf et al. (68) | Survey | General population | Online survey for general population | TCIM | The Netherlands | May 2020 | 495 | 509 | Not reported | Prophylactic or therapeutic |
| Wan et al. (69) | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 patient case reviews | TCM | China | Jan–Feb 2020 | 72 | 63 | Average 47 years (36–56) | Therapeutic |
| Wang et al. (70) | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 patient case reviews | TCM | China | Jan–Feb 2020 | 105 | 94 | Average 46.3 years (16.4) | Therapeutic |
| Wong et al. (71) | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 patient case reviews | TCM | China | Jan–Feb 2020 | 839 | 3,932 | Not reported | Therapeutic |
| Wong (71)* | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 patient case reviews | TCM | China | Jan–Feb 2020 | 43 | 605 | Not reported | Therapeutic |
| Wu et al. (72) | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 patient case reviews | TCM | China | Jan–Feb 2020 | 39 | 41 | Average 46.1 years (15.42) | Therapeutic |
| Yan et al. (73) | Cross sectional study | COVID patients in hospital | Online survey for general population | TCM medication | China | Jan–Jun 2020 | 122 | 96 | Average 42.9 years (32.0–52.3) | Therapeutic |
| Zaworski et al. (74) | Survey | General population | Hospital-based COVID-19 patient case reviews | Physical activity | Poland | Apr 2020 | 197 | 491 | Average 28.61 years (9.5) | Prophylactic |
| Zhang et al. (75) | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 patient case reviews | TCM medication | China | Jan–Feb 2020 | 23 | 30 | Average 46.3 years (19.6) | Therapeutic |
| Zhang et al. (76) | Cross sectional study | COVID patients in hospital | Hospital-based COVID-19 pediatric patient case reviews | TCM medication | China | Jan–Feb 2020 | 92 | 80 | Average 47.9 years (18.4) | Therapeutic |
| Zhou et al. (77) | Cross sectional study | Pediatric COVID patients in hospital | Online survey for patients recovered from COVID-19 | TCM medication | China | Jan–Feb 2020 | 2 | 5 | Median 3 years | Therapeutic |

*This study included two data sets of different two areas, Hong Kong and mainland China in a study.

TCM, Traditional Chinese Medicine; TCIM, Traditional Complementary and Integrative Medicine; SD, standard deviation; IQR, interquartile range.
bias, sample size calculation, statistical methods with adjustments on excluded participant numbers at each stage of the study (Supplementary Table 2).

**Overall Estimated Prevalence of TCIM Usage**

From the included studies, 53 studies (n = 61,831) suggested a total number of respondents or patients who used TCIM interventions during the COVID-19 pandemic period. The overall pooled prevalence of TCIM usage was estimated to be 0.64 (95% CI 0.54–0.73). The $I^2$ statistic was 99.88%, which implied severe statistical heterogeneity among the included studies (Figure 2). In screening for outliers by evaluating the studentized residuals of the included studies, one study (71) was identified as a potential outlier ($z = -2.68$, Supplementary Figure 1). When this study was excluded, the pooled prevalence was estimated to be 0.65 (95% CI 0.56–0.74). In the population-based survey, the overall prevalence of TCIM usage was 0.63 (95% CI 0.52–0.73), which did not show a severe difference when compared with findings from the hospital-based patient case review (overall prevalence 0.65, 95% CI 0.48–0.81, Figure 2).

To analyze statistical heterogeneity among the included studies, subgroup analysis was conducted based on potential effect modifiers, including the type of studies (population-based survey vs. hospital-based COVID-19 patient case reviews), study population (general population vs. COVID-19 patients) and country of the study population (China vs. other countries). The $R^2$ score for a potential effect modifier and the type of study was estimated to be 0%, which indicated that study type was not a strong effect modifier in this review. The study population ($R^2$ score = 0%, Supplementary Figure 2) and country ($R^2$ score = 1.03%, Supplementary Figure 3) could not explain the heterogeneity. In addition, a meta-regression test for the sample size of the included studies did not suggest that study size was an effect modifier (intercept: 0, P-value: 0.9108).

When comparing prevalence between countries, the country with the highest usage proportion of TCIM interventions was Ecuador (estimated proportion 0.9614, 95% CI 0.9471–0.9735), and Ethiopia showed the lowest proportion (0.1136, 95% CI 0.0931–0.1358, Table 2). There were no definitive regional trends in the usage proportion of TCIM interventions visually observed from the world map of proportion distribution (Supplementary Figure 4).

**Usage Prevalence of Individual Types of TCIM Interventions**

Twenty-five studies assessed the usage prevalence of TCIM medication, and the synthesized proportion was estimated to be 0.62 (95% CI 0.45–0.78), which showed severe statistical heterogeneity ($I^2 = 100$%, Supplementary Figure 5A). The usage proportions of Ayurveda (n = 2) and homeopathy (n = 2) were 0.44 (95% CI 0.04–0.91, Supplementary Figure 5B) and 0.30 (95% CI 0.00–0.97, Supplementary Figure 5C). The usage prevalence of yoga was suggested in 7 studies, and the estimated proportion was 0.53 (95% CI 0.27–0.78, Supplementary Figure 5D). Acupuncture was assessed in 3 studies, and the estimated prevalence was 0.20 (95% CI 0.00–0.58, Supplementary Figure 5E). Physical exercise was evaluated in 4 studies, and the estimated prevalence was 0.70 (95% CI 0.33–0.96, Supplementary Figure 5F). The proportion of dietary supplements, herbs or natural products used was estimated to be 0.58 (95% CI 0.42–0.73, Supplementary Figure 5G) from the meta-analysis of 14 studies. The usage prevalence of spiritual therapy (n = 3) and massage (n = 2) were 0.24 (95% CI 0.01–0.65, Supplementary Figure 5H) and 0.28 (95% CI 0.00–0.87, Supplementary Figure 5I), respectively.

**Publication Bias**

To assess potential publication bias, visual inspection of funnel plots was conducted, and no obvious asymmetry was observed (Supplementary Figure 6). Egger’s test results suggested that there was no significant publication bias ($P = 0.6856$).

**DISCUSSION**

From 62 studies, the overall prevalence of TCIM usage during the COVID-19 pandemic was estimated to be 0.64 (95% CI 0.54–0.73), which also showed severe statistical heterogeneity and poor reporting quality. When comparing the rates of TCIM use across countries, the estimated proportion showed very large differences from 0.6914 (95% CI 0.9471–0.9735) in Ecuador to 0.1136 (95% CI 0.0931 to 0.1358) in Ethiopia. Study types for data acquisition did not affect the overall prevalence of TCIM usage 0.63 (95% CI 0.52–0.73) in the population-based survey and 0.65 (95% CI 0.48–0.81) in the hospital-based patient case review ($R^2$ index = 0%). Although we explored potential effect modifiers for assessing statistical heterogeneity of this review, we failed to identify any meaningful reasons. Type of studies, study population and country of the population could not explain the considerable statistical heterogeneity of this study result.

From this review, it was found that TCIM interventions have been used for preventive and therapeutic purposes. Why do people use TCIM interventions for COVID-19? Disease burden, previous TCIM experience and perception of TCIM efficacy are well-known determinants for the usage of TCIM interventions for disease management (78, 79). During the COVID-19 pandemic when some underdeveloped countries experienced shortage of medical resources and restricted access to medical institutions, TCIM interventions tended to be accepted as a panacea, and this kind of attitude is based on health-related beliefs and the desire for self-care to improve immunity from the viral infection with a holistic approach (26, 80, 81). China published TCIM guidelines for COVID-19, which might be related to the high usage rate of TCIM interventions for therapeutic purposes during the pandemic period (7, 82–84). Meanwhile, the prevalence of TCIM usage in Western countries, such as the United States, was as high as that in underdeveloped countries. This might be due to different reasons, including dissatisfaction with the quality of conventional healthcare services (85). In addition, TCIM interventions such as mind-body practice have been used to maintain psychosocial health in many countries during the pandemic (35, 42, 45). Regarding reasons for the use of TCIM interventions during the
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FIGURE 2 | Meta-analysis of overall usage prevalence of TCIM interventions.

| Study                      | Events | Total | Proportion | 95%–CI | Weight |
|----------------------------|--------|-------|------------|--------|--------|
| Subgroup = Population-based survey |        |       |            |        |        |
| Abdulraeef 2021            | 165    | 428   | 0.39       | [0.34; 0.43] | 1.9%   |
| Abdullah 2021              | 977    | 1054  | 0.93       | [0.91; 0.94] | 1.9%   |
| Ahmed 2020                 | 704    | 1222  | 0.58       | [0.55; 0.60] | 1.9%   |
| Alnajrany 2021             | 955    | 1473  | 0.65       | [0.62; 0.67] | 1.9%   |
| Alonso–Castro 2021         | 1300   | 2100  | 0.62       | [0.60; 0.64] | 1.9%   |
| Alyami 2020                | 783    | 6258  | 0.15       | [0.14; 0.16] | 1.9%   |
| Ashiq 2020                 | 133    | 316   | 0.42       | [0.37; 0.48] | 1.9%   |
| Barnes 2021                | 114    | 262   | 0.44       | [0.37; 0.50] | 1.9%   |
| Charan 2020                | 128    | 495   | 0.26       | [0.22; 0.30] | 1.9%   |
| Cheng 2020                 | 110    | 116   | 0.95       | [0.89; 0.98] | 1.9%   |
| Chrisinger 2021            | 518    | 847   | 0.61       | [0.58; 0.64] | 1.9%   |
| de los Angeles 2020        | 797    | 829   | 0.96       | [0.95; 0.97] | 1.9%   |
| Erdem 2020                 | 157    | 300   | 0.52       | [0.47; 0.58] | 1.9%   |
| Fransis 2020               | 587    | 825   | 0.71       | [0.68; 0.74] | 1.9%   |
| Green 2021                 | 7332   | 8392  | 0.87       | [0.87; 0.88] | 1.9%   |
| Hamdani 2020               | 105    | 500   | 0.21       | [0.18; 0.25] | 1.9%   |
| Hellem 2021                | 325    | 325   | 1.00       | [0.99; 1.00] | 1.9%   |
| Karbowiak 2021             | 399    | 434   | 0.78       | [0.74; 0.82] | 1.9%   |
| Khodak 2021                | 636    | 774   | 0.82       | [0.79; 0.85] | 1.9%   |
| Kristlandi 2021            | 4069   | 5924  | 0.69       | [0.67; 0.70] | 1.9%   |
| Lam 2021                   | 278    | 632   | 0.44       | [0.40; 0.48] | 1.9%   |
| Lenaerts 2021              | 10802  | 11352 | 0.95       | [0.95; 0.96] | 1.9%   |
| Mamo 2021                  | 97     | 854   | 0.11       | [0.09; 0.14] | 1.9%   |
| Nguyen 2021                | 249    | 508   | 0.49       | [0.45; 0.53] | 1.9%   |
| Panagiotakos 2021           | 429    | 2258  | 0.19       | [0.17; 0.21] | 1.9%   |
| Perimala 2021              | 540    | 958   | 0.56       | [0.53; 0.60] | 1.9%   |
| Sahni 2021                 | 497    | 643   | 0.77       | [0.74; 0.80] | 1.9%   |
| Teke 2021                  | 255    | 560   | 0.46       | [0.41; 0.50] | 1.9%   |
| Van der Werf 2021          | 683    | 1004  | 0.68       | [0.65; 0.71] | 1.9%   |
| Zaworski 2020              | 623    | 688   | 0.91       | [0.88; 0.93] | 1.9%   |

Random effects model
| Study                      | Events | Total | Proportion | 95%–CI | Weight |
|----------------------------|--------|-------|------------|--------|--------|
| An 2021                    | 191    | 372   | 0.51       | [0.46; 0.57] | 1.9%   |
| Cen 2020                   | 651    | 1007  | 0.65       | [0.62; 0.68] | 1.9%   |
| Chen 2020                  | 437    | 662   | 0.66       | [0.62; 0.70] | 1.9%   |
| Du 2021                    | 12     | 182   | 0.07       | [0.03; 0.11] | 1.9%   |
| Feng 2020a                 | 128    | 134   | 0.96       | [0.91; 0.98] | 1.9%   |
| Feng 2020b                 | 86     | 114   | 0.75       | [0.66; 0.83] | 1.9%   |
| He 2020                    | 12     | 35    | 0.34       | [0.19; 0.52] | 1.8%   |
| Jethani 2021               | 138    | 196   | 0.70       | [0.63; 0.77] | 1.9%   |
| Ji 2021                    | 26     | 27    | 0.96       | [0.81; 1.00] | 1.8%   |
| Ma 2021                    | 133    | 709   | 0.19       | [0.16; 0.22] | 1.9%   |
| Shu 2020                   | 273    | 293   | 0.93       | [0.90; 0.96] | 1.9%   |
| Sun 2021a                  | 92     | 165   | 0.56       | [0.48; 0.63] | 1.9%   |
| Sun 2021b                  | 186    | 286   | 0.65       | [0.59; 0.71] | 1.9%   |
| Tian 2020                  | 37     | 37    | 1.00       | [0.91; 1.00] | 1.8%   |
| Wan 2020                   | 124    | 135   | 0.92       | [0.86; 0.96] | 1.9%   |
| Wang 2020                  | 80     | 199   | 0.40       | [0.33; 0.47] | 1.9%   |
| Wong 2021a                 | 0      | 4771  | 0.00       | [0.00; 0.00] | 1.9%   |
| Wong 2021b                 | 565    | 648   | 0.87       | [0.84; 0.90] | 1.9%   |
| Wu 2020                    | 3      | 80    | 0.04       | [0.01; 0.11] | 1.9%   |
| Yan 2020                   | 196    | 218   | 0.90       | [0.85; 0.94] | 1.9%   |
| Zhang 2020                 | 48     | 53    | 0.91       | [0.79; 0.97] | 1.8%   |
| Zhang 2021                 | 172    | 172   | 1.00       | [0.98; 1.00] | 1.9%   |
| Zhou 2021                  | 4      | 7     | 0.57       | [0.18; 0.90] | 1.5%   |

Random effects model
Random effects model

FIGURE 2 | Meta-analysis of overall usage prevalence of TCIM interventions.
TABLE 2 | Estimated proportion of TCIM usage in each country.

| Country     | Proportion | 95% confidence intervals | Number of studies |
|-------------|------------|--------------------------|-------------------|
| Ecuador     | 0.9614     | 0.9471–0.9735            | 1                 |
| Belgium     | 0.9516     | 0.9475–0.9554            | 1                 |
| United States | 0.8796    | 0.5655–1.0000            | 3                 |
| Poland      | 0.8491     | 0.7086–0.9492            | 2                 |
| Nepal       | 0.8217     | 0.7939–0.8479            | 1                 |
| China       | 0.8571     | 0.4896–0.8071            | 24                |
| Indonesia   | 0.8869     | 0.6750–0.6986            | 1                 |
| Netherlands | 0.8803     | 0.6511–0.7099            | 1                 |
| Mexico      | 0.619      | 0.5982–0.6397            | 1                 |
| India       | 0.6051     | 0.4168–0.7785            | 5                 |
| Saudi Arabia| 0.5902     | 0.1261–0.9675            | 3                 |
| Bangladesh  | 0.5781     | 0.5483–0.6037            | 1                 |
| Vietnam     | 0.4902     | 0.4467–0.5337            | 1                 |
| Turkey      | 0.4864     | 0.4203–0.5528            | 2                 |
| Australia   | 0.4351     | 0.3755–0.4956            | 1                 |
| Pakistan    | 0.4209     | 0.3669–0.4758            | 1                 |
| Iraq        | 0.3855     | 0.3399–0.4322            | 1                 |
| Algeria     | 0.21       | 0.1754–0.2469            | 1                 |
| Greece      | 0.19       | 0.1741–0.2064            | 1                 |
| Ethiopia    | 0.1136     | 0.0931–0.1358            | 1                 |

TCIM, Traditional Complementary and Integrative Medicine.

COVID-19 pandemic, it is necessary to evaluate the underlying reasons by region in future research in detail.

This study has limitations. First, we failed to identify meaningful effect modifiers to explain the statistical heterogeneity. The reasons for using TCIM interventions such as prophylactic purpose or therapeutic purpose might be related to the potential heterogeneity of this review result. Different economic statuses and the medical systems of each country might be closely related to the diverse usage status of TCIM interventions, but these factors could not be assessed due to the limited numbers of included studies. In addition, one of the most powerful suspicious factors is the study population that may be different than the initial patterns. An updated review that includes 2021 data is needed. Currently, an international survey on the prevention of and treatments for COVID-19 has been conducted, which might suggest more reliable data on the prevalence of TCIM interventions used worldwide.

In conclusion, various TCIM interventions were reported to be used at a comparatively high frequency, but this result should be interpreted carefully due to the heterogeneity and low reporting quality of the included studies. Future studies need to be updated to include global data through international collaborative research, which might overcome the main limitation of this study, i.e., the heterogeneity of the included data.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

ML and T-HK: conceptualization and writing—original draft. T-HK and S-RJ: methodology and investigation. T-HK: software and visualization. JK and HL: validation. T-HK and LA: formal analysis. T-HK and HL: resources. JK and LA: data curation. JK, S-RJ, LA, and HL: writing—review and editing. T-HK, ML, and JK: supervision. S-RJ and HL: project administration. ML: funding acquisition. All authors read and approved the final manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmed.2022.884573/full#supplementary-material.
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