Acta Neuropsychiatrica

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The COVID-19 pandemic and obsessive-compulsive disorder: a systematic review of comparisons between males and females

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Review Article

Cite this article: Jalalifar E, Arad A, Rastkar M, and Beheshti R. (2023) The COVID-19 pandemic and obsessive-compulsive disorder: a systematic review of comparisons between males and females. *Acta Neuropsychiatrica* **35**:270–291.
doi: 10.1017/neu.2023.15

Received: 13 July 2022
Revised: 5 February 2023
Accepted: 6 February 2023
First published online: 2 March 2023

Key words:
obsessive-compulsive disorder; COVID-19; female; male; sex

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Abstract

Coronavirus disease, one of the most disastrous epidemics, has caused a worldwide crisis, and the containment measures applied to decelerate the progression of the pandemic can increase the risk of obsessive-compulsive disorder (OCD). Identifying vulnerable groups in this area can lead us to better resource expenditure, and therefore, this systematic review aims to make a comparison between males and females to determine which of the two groups was most affected by the COVID-19 pandemic regarding OCD. Also, a meta-analysis was designed to investigate the prevalence of OCD during the COVID-19 pandemic. A comprehensive search was conducted among three databases (Medline, Scopus, Web of Science) until August 2021 which resulted in 197 articles, and 24 articles met our inclusion criteria. Overall, more than half of the articles stated the role of gender in OCD during the COVID-19 pandemic. Several articles emphasized the role of the female gender, and some others the role of the male gender. The meta-analysis revealed a 41.2% overall prevalence of OCD during the COVID pandemic and 47.1% and 39.1% OCD prevalence for female and male genders respectively. However, the difference between the two genders was not statistically significant. Generally, it seems that females are at greater risk of OCD during the COVID-19 pandemic. In the following groups, the female gender may have acted as a risk factor: under-18 years students, hospital staff, and the studies in the Middle East. In none of the categories, male gender was clearly identified as a risk factor.

Summations

- The prevalence of obsessive-compulsive disorder (OCD) during the COVID-19 pandemic was higher in females compared to males; however, this difference was not statistically significant.
- In the following groups, the female gender was identified as a possible risk factor regarding OCD during the COVID-19 pandemic: under-18 years students, hospital staff, and studies in the Middle East. In none of the categories investigated in this study, male gender was clearly identified as a risk factor.
- Considering the role of differences between geographical regions, cultures, and economic status is essential when studying OCD.

Considerations

- Assessing the gender differences regarding OCD during the COVID-19 pandemic has not been performed independently. Future studies should examine the differences between the two genders as their main topic, and not as a side factor.
- Examining the OCD symptoms differences between the two genders has been neglected during the COVID-19 pandemic.
- The groups in which the female gender has been introduced as a possible risk factor for OCD during the COVID-19 pandemic are not decisive, since the studies conducted in each of the geographical regions or sample groups had different objectives.

Introduction

In December 2019, a new respiratory disease was detected in Wuhan, China for the first time, named Coronavirus disease-19 (COVID-19) and get spread rapidly in other regions and became a global warning all around the world (Hu *et al.*, 2020; Lipsitch *et al.*, 2020) and therefore World Health Organization (WHO) declared it as a universal pandemic on 11 March 2020 less than

3 months after its presentation. Up to this moment that we write this article (27 July), about 195M people were infected by this virus and around 4M people were killed due to the current pandemic all around the world, and this statistical information confirmed that we can consider COVID-19 pandemic as one of the biggest public health challenges in the recent history.

The first findings of COVID-19 indicated that Coronavirus can spread in different ways such as respiration, eyes, nose, or mouth (Liu *et al*., 2020; Richard *et al*., 2020), and with polluted hands, those touched the surfaces that the virus has contaminated them (Kwok *et al*., 2015; Karia *et al*., 2020). Additionally, as we experienced some similar conditions like influenza (Jefferson *et al*., 2011; Ahmed *et al*., 2018), and Ebola (Osungbade & Oni, 2014), we know this situation needs an emerging action on a major scale to expand public health level to prevent a disaster to human life. So experts published some advice like social distancing (Güner *et al*., 2020; Lotfi *et al*., 2020), improving a self-hygiene level like several hands washing (Alzyood *et al*., 2020; Güner *et al*., 2020; Mahmood *et al*., 2020; Lotfi *et al*., 2020) and wearing masks (Lotfi *et al*., 2020; Brooks *et al*., 2020a), those can be effective to prevent COVID-19.

Forasmuch as we faced with same pandemics and experienced the impact of them on public mental health, like the 2009 H1N1 (Pfefferbaum *et al*., 2012), and 2003 SARS outbreak (Hawryluck *et al*., 2004; Cava *et al*., 2005; Mak *et al*., 2009), we can hypothesis the same results for the COVID-19 pandemic (Hossain *et al*., 2020; Xiong *et al*., 2020a). Although it is accepted that everyone has a chance of getting infected by the COVID-19, but some studies concluded that people with mental illness had a greater risk of pneumonia and pneumococcal disease (Seminog & Goldacre, 2013). In addition, for people with mental illness, their underlying mental health may deteriorate or recur due to their high-potential stress compared to the general population (Yao *et al*., 2020).

Among all mental diseases, we can point to obsessive-compulsive disorder (OCD) as a common and serious one. OCD had a high level of comorbidity with other mental diseases (Ruscio *et al*., 2010; Quarantini *et al*., 2011; Subramaniam *et al*., 2012), physical disorders (Subramaniam *et al*., 2012), and also had a connection with suicidal actions (Fernández de la K amath *et al*., 2007; Torres *et al*., 2011; Huz *et al*., 2016; Cruz *et al*., 2017). In several studies in different regions, OCD's lifetime prevalence range mostly was calculated from 1.8% to 3.3% (Karno *et al*., 1988; Weissman *et al*., 1994; Mohammadi *et al*., 2004; Ruscio *et al*., 2010; Subramaniam *et al*., 2012; Jaisoorya *et al*., 2017), and OCD is mentioned as the fourth most common mental disease in some studies (Grant, 2014; Veale & Roberts, 2014; Ansari *et al*., 2020; Asghar *et al*., 2020).

OCD is a chronic mental illness that causes unwanted thoughts (obsessions), and repetitive behaviours (e.g. hand washing or checking), or mental acts, or compulsions, which can disrupt patients' life (Veale & Roberts, 2014; Brock & Hany, 2021).

As mentioned, the first findings suggested that hand washing is effective in reducing infections and is a preventive one against COVID-19 spreading, and society was encouraged to take this advice seriously, but excessive hand washing is one of the most common symptoms among 50% of OCD patients (Brady *et al*., 2010). So, this extra emphasis on hand sanitation may increase fear of contamination and therefore result in OCD symptoms worsening (Abba-Aji *et al*., 2020). Also, various studies indicate that inflammatory cytokines are increased in OCD (Fontenelle *et al*., 2012; Rao *et al*., 2015; Karagüzel *et al*., 2019; Kutuk *et al*., 2020). Increased cytokine levels are involved in severe neurological disorders (Bodro *et al*., 2021). The pathophysiology of several psychiatric disorders including anxiety, depression, post-traumatic stress disorder, and OCD, is associated with these changes (Grace, 2016; Raony *et al*., 2020). OCD patients might have remarkably higher plasma levels of IL-1β, IL-6, IL-17, TNF-α, CCL3, CXCL8, sTNFR1, and sTNFR2 (Fontenelle *et al*., 2012; Rao *et al*., 2015; Karagüzel *et al*., 2019; Kutuk *et al*., 2020). When an individual is infected with the coronavirus, depending on the local or peripheral presence of SARS-CoV2, the virus could lead to systemic inflammatory responses (Bodro *et al*., 2021). One of the important stages in the pathophysiology of COVID-19 is the binding of SARS-Cov2 to angiotensin-converting enzyme 2 (ACE2) in respiratory epithelial cells, and then blood vessels' epithelial cells. This binding allows SARS-Cov2 to trigger a cytokine storm with significantly increased levels of IL-1, IL-6, and TNF (Mehta *et al*., 2020; Xiong *et al*., 2020b). Therefore, considering the higher levels of cytokines in OCD patients, the neuro-inflammatory mechanisms could be involved in the pathophysiology of the neuropsychiatric manifestations (Muccioli *et al*., 2021).

OCD has become important for various reasons during the COVID-19 pandemic and has been the subject of studies, including this systematic review. The most important reason is the increase in the incidence of this disease (Abba-Aji *et al*., 2020; Cox & Olatunji, 2021). OCD-related behaviours are often seen in society, and even some behaviours that were subsequently rejected by health authorities, are performed abundantly by society members, such as washing hands after every contact with the environment, in a situation where the possibility of direct infection with Coronavirus through surface contact and environment has weakened, and now it is assumed that the virus is primarily transmitted from person to person through respiratory and oral aerosols and droplets (Rahman *et al*., 2020). At the beginning of the outbreak, governments, public figures, and authorities responsible for health-related matters prompted society to wash their hands frequently (Davide *et al*., 2020). Considering that based on some studies excessive washing, the feeling of being contaminated, and the fear of dirt are the most common cases that affect about 50% of patients (Brady *et al*., 2010), and taking into account the general fear of getting infected with the virus and the recommendations in health advisories regarding hand washing, the contamination fear might increase (Abba-Aji *et al*., 2020), and the OCD symptoms might worsen (Reynolds *et al*., 2008). In addition, frequent cleaning habits becoming a normal and prevalent protective behaviour might cause contamination-related obsessions and compulsions, especially in individuals who have other types of obsessions and compulsions (Davide *et al*., 2020). Also, according to recent literature, individuals who had been diagnosed with OCD before the current pandemic may be the group most affected by the pandemic among those with mental disorders (Fineberg *et al*., 2020), and in a situation where many dimensions of mental illnesses, including OCD, are undiagnosed in pandemic conditions and the possibility of conducting targeted studies is weakened, this disease and its various aspects of the relationship with COVID-19 pandemic became the subject of this systematic review. According to recent literature, individuals who had been diagnosed with OCD prior to the current pandemic may be the group most affected by the pandemic among those with mental disorders (Fineberg *et al*., 2020), and therefore this disease has gained lots of attention from researchers worldwide.

This pandemic will be ended soon or late, but according to previous experiences, its physical and mental consequences will remain for some time. Early intervention is always one of the most effective ways to prevent or control diseases at low levels of

https://doi.org/10.1017/neu.2023.15 Published online by Cambridge University Press

progression (Pozza *et al.*, 2020). But when society and policy-makers face situations like the COVID-19 pandemic that impose enormous and unforeseen costs, early intervention on various issues, especially mental disorders, becomes impossible. Under these circumstances, identifying at-risk groups can direct the limited and damaged resources of society to them and thus achieve greater efficiency. The present study, therefore, aims to identify gender-related risk groups in relation to OCD and to provide resources for early intervention, especially in relation to education (stress management, OCD symptoms, and the COVID-19 pandemic).

Although the OCD has attracted the global attention of researchers due to the clearer demonstrations it has generated in the society during the COVID-19 pandemic, the previous studies performed in this area acted so separately when comes to the objectives of the studies and the demographical sample groups that were investigated. Thus, there was a lack of a systematic review to guide future studies on this basis, and this study seeks to fill this gap. This systematic review aims to evaluate the possible changes in the relationship between the OCD and gender due to the circumstances created by the COVID-19 pandemic. This study also seeks to identify gender-related at-risk groups regarding OCD during the pandemic and to act as a guide for future studies to focus the resources on those who are specified as at-risk in this systematic review. This study also tries to investigate the differences among different geographical regions with regard to mentioned relationship and highlights the importance of cultural differences in OCD, as the peripheral factors are of the most important factors affecting this disease.

Material and methods

The systematic review was performed based on the preferred reporting items for systematic reviews and meta-analyses (PRISMA) recommendations for the literature search and screening, including studies and reporting results (Moher *et al.*, 2009).

Search strategy

In order to carry out this systematic review, we performed a comprehensive search in Medline, Scopus, and Web of Science databases from their inception to the 10th of August 2021 to identify the literature investigating the role of gender on OCD prevalence and symptom severity during the COVID-19 pandemic. A search strategy was performed based on the combination of three groups of OCD, COVID-19, and different forms of keywords relevant to gender. In the first stage, the following keywords were combined through OR: Female, Male, Women, Men, Sex, Sex Factors. Then results from the mentioned step were combined with OCD and COVID-19 keywords through AND. Keywords were chosen by searching MeSH terms, reviewing related articles, and consulting with researchers. In the end, we investigated the reference lists of our included studies to identify and include further relevant literature in case we missed them during the mentioned steps.

On the 23rd and 24th of July and 10th of August 2021, we updated our search and repeated the above steps. Table 1 shows details of the search strategy for each database.

The studies included by following criteria:

(1) Studies investigating the risk factors (including gender) for OCD during the COVID-19 pandemic. (2) The article was published in English.

Our exclusion criteria were:

(1) Reviews, letters, conference papers, and editorials. (2) We also excluded studies that examined OCD not independently but as part of mental health, and even identified the role of gender. Because the impact of other mental disorders such as depression, anxiety, etc. on the results cannot be determined.

Two authors (EJ & AA) separately searched the databases and screened the title and abstract of articles based on the inclusion/exclusion criteria. Once the primary screening, potentially eligible articles were screened by two reviewers (EJ & AA) based on reviewing the full text, in keeping with inclusion/exclusion criteria. The disagreement on articles was resolved by discussion between two authors (EJ & AA); otherwise, the third author (MR) would be consulted. Our search method resulted in 197 articles, of which 24 met our inclusion criteria. Figure 1 illustrates the diagram of the literature search and inclusion/exclusion criteria.

Data extraction

Two independent authors extracted the required data and reported the findings based on PRISMA (Liberati *et al.*, 2009). A self-defined table was used for extracting data including first author name, publication date, country, study design, sample number, age and gender characteristics, OCD parameters and measurement tool, Categorical variable' (Gender) association parameters, Population, and significant results (Table 2).

Risk of bias assessment

We used the Newcastle–Ottawa scale (Stang, 2010) to evaluate the cohort studies. This scale consists of three groups: selection, comparability, and outcome. A cohort study can get a maximum of 1 score for each question of selection and outcome, and a maximum of 2 scores for comparability. Thus, a study can get a maximum of 9 scores from the Newcastle–Ottawa scale. Table 3 shows the result of evaluating cohort studies.

We also used an adapted version of the Newcastle–Ottawa scale (Stang, 2010) to evaluate the cross-sectional studies. This scale consists of three groups: selection (maximum of 5 scores), comparability (maximum of 2 scores), and outcome (maximum of 3 scores). A cross-sectional study can get a maximum of 1 score for each question of outcome and 3 questions of selection, and a maximum of 2 scores for comparability and one question of selection. Thus, a study can get a maximum of 10 scores from the Newcastle–Ottawa scale. Table 4 shows the result of evaluating cross-sectional studies.

Data synthesis

The prevalence of OCD in the total population and the two genders was pooled in a meta-analysis with a confidence interval of 95%. The Cochrane Q p-value and I^2 statistics were used to define statistical heterogeneity. If there was no significant heterogeneity (I^2 less than 50% or Cochrane Q with a p-value > 0.05), pooled estimates were generated using the fixed-effect model; otherwise, the random-effect model was applied when significant heterogeneity was found. Due to the inappropriate number of studies reporting the prevalence of OCD, publication bias was not performed. Comprehensive Meta-Analysis version 3 was used for all statistical analysis.

Results

By conducting a comprehensive search in Medline, ScienceDirect Scopus, and Web of Science databases using OCD, COVID-19, and

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Table 1. Search strategy

Database	Date	Search Strategy
Medline	6.8.2021, 7.23.2021, 8.10.2021	((((((((((((((((Obsessive-Compulsive Disorder[MeSH Terms]) OR (Obsessive-Compulsive Disorder[Text Word])) OR (Disorder, Obsessive-Compulsive[Text Word])) OR (Disorders, Obsessive-Compulsive[Text Word])) OR (Obsessive Compulsive Disorder[Text Word])) OR (Obsessive-Compulsive Disorders[Text Word])) OR (Neurosis, Obsessive-Compulsive[Text Word])) OR (Neuroses, Obsessive-Compulsive[Text Word])) OR (Neurosis, Obsessive Compulsive[Text Word])) OR (Obsessive-Compulsive Neuroses[Text Word])) OR (Obsessive-Compulsive Neurosis[Text Word])) OR (Anankastic Personality[Text Word])) OR (Anankastic Personalities[Text Word])) OR (Personalities, Anankastic[Text Word])) OR (Personality, Anankastic[Text Word])) AND ((((((((((((((((((((((((((((((((COVID-19[MeSH Terms]) OR (COVID-19[Text Word])) OR (COVID 19[Text Word])) OR (COVID-19 Virus DiseaseCOVID 19 Virus Disease[Text Word])) OR (COVID-19 Virus Diseases[Text Word])) OR (Disease, COVID-19 Virus[Text Word])) OR (Virus Disease, COVID-19[Text Word])) OR (COVID-19 Virus Infection[Text Word])) OR (COVID 19 Virus Infection[Text Word])) OR (COVID-19 Virus Infections[Text Word])) OR (Infection, COVID-19 Virus[Text Word])) OR (Virus Infection, COVID-19 [Text Word])) OR (2019-nCoV Infection[Text Word])) OR (2019 nCoV Infection[Text Word])) OR (2019-nCoV Infections[Text Word])) OR (Infection, 2019-nCoV[Text Word])) OR (Coronavirus Disease-19[Text Word])) OR (Coronavirus Disease 19[Text Word])) OR (2019 Novel Coronavirus Disease[Text Word])) OR (2019 Novel Coronavirus Infection[Text Word])) OR (2019-nCoV Disease[Text Word])) OR (2019 nCoV Disease[Text Word])) OR (2019-nCoV Diseases[Text Word])) OR (Disease, 2019-nCoV[Text Word])) OR (COVID19[Text Word])) OR (Coronavirus Disease 2019[Text Word])) OR (Disease 2019, Coronavirus[Text Word])) OR (SARS Coronavirus 2 Infection[Text Word])) OR (SARS-CoV-2 Infection[Text Word])) OR (Infection, SARS-CoV-2[Text Word])) OR (SARS CoV 2 Infection[Text Word])) OR (SARS-CoV-2 Infections[Text Word])) OR (COVID-19 Pandemic[Text Word])) OR (COVID 19 Pandemic[Text Word])) OR (COVID-19 Pandemics[Text Word])) OR (Pandemic, COVID-19[Text Word]))) AND ((((((female[MeSH Terms]) OR (Females[Text Word])) OR ((male[MeSH Terms]) OR (Males[Text Word]))) OR ((((((((women[MeSH Terms]) OR (women[Text Word])) OR (Girls[Text Word])) OR (Girl[Text Word])) OR (Woman[Text Word])) OR (Women's Groups[Text Word])) OR (Women Groups[Text Word])) OR (Women's Group[Text Word]))) OR (((((Men[MeSH Terms]) OR (Men[Text Word])) OR (boys[Text Word])) OR (man[Text Word])) OR (boy[Text Word]))) OR (((((sex[MeSH Terms]) OR (Phenotypic Sex[Text Word])) OR (Sex, Phenotypic[Text Word])) OR (Genotypic Sex[Text Word])) OR (Sex, Genotypic[Text Word]))) OR ((((Sex Factors[MeSH Terms]) OR (Factor, Sex[Text Word])) OR (Factors, Sex[Text Word])) OR (Sex Factor[Text Word]))))
Scopus	6.9.2021, 7.23.2021, 8.10.2021	((TITLE-ABS-KEY (obsessive-compulsive AND disorder) OR TITLE-ABS-KEY (disorder, AND obsessive-compulsive) OR TITLE-ABS-KEY (disorders, AND obsessive-compulsive) OR TITLE-ABS-KEY (obsessive AND compulsive AND disorder) OR TITLE-ABS-KEY (obsessive-compulsive AND disorders) OR TITLE-ABS-KEY (neurosis, AND obsessive-compulsive) OR TITLE-ABS-KEY (neuroses, AND obsessive-compulsive) OR TITLE-ABS-KEY (neurosis, AND obsessive AND compulsive) OR TITLE-ABS-KEY (obsessive-compulsive AND neuroses) OR TITLE-ABS-KEY (obsessive-compulsive AND neurosis) OR TITLE-ABS-KEY (anankastic AND personality) OR TITLE-ABS-KEY (anankastic AND personalities) OR TITLE-ABS-KEY (personalities, AND anankastic) OR TITLE-ABS-KEY (personality, AND anankastic))) AND ((TITLE-ABS-KEY (covid-19) OR TITLE-ABS-KEY (covid 19) OR TITLE-ABS-KEY (covid-19 AND virus AND disease) OR TITLE-ABS-KEY (covid 19 virus AND disease) OR TITLE-ABS-KEY (covid-19 AND virus AND diseases) OR TITLE-ABS-KEY (disease, AND covid-19 AND virus) OR TITLE-ABS-KEY (virus AND disease, AND covid-19) OR TITLE-ABS-KEY (covid-19 AND virus AND infection) OR TITLE-ABS-KEY (covid 19 virus AND infection) OR TITLE-ABS-KEY (covid-19 AND virus AND infections) OR TITLE-ABS-KEY (infection, AND covid-19 AND virus) OR TITLE-ABS-KEY (virus AND infection, AND covid-19) OR TITLE-ABS-KEY (2019-ncov AND infection) OR TITLE-ABS-KEY (2019 ncov AND infection) OR TITLE-ABS-KEY (2019-ncov AND infections) OR TITLE-ABS-KEY (infection, AND 2019-ncov) OR TITLE-ABS-KEY (coronavirus AND disease-19) OR TITLE-ABS-KEY (coronavirus AND disease 19) OR TITLE-ABS-KEY (2019 novel AND coronavirus AND disease) OR TITLE-ABS-KEY (2019 novel AND coronavirus AND infection) OR TITLE-ABS-KEY (2019-ncov AND disease) OR TITLE-ABS-KEY (2019 ncov AND disease) OR TITLE-ABS-KEY (2019-ncov AND diseases) OR TITLE-ABS-KEY (disease, AND 2019-ncov) OR TITLE-ABS-KEY (covid19) OR TITLE-ABS-KEY (coronavirus AND disease 2019) OR TITLE-ABS-KEY (disease AND 2019, AND coronavirus) OR TITLE-ABS-KEY (sars AND coronavirus 2 infection) OR TITLE-ABS-KEY (sars-cov-2 AND infection) OR TITLE-ABS-KEY (infection, AND sars-cov-2) OR TITLE-ABS-KEY (sars AND cov 2 infection) OR TITLE-ABS-KEY (sars-cov-2 AND infections) OR TITLE-ABS-KEY (covid-19 AND pandemic) OR TITLE-ABS-KEY (covid 19 pandemic) OR TITLE-ABS-KEY (covid-19 AND pandemics) OR TITLE-ABS-KEY (pandemic, AND covid-19))) AND (((TITLE-ABS-KEY (female) OR TITLE-ABS-KEY (females))) OR ((TITLE-ABS-KEY (male) OR TITLE-ABS-KEY (males))) OR ((TITLE-ABS-KEY (women) OR TITLE-ABS-KEY (girls) OR TITLE-ABS-KEY (girl) OR TITLE-ABS-KEY (woman) OR TITLE-ABS-KEY (women's AND groups) OR TITLE-ABS-KEY (women AND groups) OR TITLE-ABS-KEY (women's AND group))) OR ((TITLE-ABS-KEY (men) OR TITLE-ABS-KEY (boys) OR TITLE-ABS-KEY (man) OR TITLE-ABS-KEY (boy))) OR ((TITLE-ABS-KEY (sex) OR TITLE-ABS-KEY (phenotypic AND sex) OR title-abs KEY (sex, AND phenotypic) OR TITLE-ABS-KEY (genotypic AND sex) OR TITLE-ABS-KEY (sex, AND genotypic))) OR ((TITLE-ABS-KEY (sex AND factors) OR TITLE-ABS-KEY (factor, AND sex) OR TITLE-ABS-KEY (factors, AND sex) OR TITLE-ABS-KEY (sex AND factor))))
Web of Science	6.10.2021, 7.24.2021, 8.10.2021	TOPIC: ((((Obsessive-Compulsive Disorder) OR (Disorder, Obsessive-Compulsive) OR (Disorders, Obsessive-Compulsive) OR (Obsessive Compulsive Disorder) OR (Obsessive-Compulsive Disorders) OR (Neurosis, Obsessive-Compulsive) OR (Neuroses, Obsessive-Compulsive) OR (Neurosis, Obsessive Compulsive) OR (Obsessive-Compulsive Neuroses) OR (Obsessive-Compulsive Neurosis) OR (Anankastic Personality) OR (Anankastic Personalities) OR (Personalities, Anankastic) OR (Personality, Anankastic))) AND (((COVID 19) OR (COVID-19 Virus Disease) OR (COVID-19) OR (COVID 19 Virus Disease) OR (COVID-19 Virus Diseases) OR (Disease, COVID-19 Virus) OR (Virus Disease, COVID-19) OR (COVID-19 Virus Infection) OR (COVID 19 Virus Infection) OR (COVID-19 Virus Infections) OR (Infection, COVID-19 Virus) OR (Virus Infection, COVID-19) OR (2019-nCoV Infection) OR (2019 nCoV Infection) OR (2019-nCoV Infections) OR (Infection, 2019-nCoV) OR (Coronavirus Disease-19) OR (Coronavirus Disease 19) OR (2019 Novel Coronavirus Disease) OR (2019 Novel Coronavirus Infection) OR (2019-nCoV Disease) OR (2019 nCoV Disease) OR (2019-nCoV Diseases) OR (Disease, 2019-nCoV) OR (COVID19) OR (Coronavirus Disease 2019) OR (Disease 2019, Coronavirus) OR (SARS Coronavirus 2 Infection) OR (SARS-CoV-2 Infection) OR (Infection, SARS-CoV-2) OR (SARS CoV 2 Infection) OR (SARS-CoV-2 Infections) OR (COVID-19 Pandemic) OR (COVID 19 Pandemic) OR (COVID-19 Pandemics) OR (Pandemic, COVID-19) OR (COVID-19))) AND (((Female) OR (Females) OR (Male) OR (Males) OR (Women) OR (Girls) OR (Girl) OR (Woman) OR (Women's Groups) OR (Women Groups) OR (Women's Group) OR (Men) OR (boys) OR (man) OR (boy) OR (Sex) OR (Phenotypic Sex) OR (Sex, Phenotypic) OR (Genotypic Sex) OR (Sex, Genotypic) OR (Sex Factors) OR (Factor, Sex) OR (Factors, Sex) OR (Sex Factor))))

https://doi.org/10.1017/neu.2023.15 Published online by Cambridge University Press

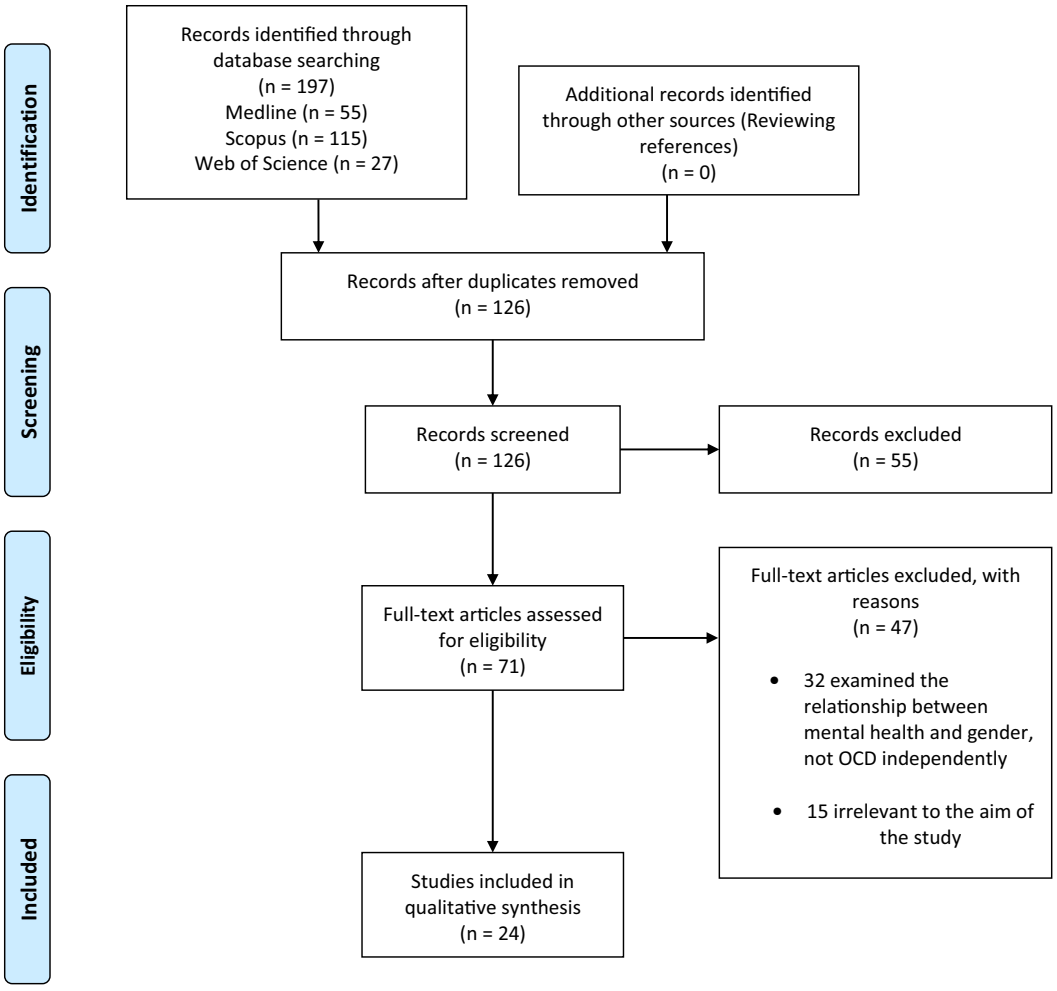

Fig. 1. Diagram of the literature search (PRISMA 2009 Flow Diagram).

gender-related keywords, 197 articles were obtained, of which 24 met our inclusion criteria and we present them based on the study population type, the country where the study was conducted, and the obtained results. Overall, more than half of the articles stated the role of gender in OCD during the COVID-19 pandemic, with 13 articles identifying gender as a risk factor but 11 articles declaring OCD as independent of gender. Several articles referred to the role of the female gender regarding OCD, some to the role of the male gender, and some did not identify gender as a risk factor. Studies have been conducted in North America, Europe, the Middle East, and China. The main part of the articles belonged to two regions of Europe and the Middle East. Except for three cases that were cohort studies, the rest of the studies used the cross-sectional method. In the majority of articles, the participants were more female than male, a difference that was severe in a significant number of studies. Table 2 presented the general characteristics of included studies.

As Table 2 demonstrates, the studies have many differences from each other. They have been carried out in different geographical areas, examined various sample groups, and had different objectives for their study. Therefore, for a better and more targeted investigation, the studies were divided into different subgroups to reduce their heterogeneity from each other, and by examining these subgroups, specific results and conclusions can be reached. These subgroups are presented in detail in the discussion section. One of these divisions was studies that investigated the prevalence of OCD during the COVID-19 pandemic, for which a meta-analysis was conducted.

The total prevalence of OCD during the COVID-19 pandemic was reported in seven studies (Darvishi *et al.*, 2020; Munk *et al.*, 2020; Zheng *et al.*, 2020; Aftab *et al.*, 2021; AlHusseini *et al.*, 2021; McKune *et al.*, 2021; Taher *et al.*, 2021) and results of quantitative synthesis with random effects analysis found a 41.2% OCD prevalence (95% CIs: 27.8–55.9%; I^2: 99.07%) (Fig. 2).

The prevalence of OCD in both genders was investigated in five studies (Darvishi *et al.*, 2020; Zheng *et al.*, 2020; AlHusseini *et al.*, 2021; McKune *et al.*, 2021; Taher *et al.*, 2021), and the meta-analysis using random effect analysis indicated that the female gender had a OCD prevalence of 47.1% (95% CIs: 30.3–64.5%; I^2: 98.62%), while the male gender had a prevalence of 39.1% (95% CIs: 23.8–56.9%; I^2: 97.38%) (Fig. 3). Therefore, compared to the male gender, OCD prevalence was higher in the females, however, this difference was not statistically significant.

Discussion

The current study is the first one to compare being female or male as a risk factor for OCD during the COVID-19 pandemic. As we know, the COVID-19 pandemic is one of the worst diseases that mankind has faced during the last century. Several studies indicated that the impression of this pandemic on mental health is remarkable (Hossain *et al.*, 2020; Xiong *et al.*, 2020a; Vindegaard & Benros,

https://doi.org/10.1017/neu.2023.15 Published online by Cambridge University Press

Table 2. Characteristics of included studies

Reference	Study design and duration (Sample number)	Place of study	Mean age (SD) or age range	Gender distribution	OCD parameters (measurement tool)	Categorical variable' (Gender) association parameters	Study population	Significant results
Mazza *et al.* (2020)	Prospective cohort Study over 1 month $N = 402$	Italy	Mean age of 57.80 ± 13.33 Mean age of females 55.90 ± 14.69 Mean age of males 58.79 ± 12.49	65.92% (265) Male/ 34.07% (137) Female	Obsessive-Compulsive Inventory (OCI)	Student's *t*-test/ Pearson $\chi 2$ test	Patients surviving COVID-19	Females suffered more in all psychopathological dimensions including obsessive compulsive disorder
Ahmed *et al.* (2021)	Cross-sectional study $N = 524$	Egypt	53.05% in range 31–40 38.2% in range 20–30	Total: $N = 524$ 42.6% (223) Male/ 57.4% (301) Female Non HCWs: $N = 402$ 43% (173) Male/ 57% (229) Female HCWs: $N = 122$ 41% (50) Male/59% (72) Female	Arabic version of Yale-Brown Obsessive-Compulsive Scale (Y-BOCS)	The Chi-square test	General Population and Health Care Workers	Female gender is an effective factor for the OCD's symptom severity during the COVID-19 pandemic
Fontenelle *et al.* (2021)	Cross-sectional study $N = 829$	United States	Mean age of 38.52 ± 12.69	47.4% (393) Male/ 52.6% (436) Female	The Dimensional Obsessive- Compulsive Scale (DOCS)/ Vancouver Obsessional Compulsive Inventory – Mental Contamination (VOCI-MC)	McNemar tests/ Regression analysis	General population	Female gender predicted increased DOCS scores and greater excessive OCD symptoms during the COVID-19 pandemic
El O thman *et al.* (2021)	Cross-sectional study $N = 386$	Lebanon	Mean age of 31.32 ± 11.11	24.1% (93) Male/ 75.9% (293) Female	Yale-Brown Obsessive-Compulsive Scale (Y-BOCS)	Descriptive analysis with the absolute frequency and percentages/Linear regression analysis	General population	A remarkably higher mean of obsession and compulsion alongside with OCS score was indicated in females compared to males
Darvishi *et al.* (2020)	Cross-sectional study $N = 150$	Iran	Mean age of Females: 16.37 / Mean age of Males: 16.97	35.3% (53) Male/ 64.7% (97) Female	Maudsley Obsessive-Compulsive Inventory Questionnaire (MOCI)	-	High school and pre-university students (13–19 years)	The results showed that the prevalence of OCD symptoms and severity of 4 subscales of OCD was remarkably higher in females compared to males
Højgaard *et al.* (2021)	Cross-sectional study $N = 201$	Denmark	Mean age of 39.66 [37.49, 41.82]	34.3% (69) Male/ 65.7% (132) Female	Five questions based on the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS)	Bivariate analyses/ Multiple linear Regression analysis/ Independent sample *T*-test	Members of Danish OCD Association (OCD patients)	Female gender is significantly associated with increasing OCD severity during the COVID-19 pandemic
Abuhmaidan and Al-Majali (2020)	Cross-sectional study $N = 258$	UAE	91.1% in range ≥ 20 8.9% in range ≤ 20	23.6% (61) Male/ 76.4% (197) Female	R S CL-90 Symptoms Check List	*T*-test	Undergraduate University Students	Females had a greater rate of OCD in comparison with males
Dehkordi *et al.* (2021)	Cross-sectional study $N = 2919$	Iran	–	35.67% (1004) Male/ 64.33% (1811) Female	Symptom Check List-revised (SCL-90-R)	–	General Population	Gender was not an influent factor with regard to the dimension of psychological problems including OCD

(*Continued*)

Table 2. (*Continued*)

Reference	Study design and duration (Sample number)	Place of study	Mean age (SD) or age range	Gender distribution	OCD parameters (measurement tool)	Categorical variable' (Gender) association parameters	Study population	Significant results
Zhang *et al.* (2020)	Cross-sectional study $N = 2182$	China	96.3% in range 18–60 3.2% in range > 60	35.8% (781) Male/ 64.2% (1401) Female	Chinese versions of the Symptom Check List-revised (SCL-90-R)	$\chi 2$ tests/Multivariate logistic regression analyses	General Population (Medical health workers and non-medical health workers)	Being female is not a common risk factor for OCD
Juan *et al.* (2020)	Cross-sectional study $N = 456$	China	Mean age of 30.67 ± 7.48	29.4% (134) Male/ 70.6% (322) Female	Yale-Brown Obsessive-Compulsive Scale (Y-BOCS)	The Chi-square test/ Multiple logistic regression analysis	Hospital Staff	Females are at higher risk of psychological distress, particularly with regard to OCS. It was observed that females had more OCD symptom severity
McKune *et al.* (2021)	Cross-sectional study $N = 280$	United States	No Data (K-12 Students)	48% (135) Male/ 51.8% (145) Female	A set of categorical questions (5-point Likert scale) for each symptom of OCD	Bivariate analysis/ Logistic and multinomial logistic regression analysis	K-12 Students	The female gender is at higher risk of OCD-related symptoms
Aftab *et al.* (2021)	Cross-sectional study $N = 418$	All over the world	84.7% in range ≥ 25 12.2% in range 20–30	34.9% (146) Male/ 65.1% (272) Female	Zohar–Fineberg Obsessive Compulsive Screen (ZF-OCS)	The Chi-square test	Undergraduate and postgraduate medical students	No significant correlation between gender and OCD diagnosis
Munk *et al.* (2020)	Cross-sectional study $N = 949$	Germany	Mean age of 28.9 ± 10.8	19.9% (189) Male/ 79.5% (754) Female/ 0.6% (6) Non-binary	German version of OCI-R (Obsessive Compulsive Inventory Revised)	Descriptive analysis	Members of Justus-Liebig University of Giessen, Germany	Gender is not a significant variable, and it did not affect the OCD symptom severity during the COVID-19 pandemic
Alateeq *et al.* (2021)	Cross-sectional study $N = 2909$	Saudi Arabia	56.4% in range 18–29 18.2% in range 30–39	26.1% (760) Male/ 73.9% (2149) Female	The Brief Obsessive-Compulsive Scale (BOCS)	The Chi-square test	General Population	Gender is not a significant variable, and it did not affect the OCD symptom severity during the COVID-19 pandemic
Davide *et al.* (2020)	Cross-sectional study $N = 30$	Italy	Mean age of 43.17 ± 14.87	46.66% (14) Male/ 53.33% (16) Female	Yale-Brown Obsessive-Compulsive Scale Severity Score (Y–BOCS-SC)	Student's t-tests/ Generalized linear regression analysis	OCD patients	Gender cannot be considered as an effective factor in the worsening of OCD symptoms
Zheng *et al.* (2020)	Cross-sectional study $N = 541$	China	44.7% in range 25–34 23.7% in range 15–24	42.5% (230) Male/ 57.5% (311) Female	Yale-Brown Obsessive-Compulsive Scale (Y-BOCS)	The Chi-square test/ Multiple logistic regression analysis	General Population	Gender is not a significant factor for OCD prevalence
Taher *et al.* (2021)	Cross-sectional study $N = 1644$	Iraq	Mean age of 20.73 ± 1.83	32.1% (528) Male/ 67.9% (1116) Female	Arabic version of Obsessive- Compulsive Inventory – Revised (OCI-R)	The Chi-square test/ T-test	Medical students	No correlation between gender and OCD prevalence
Moreira *et al.* (2021)	Cross-sectional study $N = 1280$	Portugal	Mean age of 37.1 ± 12.1	20.16% (258) Male/ 79.84% (1022) Female	Obsessive- Compulsive Inventory – Revised (OCI-R)	Linear regression analysis	A Portuguese sample (General Population)	Gender is not a protective element of mental health and OCD status

Table 2. (*Continued*)

Meda *et al.* (2021)	Cohort study over 6 months $N = 358$	Italy	Mean age of 21.3 ± 2.1	20.11% (72) Male/ 79.89% (286) Female	Obsessive- Compulsive Inventory – Revised (OCI-R)	The β regression coefficient estimate	Students (aged 18–30)	Gender does not act as a risk factor
Ferreira *et al.* (2021)	Cross-sectional study $N = 420$	Portugal	Total: 53.0 (23.0) Frontline Workers: 47.0 (22.0) Non-Frontline Workers: 60.0 (21.2)	Total: $N = 420$ 51.7% (217) Male/ 48.3% (203) Female Frontline Workers: $N = 200$ 46.5% (93) Male/53.5% (107) Female Non-Frontline Workers: $N = 220$ 56.4% (124) Male/43.6% (96) Female	Obsessive- Compulsive Inventory – Revised (OCI-R)	The Chi-square test	Health Care Workers (Physicians)	Gender is not a significant variable, and it did not affect the OCD symptom severity during the COVID-19 pandemic
Samuels *et al.* (2021)	Cross-sectional study $N = 2117$	United States	Mean age of 45.8 ± 16.0	46.3% (980) Male/ 53.7% (1137) Female	Obsessive- Compulsive Inventory – Revised (OCI-R)/ Dimensional Yale-Brown Obsessive-Compulsive Scale (DY-BOCS)	Logistic regression analysis/Adjusted models	General Population	Men are at more risk for contamination obsessions and contamination phobias in comparison with women
Abba-Aji *et al.* (2020)	Cross-sectional study $N = 6041$	Canada	43.3% in range 41–60 37% in range 26–40	12.4% (740) Male/ 86.6% (5185) Female/1.0% (61) Other Gender	The Brief Obsessive-Compulsive Scale (BOCS) with two items	The Chi-square test	Subscribers to Text4Hope (People with possible mental issues)	A high correlation between obsessions related to dirt, germs, and viruses and male gender was observed, but there was no significant correlation between gender as a variable and compulsive hand washing
AlHusseini *et al.* (2021)	Cross-sectional study $N = 2186$	Saudi Arabia	28.4% in range 25–35 22.1% in range 18–24 21.9% in range 36–45	39.5% (864) Male/ 60.5% (1322) Female	Obsessive- Compulsive Inventory – Revised (OCI-R)	The Chi-square test	General Population	Males showed more frequency of OCD than females
Ji *et al.* (2020)	Cohort study over 80 days? Survey 1: $N = 13\,478$ Survey 2: $N = 8467$ Survey 3: $N = 8816$ Matched subjects from all surveys: $N = 4006$	China	Mean age of survey 1: 21.3 ± 2.5 Mean age of survey 2: 21.2 ± 2.3 Mean age of survey 3: 20.9 ± 2.0	Survey 1: 34.6% (4662) Male/65.4% (8816) Female Survey 2: 35.3% (2991) Male/64.7% (5476) Female Survey 3: 35.3% (3113) Male/54.7% (5703) Female	Yale-Brown Obsessive-Compulsive Scale (Y-BOCS)	Analysis of variance (ANOVA)/ The Chi-square tests/ Regression analyses	College students (medical and nonmedical students)	Males aged < 26 have a strong correlation with a higher Y-BOCS score, but the rates of possible OCD were not remarkably different between males and females aged ≥ 26 years

Table 3. Results of evaluating cohort studies

Study	Selection				Compatibility		Outcome		Total score
Mazza *et al.* (2020)	*	*	*	*			*	*	6
Meda *et al.* (2021)	*	*	*	*			*	*	6
Ji *et al.* (2020)	*	*	*	*			*	*	6

Table 4. Results of evaluating cross-sectional studies

Study	Selection				Compatibility		Outcome		Total score
Ahmed *et al.* (2021)	*	*			**	**	*	*	8
Fontenelle *et al.* (2021)	*	*			**	**	*	*	8
El O thman *et al.* (2021)	*	*			**	**	*	*	8
Darvishi *et al.* (2020)					**	*	*	*	5
Højgaard *et al.* (2021)	*	*			*	**	*	*	7
Abuhmaidan and Al-Majali (2020)					* *	*	*	*	5
Dehkordi *et al.* (2021)		*			**	*	*	*	6
Zhang *et al.* (2020)	*	*			**	**	*	*	8
Juan *et al.* (2020)	*	*			**	*	*	*	7
McKune *et al.* (2021)	*	*			*	*	*	*	6
Aftab *et al.* (2021)	*	*			**	*	*	*	7
Munk *et al.* (2020)	*	*			**	*	*	*	7
Alateeq *et al.* (2021)	*	*			**	**	*	*	8
Davide *et al.* (2020)					**	*	**	*	6
Zheng *et al.* (2020)	*	*			**	**	*	*	8
Taher *et al.* (2021)	*	*			**	*	*	*	7
Moreira *et al.* (2021)		*			**	**	*	*	7
Ferreira *et al.* (2021)	*	*	*		**	**	*	*	9
Samuels *et al.* (2021)	*	*			**	*	*	*	7
Abba-Aji *et al.* (2020)	*	*			*	**	*	*	7
AlHusseini *et al.* (2021)	*	*			**	**	*	*	8

2020). The containment measures implemented to reduce the progression of the COVID-19 pandemic can increase the risk of serious mental disorders, including OCD (Davide *et al.*, 2020; Ji *et al.*, 2020; Brooks *et al.*, 2020b). The recommendations by WHO and other health organisations can cause difficulties for OCD patients and spread the prevalence of OCD among the general population. One of the most important and troublemaking recommendations in this area is hand washing (Abba-Aji *et al.*, 2020). A process that is also used to identify OCD in individuals, considering the fact that hand washing is one of the main symptoms of OCD (Brady *et al.*, 2010). In a pandemic, government and community resources are under intense pressure, which deprives them of the ability to manoeuver properly when comes to mental health issues. Prolonged quarantines, business downturns, and the deaths of community members put countries in a difficult position. In these circumstances, attention to mental health, which does not show an immediate impact on society, is not a priority for policymakers. Therefore, the mental health of the community suffers more, and its long-term effects are more severe. So, identifying at-risk groups can provide sufficient justification for investment and government attention, and thus, at a lower cost, improve the mental health of the community and reduce its long-term effects. With the explanations provided, it is clear that OCD is one of the disorders that is particularly affected by the pandemic and identifying groups at risk of this disease, especially whether women are at higher risk or men, can create better conditions for community mental health at a lower cost (Chu *et al.*, 2020; Davide *et al.*, 2020; Brooks *et al.*, 2020b; Galea *et al.*, 2020).

Several studies have previously evaluated such correlation as independent of the status of the COVID-19 outbreak. A meta-analysis by Fawcett *et al.* (2020), was performed to investigate the global prevalence of OCD and examine whether females are at higher risk than males and explore alternative moderators of OCD prevalence. Their search was fulfilled until January 2017 and 34 articles were ultimately included. Only the studies were included that the age range of their participants was more than 18 years old. They found that in a typical sample, females are 1.6 times more likely to have OCD compared to males, with a lifetime prevalence rate of 1.5% in females and 1.0% in males. In addition, women are at higher risk of experiencing OCD in their lifetime than men (Fawcett *et al.*, 2020). Also, a systematic review by Mathis *et al.* (2011) was conducted to investigate the gender differences in clinical, genetic, or familial aspects of OCD. This study indicated that male patients are more likely to present early onset of symptoms and chronic course of the disorder. On the other hand, female patients present more contamination/cleaning symptoms (Mathis *et al.*, 2011). These two studies have examined the state of OCD among men and women in a normal situation of society, but for the reasons mentioned, examining this relationship in a pandemic situation is a necessity to identify more sensitive groups.

Our search method resulted in 24 articles included, and noteworthy, except for three articles that used the cohort study method (Ji *et al.*, 2020; Mazza *et al.*, 2020; Meda *et al.*, 2021), all the other articles were based on the cross-sectional study method.

The articles reviewed in this systematic review were from different regions and countries, one-third of which belong to the Middle

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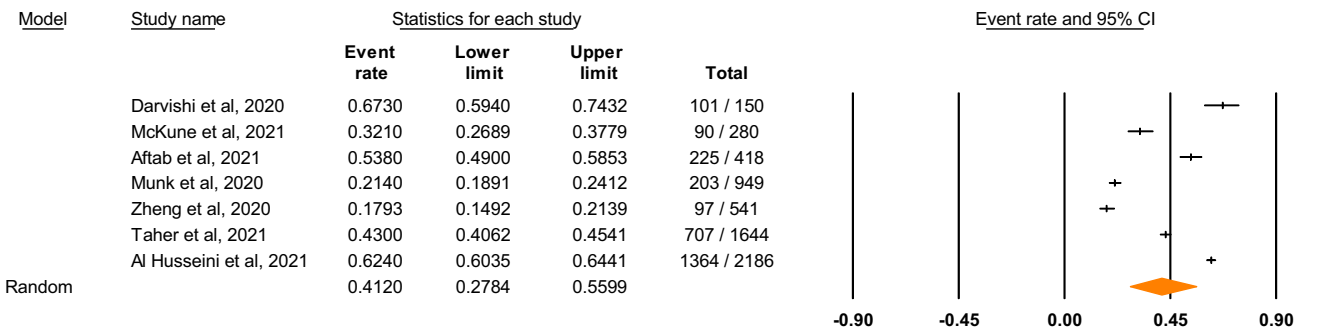

Fig 3. prevalence of OCD

Fig. 2. Prevalence of OCD in total population.

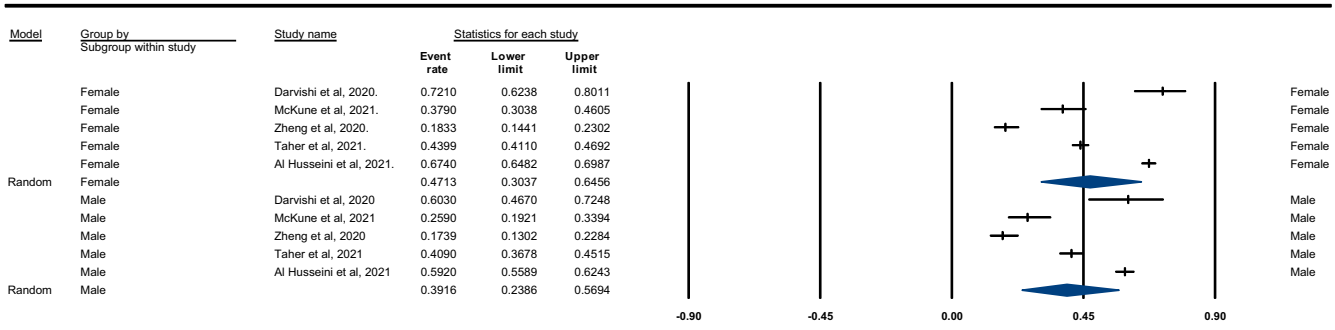

Fig 3. prevalence of OCD with subgroups of gender

Fig. 3. Prevalence of OCD among genders.

East and the other third to Europe, which could affect the generalizability of the study results.

The human development index (Roser, 2014), gender equality (Inglehart *et al.*, 2002; Ortenblad *et al.*, 2017), and the rate of employed women compared to men (Tzannatos, 1999; Elder & Schmidt, 2004) are the indicators that can influence the stated results. Considering the fact that the rate of all these indicators is different around the world, the Middle East and Europe cannot act as a sample model, and we recommend the Middle Eastern and European researchers investigate the effects of these indicators on the prevalence and symptom severity of OCD between males and females.

Before continuing with the article, we should refer to one of the articles that were done in Portugal and stated that the study population was selected from a Portuguese sample (higher than 18 years old), but then stated that more than 92% of the participants suffered from psychological disorders. Also, nearly 67% of the participants declared that they are suffering from physical disorders. These numbers are unusual for a sample that has selected its members from the general population. Therefore, this study loses the score of the first question (Representativeness of the sample) in our qualitative analysis (Moreira *et al.*, 2021).

As mentioned, the studies included in this systematic review have many differences from each other. They have been carried out in different geographical areas, examined various sample groups, and had different objectives for their study. Therefore, for a better and more targeted investigation, the studies were divided into different subgroups to reduce their heterogeneity from each other, and by examining these subgroups, specific results and conclusions can be reached.

As mentioned, in order to better and more targeted investigation, the studies were divided into different subgroups, and in one of them, we investigated the prevalence of OCD during the COVID-19 pandemic. Seven studies assessed the prevalence of OCD (Darvishi *et al.*, 2020; Munk *et al.*, 2020; Zheng *et al.*, 2020; Aftab *et al.*, 2021; AlHusseini *et al.*, 2021; McKune *et al.*, 2021; Taher *et al.*, 2021) and results of the meta-analysis showed a 41.2% OCD prevalence. All studies were based on the cross-sectional method. Of the seven studies (Darvishi *et al.*, 2020; Munk *et al.*, 2020; Zheng *et al.*, 2020; Aftab *et al.*, 2021; AlHusseini *et al.*, 2021; McKune *et al.*, 2021; Taher *et al.*, 2021), three were conducted in the Middle East (Darvishi *et al.*, 2020; AlHusseini *et al.*, 2021; Taher *et al.*, 2021), one in the United States (McKune *et al.*, 2021), one in Europe (Munk *et al.*, 2020), and one in China (Zheng *et al.*, 2020). A study also selected its population from all over the world (Aftab *et al.*, 2021). These studies used five different methods to assess OCD status. Three studies used the OCI-R method

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Table 5. OCD symptoms

Reference	Study population	More at risk gender	Female symptoms	Male symptoms
Samuels *et al.* (2021)	General population	Male	–	Contamination obsessions, Contamination phobias
Darvishi *et al.* (2020)	High school and pre-university students (13–19 years)	Female	Checking, Washing, Strictness, Doubting	–
Abba-Aji *et al.* (2020)	Subscribers to Text4Hope (People with possible mental issues)	Male	–	Obsessions related to dirt, germs, and viruses (Being worried about getting contaminated with dirt, germs, and viruses)

(Munk *et al.*, 2020; AlHusseini *et al.*, 2021; Taher *et al.*, 2021). The other methods including Y-BOCS (Zheng *et al.*, 2020), MOCI (Darvishi *et al.*, 2020), and ZF-OCS (Aftab *et al.*, 2021) were each selected by one study. A study also stated that it used a self-designed instrument to investigate OCD status, which caused it to lose one point in the selection section of the qualitative analysis (McKune *et al.*, 2021). These studies selected their study sample from three different groups. Two studies were conducted among under 18 years old students (Darvishi *et al.*, 2020; McKune *et al.*, 2021), three studies among university students (Munk *et al.*, 2020; Aftab *et al.*, 2021; Taher *et al.*, 2021), and two studies among the general population (Zheng *et al.*, 2020; AlHusseini *et al.*, 2021). The largest number of sample groups in studies was 2186, which belonged to a study conducted among the general population in the Middle East (AlHusseini *et al.*, 2021), and the lowest number of sample groups was related to another study in the Middle East with the number of 150, which was conducted among under 18 years old students (Darvishi *et al.*, 2020). In the qualitative analysis (Newcastle −Ottawa scale) conducted for these studies, two studies scored 8 points (Zheng *et al.*, 2020; AlHusseini *et al.*, 2021), three studies scored 7 points (Munk *et al.*, 2020; Aftab *et al.*, 2021; Taher *et al.*, 2021), one study scored 6 points (McKune *et al.*, 2021), and one study scored 5 points (Darvishi *et al.*, 2020). The two studies that had the lowest scores also had the smallest number of samples (Darvishi *et al.*, 2020; McKune *et al.*, 2021), so one studied 150 people (Darvishi *et al.*, 2020) and the other 280 people (McKune *et al.*, 2021). Both studies were conducted among under 18 years old students (Darvishi *et al.*, 2020; McKune *et al.*, 2021). Also, the two studies with the highest scores were both conducted among the general population (Zheng *et al.*, 2020; AlHusseini *et al.*, 2021).

The pre-COVID-19 meta-analysis that was reviewed at the beginning of the discussion section reported that overall current, period, and lifetime estimates of OCD prevalence were 1.1%, 0.8%, and 1.3%, respectively (Fawcett *et al.*, 2020). Furthermore, in several studies, OCD's lifetime prevalence was calculated from 1.8% to 3.3% (Karno *et al.*, 1988; Weissman *et al.*, 1994; Mohammadi *et al.*, 2004; Ruscio *et al.*, 2010; Subramaniam *et al.*, 2012; Jaisoorya *et al.*, 2017). The results of the current meta-analysis show a significant difference from the results of studies conducted before the COVID-19 pandemic and indicate a sharp increase in the prevalence of OCD. This higher prevalence of OCD during the COVID-19 pandemic might be due to several reasons. One of these reasons can be related to the health recommendations of the authorities at the beginning of the outbreak, who prompted society to wash their hands frequently (Davide *et al.*, 2020). Considering that OCD status in a high number of patients is affected by excessive washing, the feeling of being contaminated, and the fear of dirt (Brady *et al.*, 2010), and taking into account the general fear of getting infected with the virus, the contamination fear might increase (Abba-Aji *et al.*, 2020), and the OCD symptoms might worsen (Reynolds *et al.*, 2008). In addition, frequent cleaning habits becoming a normal and prevalent protective behaviour might cause contamination-related obsessions and compulsions (Davide *et al.*, 2020). Another reason can be related to stress and anxiety as two risk factors of OCD (Weingarden *et al.*, 2016; Adams *et al.*, 2018; Raposo-Lima & Morgado, 2020), which have increased due to the conditions resulting from the COVID-19 pandemic in various social groups such as hospital staff, university students, etc. (Couarraze *et al.*, 2021; Durbas *et al.*, 2021; Özdin & Bayrak Özdin, 2020), which may have subsequently caused an increase in the prevalence of OCD. Another factor can be related to not receiving proper medical and support services during the pandemic. As a result of the quarantine, many support centres for mental patients were forced to close or reduce the provision of services, and people's access to these centres was disrupted. It is also possible that in order to be less present in society and reduce the possibility of contracting the Coronavirus, people have given up going to medical centres and receiving services, which may have caused mental problems or added to their previous problems. Finally, another reason can be related to the non-adaptation of the methods of assessing the status of OCD with conditions such as the COVID-19 pandemic, which has caused the prevalence of OCD to be falsely shown. For example, some OCD behaviours that have emerged or increased during the pandemic will continue permanently in some people, but they will probably subside after a while in the majority of society. In this situation, it does not seem correct to consider these people as suffering from OCD. Also, some behaviours that are considered OCD behaviour in various assessment tools have inevitably increased during the pandemic, and the sum of these factors has probably caused the prevalence of OCD to be overestimated.

In another part of the meta-analysis, five studies that investigated the prevalence of OCD in both genders during the COVID-19 pandemic were examined (Darvishi *et al.*, 2020; Zheng *et al.*, 2020; AlHusseini *et al.*, 2021; McKune *et al.*, 2021; Taher *et al.*, 2021). The results of the meta-analysis indicated that the female gender had an OCD prevalence of 47.1%, while the male gender had a prevalence of 39.1%. Therefore, compared to the male gender, OCD prevalence was higher in the females; however, this difference was not statistically significant. These five studies were conducted in three different geographical regions, three of which were in the Middle East (Darvishi *et al.*, 2020; AlHusseini *et al.*, 2021; Taher

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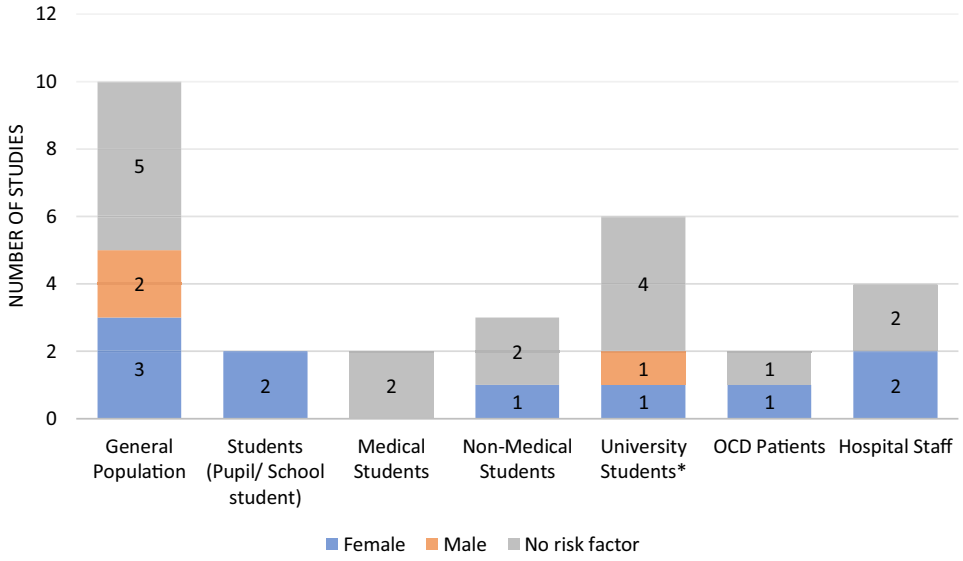

Fig. 4 Results distribution (whether gender is a risk factor and if so which gender) in different demographical subgroups. *University Students consist of both medical and non-medical students. A study in this section identified the males aged <26 as a risk factor, however, they declared that the rates of possible OCD were not remarkably different between males and females aged ≥26 years (This study is considered in this figure).

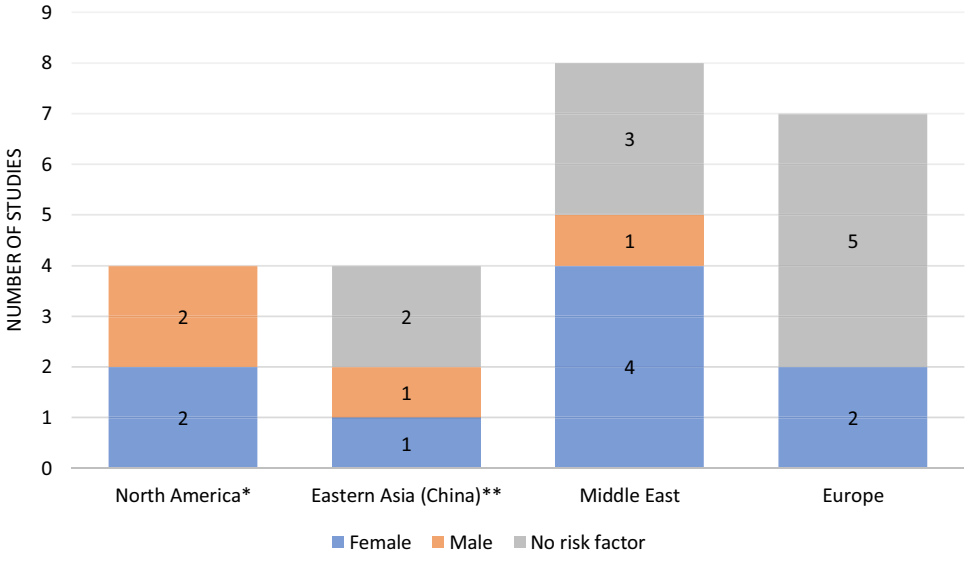

Fig. 5 Results distribution (whether gender is a risk factor and if so which gender) in different geographical locations. * A study in this section (categorized in male results) although in some items introduced male gender as a risk factor (the obsessions related to dirt, germs, and viruses), but in some late items (compulsive hand washing) did not consider gender as a risk factor at all. ** A study in this section (categorized in male results) emphasized the role of the male gender under 26 years old. But they also declared that the rates of possible OCD were not remarkably different between males and females aged ≥26 years.

et al., 2021). They also used four different methods to evaluate the status of OCD (OCI-R (AlHusseini *et al.*, 2021; Taher *et al.*, 2021), Y-BOCS (Zheng *et al.*, 2020), MOCI (Darvishi *et al.*, 2020), and a self-designed instrument (McKune *et al.*, 2021)). Two of these studies were conducted among under 18 years old students (Darvishi *et al.*, 2020; McKune *et al.*, 2021), one among medical students, and two among the general population (Zheng *et al.*, 2020; AlHusseini *et al.*, 2021). The studies among the general population got the highest qualitative analysis score (Zheng *et al.*, 2020; AlHusseini *et al.*, 2021),and the studies among under 18 years old students got the lowest qualitative analysis score (Darvishi *et al.*, 2020; McKune *et al.*, 2021).

The findings of this meta-analysis are consistence with the meta-analysis that investigated the global prevalence of OCD before the COVID-19 pandemic, which identified the female gender as a risk factor for OCD prevalence (Fawcett *et al.*, 2020). This higher prevalence of OCD among women can be due to the greater vulnerability of females to risk factors related to OCD during the COVID-19 pandemic. For example, because of the pandemic, increasing anxiety was imposed on society and according to a study by Özdin et al, women suffered more. This study reported that 45.1% of its sample scored above the cut-off point for anxiety, and women had higher levels of anxiety and health anxiety (Özdin & Bayrak Özdin, 2020). Since OCD was classified as an anxiety disorder until recently and the role of anxiety in OCD is clear (Weingarden *et al.*, 2016), this factor is one of the justifications for the higher prevalence of OCD among females. On the other hand, the pandemic caused damage to the economy and many people lost their jobs. In this meta-analysis, five studies examined the prevalence of OCD in both genders during the pandemic (Darvishi *et al.*, 2020; Zheng *et al.*, 2020; AlHusseini *et al.*, 2021; McKune *et al.*, 2021; Taher *et al.*, 2021). Three of these five studies were conducted in the Middle East (Darvishi *et al.*, 2020; AlHusseini *et al.*, 2021; Taher *et al.*, 2021). Therefore, examining the situation in the Middle East in terms of these factors can be helpful. According to the World Bank, the unemployment rate of men in the Middle East and North Africa increased from 7.1% in 2019 to 9.3% in 2021. But in the same period, women suffered more, and the unemployment rate increased from 17.4% to 19.7%. Also, the high unemployment rate is considered a risk factor

https://doi.org/10.1017/neu.2023.15 Published online by Cambridge University Press

Table 6. The major results of each population whether gender was a risk factor or not, and if so, which gender

Gender Population		Females	Males	Gender independent
Sample Groups	General population			
	Students (Pupil/ School student)			
	Medical students			
	Non-medical students			
	University students*			
	OCD patients			
	Hospital staff			
Geographical areas	Northern America			
	Eastern Asia (China)			
	Middle East			
	Europe			

*University students consist of both medical and non-medical students.

for OCD (Mohammadi *et al.*, 2004). Therefore, the higher rate of unemployment among women may serve as a justification factor for them being a possible risk factor for OCD.

Also, the rate of domestic violence against women increased during the COVID-19 pandemic (Kourti *et al.*, 2021; Women & Count, 2021). According to a report by United Nations, violence against women has increased to unprecedented levels during the pandemic (Women & Count, 2021). In a report, it is mentioned that trends regarding domestic violence are starting to emerge on a global scale, and various numbers from 25% to higher percentages have been mentioned regarding this increase (Boserup *et al.*, 2020). Also, domestic violence can act as a risk factor for OCD directly or indirectly through increasing anxiety (Ahmadzad-Asl *et al.*, 2016; Moasheri *et al.*, 2020). Therefore, in this situation, women can be considered as a risk factor for OCD.

One of the issues addressed in similar previous reviews has been the comparison of obsessive-compulsive symptoms among women and men. In the present article, it was not possible to compare the symptoms properly between men and women because none of our included studies were specifically designed to compare the symptoms of OCD between the two genders, but in this section, we present a number of symptoms that were specifically mentioned in our included studies.

A study conducted among the general population in the United States found that men are at more risk for contamination obsessions and contamination phobias in comparison with women (Samuels *et al.*, 2021). Another study conducted in Iran among students between the ages of 13 and 19 stated that the prevalence of OCD symptoms and severity of the following subscales of OCD (Checking, Washing, Strictness, Doubting subscales) was remarkably higher in females compared to males (Darvishi *et al.*, 2020). Another study was performed to assess prevalence and correlates of new-onset obsessive-compulsive symptoms among people with possible mental issues and found a high correlation between obsessions related to dirt, germs, and viruses, and male gender. It means that the male gender had a significant correlation with being worried about getting contaminated with dirt, germs, and viruses, compared to other respondents. On the other hand, this study stated that there is no significant correlation between gender as a variable and compulsive hand washing (Abba-Aji *et al.*, 2020) (Table 5).

In another division, the study population of the studies was investigated. The studies we reviewed in this article selected their study population from different groups of the community. To reduce the risk bias resulting from heterogeneity in the studied populations, we split the studies into several demographical subpopulation groups (including general population, students, medical students, non-medical students, university students, hospital staff, and obsessive-compulsive patients), and examined the mentioned relationship within these newly created categories.

Ten studies selected their target population from the general population (Ahmed *et al.*, 2021; Alateeq *et al.*, 2021; AlHusseini *et al.*, 2021; El O thman *et al.*, 2021; Fontenelle *et al.*, 2021; Zhang *et al.*, 2020; Zheng *et al.*, 2020; Dehkordi *et al.*, 2021; Moreira *et al.*, 2021; Samuels *et al.*, 2021) (two of the articles in this section will be reviewed in the section related to hospital staff either since the studies examined both populations (Zhang *et al.*, 2020; Ahmed *et al.*, 2021)), which five cases were conducted in the Middle East (Ahmed *et al.*, 2021; Alateeq *et al.*, 2021; AlHusseini *et al.*, 2021; El O thman *et al.*, 2021; Dehkordi *et al.*, 2021), two cases in the US (Fontenelle *et al.*, 2021; Samuels *et al.*, 2021) and two cases in China (Zhang *et al.*, 2020; Zheng *et al.*, 2020). There was also a case in Europe (Portugal) (Moreira *et al.*, 2021). Two studies in China both found that gender was not a risk factor for OCD during the current pandemic (Zhang *et al.*, 2020; Zheng *et al.*, 2020). However, two studies conducted in the United States did not show such a correlation with each other that one of them stated that female gender was a risk factor (Fontenelle *et al.*, 2021) and the other identified male gender as a risk factor (Samuels *et al.*, 2021). Of the five studies conducted in the Middle East (Ahmed *et al.*, 2021; Alateeq *et al.*, 2021; AlHusseini *et al.*, 2021; El O thman *et al.*, 2021; Dehkordi *et al.*, 2021), two were in Saudi Arabia (Alateeq *et al.*, 2021; AlHusseini *et al.*, 2021), one of which identified male gender as a risk factor (AlHusseini *et al.*, 2021), but the other did not consider gender as a risk factor (Alateeq *et al.*, 2021), which is also supported by another study in Iran (Dehkordi *et al.*, 2021). In contrast, two other studies in Lebanon (El O thman *et al.*, 2021) and Egypt (Ahmed *et al.*, 2021) identified female gender as a risk factor. The study conducted in Europe (Moreira *et al.*, 2021), like the Chinese studies (Zhang *et al.*, 2020; Zheng *et al.*, 2020), did not consider gender a risk factor. As is clear, studies conducted among the general population do not give us a definite conclusion, but overall, studies that considered gender as a non-risk factor weighed more. Two articles specifically examined this relationship among K-12 and under-19 years students (Darvishi *et al.*, 2020; McKune *et al.*, 2021). Both of these studies, conducted in the United States (McKune *et al.*, 2021) and Iran (Darvishi *et al.*, 2020), emphasised the role of the female gender in OCD during the COVID-19 pandemic. As it turns out, the role of the female gender in this section is clear. Two studies examined the status of OCD and its relationship to gender during the COVID-19 pandemic among medical students (Aftab *et al.*, 2021; Taher *et al.*, 2021). Both studies conducted in this section did not consider gender as a risk factor at all, one of which selected its study population from all around the world (Aftab *et al.*, 2021), which adds to its credibility. Also, three studies examined this relationship among non-medical students

https://doi.org/10.1017/neu.2023.15 Published online by Cambridge University Press

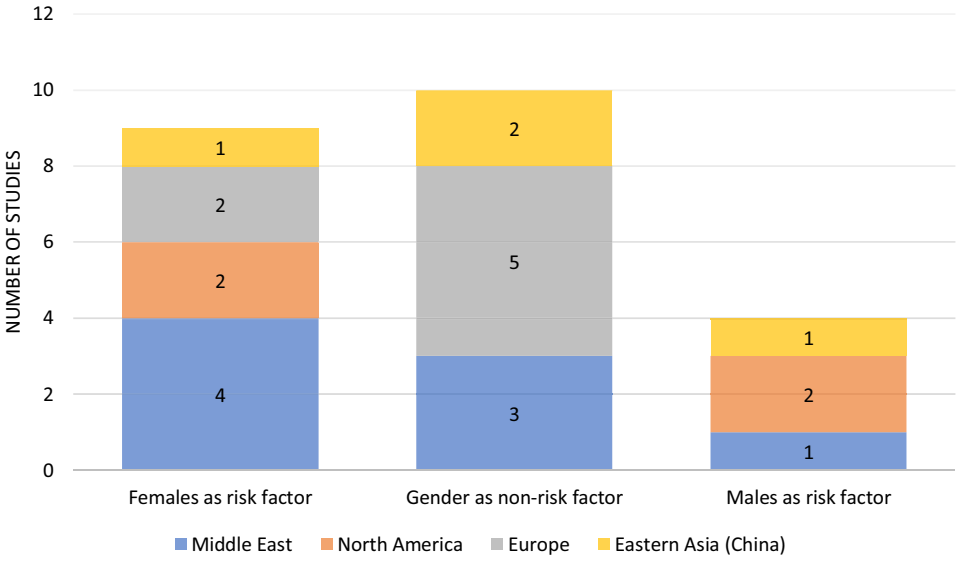

Fig. 6 Geographical distribution of studies based on their results (whether gender is a risk factor and if so which gender). *A study from all over the world stated that OCD was gender-independent during the COVID-19 pandemic; however, the purpose of this chart is to compare different geographical areas based on the obtained results, so the mentioned study is not included in this figure.

(Abuhmaidan & Al-Majali, 2020; Munk *et al.*, 2020; Meda *et al.*, 2021), none of whom identified male gender as a risk factor. One in the UAE identified female gender as a risk factor (Abuhmaidan & Al-Majali, 2020), and two other studies in Europe did not consider gender a risk factor (Munk *et al.*, 2020; Meda *et al.*, 2021). One study also examined this relationship between students of a university in China, including both medical students and non-medical students, and identified the males aged < 26 as a risk factor; however, they declared that the rates of possible OCD were not remarkably different between males and females aged ≥ 26 years (Ji *et al.*, 2020). In general, studies conducted among university students did not consider gender as a risk factor. Two studies examined this relationship among obsessive-compulsive patients (Davide *et al.*, 2020; Højgaard *et al.*, 2021). None of the two studies which was conducted in Europe considered the male gender a risk factor (Davide *et al.*, 2020; Højgaard *et al.*, 2021). As in the first section, which was done among the general population, the conflicting results of studies conducted among obsessive-compulsive patients do not lead us to a definite conclusion. Four studies also examined this relationship among hospital staff and health care workers (Juan *et al.*, 2020; Zhang *et al.*, 2020; Ahmed *et al.*, 2021; Ferreira *et al.*, 2021). A study in Europe did not consider gender a risk factor (Ferreira *et al.*, 2021), but two studies conducted in China yielded conflicting results, with one of them considering gender not as a risk factor (Zhang *et al.*, 2020), as in a European study, but the second study emphasised the role of female gender in OCD (Juan *et al.*, 2020). Also, a study in Egypt that examined the mentioned relationship among the general population and health care workers also emphasised the role of the female gender (Ahmed *et al.*, 2021). In this section, we see that the role of the female gender is more obvious so that none of the four articles in this section introduced male gender as a risk factor, and two articles directly introduced female gender as a risk factor (Fig. 4).

If we examine the studies not according to the type of study population, but according to the country and region in which they were conducted, we may reduce the risk biases related to different regions and thus reach new conclusions. To reduce the risk bias due to differences in the geographical regions of the studies, we split the studies into several geographical sub-population groups (including North America, Eastern Asia (China), Middle East, Europe), and examined the mentioned relationship within these newly created categories.

In studies conducted in the United States (Fontenelle *et al.*, 2021; McKune *et al.*, 2021; Samuels *et al.*, 2021) and Canada (Abba-Aji *et al.*, 2020), although they consider gender as a risk factor but we can't point at a specific gender, with two studies emphasising the role of female gender (Fontenelle *et al.*, 2021; McKune *et al.*, 2021) and two studies emphasising the role of male gender in OCD (Abba-Aji *et al.*, 2020; Samuels *et al.*, 2021). The study conducted in Canada, although in some sections introduced male gender as a risk factor (the obsessions related to dirt, germs, and viruses), but in some late items (compulsive hand washing) did not consider gender as a risk factor at all (Abba-Aji *et al.*, 2020). Studies in China (Ji *et al.*, 2020; Juan *et al.*, 2020; Zhang *et al.*, 2020; Zheng *et al.*, 2020), such as those in North America, do not provide clear results so that two of them did not consider gender as a risk factor (Zhang *et al.*, 2020; Zheng *et al.*, 2020), and from the other two studies, one emphasised the role of female gender (Juan *et al.*, 2020) and the other emphasised the role of the male gender under 26 years old. They also declared that the rates of possible OCD were not remarkably different between males and females aged ≥ 26 years (Ji *et al.*, 2020). But studies in Europe and the Middle East show clearer results, and the role of the female gender is more evident in these two regions. Of the eight studies conducted in the Middle East (Abuhmaidan & Al-Majali, 2020; Darvishi *et al.*, 2020; Ahmed *et al.*, 2021; Alateeq *et al.*, 2021; AlHusseini *et al.*, 2021; El O thman *et al.*, 2021; Dehkordi *et al.*, 2021; Taher *et al.*, 2021), four directly emphasised the role of female gender in this regard (Abuhmaidan & Al-Majali, 2020; Darvishi *et al.*, 2020; Ahmed *et al.*, 2021; El O thman *et al.*, 2021), three did not consider gender as a risk factor (Alateeq *et al.*, 2021; Dehkordi *et al.*, 2021; Taher *et al.*, 2021), and only one study identified male gender as a risk factor (AlHusseini *et al.*, 2021). The clarity of the role of female gender in this regard in the Middle East is intensified by the elimination of the results of Saudi Arabia (Alateeq *et al.*, 2021; AlHusseini *et al.*, 2021) so that out of the remaining six studies (Abuhmaidan & Al-Majali, 2020; Darvishi *et al.*, 2020; Ahmed *et al.*, 2021; El O thman *et al.*, 2021; Dehkordi *et al.*, 2021; Taher *et al.*, 2021), four cases of the female gender are introduced as a risk factor (Abuhmaidan & Al-Majali, 2020; Darvishi *et al.*, 2020; Ahmed *et al.*, 2021; El O thman *et al.*, 2021).

https://doi.org/10.1017/neu.2023.15 Published online by Cambridge University Press

Two other studies still do not introduce the male gender as a risk factor (Dehkordi *et al.*, 2021; Taher *et al.*, 2021). Noteworthy that in neither of the two studies conducted in Saudi Arabia, female gender was considered as a risk factor (Alateeq *et al.*, 2021; AlHusseini *et al.*, 2021).

The studies conducted in Europe provide different results from the studies in the Middle East. Of the seven studies conducted in Europe (Davide *et al.*, 2020; Mazza *et al.*, 2020; Munk *et al.*, 2020; Ferreira *et al.*, 2021; Højgaard *et al.*, 2021; Meda *et al.*, 2021; Moreira *et al.*, 2021), none considered male gender as a risk factor, so that two of them directly emphasised the role of female gender (Mazza *et al.*, 2020; Højgaard *et al.*, 2021) and the other five did not consider gender as a risk factor at all (Davide *et al.*, 2020; Munk *et al.*, 2020; Ferreira *et al.*, 2021; Meda *et al.*, 2021; Moreira *et al.*, 2021) (Fig. 5).

Considering the set of these explanations, in the following groups, the female gender may have acted as a risk factor: students (under 18 years old), hospital staff and studies performed in the Middle East. In none of the categories, male gender was clearly identified as a risk factor regarding OCD. And finally, in the following groups, gender was not identified as a risk factor: medical students, university students, and possibly the general population. Table 6 shows major results of each population and whether in each of the groups surveyed in this systematic review, gender was a risk factor, and if so, which gender.

Different hypotheses can be proposed for the obtained results. One of the conclusions made is the possibility of the female gender being a risk factor for OCD in the Middle East. In a study by Mohammadi et al, it was reported that the occupational variables of 'business' and 'housewife' decreased and increased the probability of OCD, respectively (Mohammadi *et al.*, 2004). On the other hand, according to World Bank reports, the unemployment rate of men in the Middle East and North Africa in 2018 was 7.8%. This is while the unemployment rate of women was 17.8% in the same year. Also, from 2010 to 2018, the highest unemployment rate for men was 8.2%, while the lowest unemployment rate for women was 17.1%. Since the COVID-19 pandemic started in 2019, many jobs in society were damaged. In this situation, the unemployment rate of men increased from 7.1% in 2019 to 9.3% in 2021. But in the same period, women suffered more, and the unemployment rate increased from 17.4% to 19.7%. In addition, the global unemployment rate for women in 2018 was 5.6%, and this number increased from 5.5% to 6.4% between 2019 and 2021. Therefore, we see that in the Middle East, women suffer from a higher unemployment rate and are more affected during the pandemic. Taking into account that being unemployed is considered a risk factor for OCD, therefore, the possibility of women being a risk factor in the Middle East can be justified in this way. In addition, a study by Williams et al demonstrates that lower levels of education and fewer years of educational attainment were associated with more compulsive symptoms (Williams *et al.*, 2017). The literacy rate for men in the Middle East and North Africa in 2020 was 86%, while it was 73% for women. In the meantime, the literacy rate in the world was 90% for men and 83% for women. Therefore, a greater difference in the literacy rate of women in the Middle East and the world is visible, and this point may serve as another justifying factor for women being a risk factor for OCD in the Middle East.

The possible causes cited for the Middle Eastern results have worked in the opposite way in Europe. As mentioned, it was concluded that in Europe, gender did not act as a risk factor. The unemployment rate for men in 2018 was 7%, and in the same year for women, it was 7.6%. Also, from 2019 to 2021, the unemployment rate for men increased from 6.4% to 6.7% and for women from 7% to 7.5%. Therefore, in Europe, the unemployment rate between men and women is close to each other, and there is no significant difference (similar to what was reported in the Middle East) between the two genders during the pandemic. On the other hand, the literacy status of society in Europe is generally better. In 2016, in Central Europe and Balkan, the literacy rate for both men and women was 99%. In this way, the two factors of 'high unemployment rate' and 'high illiteracy rate', which act as risk factors for OCD, are weak in Europe.

One of the other conclusions made is the possibility of the female gender being a risk factor for OCD among under 18 years old students. We know that one of the effects of the pandemic was the imposition of distance learning on students. In many countries, in order to protect the lives of students and prevent the cycle of virus transmission, regular school education was replaced by distance education. Radwan et al studied the perceived stress level in distance learning students during the COVID-19 period and found that female students had remarkably higher perceived stress levels compared to male students. They also had a greater chance of having moderate stress compared to males (Radwan *et al.*, 2021). On the other hand, stress is an important factor affecting OCD and may act as both a triggering and aggravating factor (Raposo-Lima & Morgado, 2020). Stress also leads to neuronal atrophy in frontal cortices, the caudate part of the dorsomedial striatum, and the hippocampus parallel with hypertrophy in the putamen part of the dorsolateral striatum and amygdala. These neurobiological changes are consistent with the neurological abnormalities reported in OCD (Adams *et al.*, 2018). Therefore, one of the possible hypotheses of this section can be the effect of distance learning and the greater stress caused by it in females, making this gender a possible risk factor for OCD during the pandemic.

In fact, one of the critical effects of the COVID-19 pandemic was the imposition of increasing stress on society (Couarraze *et al.*, 2021; Durbas *et al.*, 2021), considering that stress is viewed as a risk factor for OCD (Adams *et al.*, 2018; Raposo-Lima & Morgado, 2020), the way both genders face this increasing stress in different groups of society or geographical regions can justify some of the results obtained.

Regarding the hospital staff, the role of the female gender as a risk factor for OCD is also remarkable. One of the effects of the pandemic was the heavy workload imposed on hospital staff and the healthcare workers were on the front line during this crisis. A study by Couarraze et al. demonstrates that healthcare workers experienced a major stressful event and the highest levels of stress were recorded. They also declared that females had systematically higher levels of work-related stress than males (Couarraze *et al.*, 2021). As mentioned, stress may both trigger and aggravate OCD (Adams *et al.*, 2018; Raposo-Lima & Morgado, 2020). Therefore, considering that more stress has been imposed on the female hospital staff, the mentioned relationship can be justified in this way.

Another finding was that most likely, gender did not act as a risk factor for OCD among university students (both medical and non-medical students). As we mentioned, stress is considered a risk factor for OCD (Adams *et al.*, 2018; Raposo-Lima & Morgado, 2020), and therefore, any gender that has suffered more stress during the pandemic, may face greater challenges regarding OCD. Unlike the students (under 18 years old) and hospital staff in which the female gender probably suffered more stress, no gender seems to be more stressed among university students. A study by Chu

https://doi.org/10.1017/neu.2023.15 Published online by Cambridge University Press

et al investigated the potential impact of online learning during the pandemic on the mental health status of university students by assessing the differences in psychological distress and student life stress. They reported that gender did not affect the psychological distress nor the subdomains of student life stress and overall life stress (Chu & Li, 2022). Therefore, when the two genders did not differ significantly in terms of stress among university students, perhaps, for this reason, gender did not emerge as a risk factor for OCD in this sample group.

The cases that were raised only examine a number of possible hypotheses and there are definitely several factors that have affected these relationships and results, which can be the subject of future studies.

Articles can be reviewed based on another category. If we divide the articles into three sections, so that the first section (nine articles) refers to articles that consider the female gender as a risk factor for OCD (Abuhmaidan & Al-Majali, 2020; Darvishi *et al*., 2020; Ahmed *et al*., 2021; El J uan *et al*., 2020; Mazza *et al*., 2020; Othman *et al*., 2021; Fontenelle *et al*., 2021; Højgaard *et al*., 2021; McKune *et al*., 2021), the second section (11 articles) refers to articles that did not consider gender as a risk factor at all (Davide *et al*., 2020; Aftab *et al*., 2021; Alateeq *et al*., 2021; Ferreira *et al*., 2021; Munk *et al*., 2020; Zhang *et al*., 2020; Zheng *et al*., 2020; Dehkordi *et al*., 2021; Meda *et al*., 2021; Moreira *et al*., 2021; Taher *et al*., 2021), and the third section (4 articles) including the articles that considered male gender as a risk factor (Abba-Aji *et al*., 2020; Ji *et al*., 2020; AlHusseini *et al*., 2021; Samuels *et al*., 2021), we can make the following comparisons (needs to be mentioned that there are two articles in the third section that in a number of cases have stated that neither male nor female gender was risk factors, but because in a number of items male gender was expressed as a risk factor, we brought in this section and in previous sections of the discussion, we discussed these articles in detail (Abba-Aji *et al*., 2020; Ji *et al*., 2020):

In the first section, four studies were established in the Middle East (Abuhmaidan & Al-Majali, 2020; Darvishi *et al*., 2020; Ahmed *et al*., 2021; El O thman *et al*., 2021), two in Northern America (Fontenelle *et al*., 2021; McKune *et al*., 2021), two in Europe (Mazza *et al*., 2020; Højgaard *et al*., 2021), and one in Eastern Asia (China) (Juan *et al*., 2020). Although these studies were established in four different continents, the fact that nearly half (four articles) of these studies were established in the middle east, cannot be ignored, and it may negatively affect the generality of the results of this section. Also, five studies in the second section were established in Europe, which is a remarkably high percentage (50.0%) for a specific region (Davide *et al*., 2020; Munk *et al*., 2020; Ferreira *et al*., 2021; Meda *et al*., 2021; Moreira *et al*., 2021) (Fig. 6).

The most popular methods used to assess the status of OCD are the Yale-Brown obsessive-compulsive scale (Y-BOCS) (Davide *et al*., 2020; Ahmed *et al*., 2021; El J i *et al*., 2020; Juan *et al*., 2020; Zheng *et al*., 2020; Othman *et al*., 2021; Højgaard *et al*., 2021) and the OCI-R (Munk *et al*., 2020; AlHusseini *et al*., 2021; Ferreira *et al*., 2021; Meda *et al*., 2021; Moreira *et al*., 2021; Samuels *et al*., 2021; Taher *et al*., 2021), each of which was used by seven articles. Also, one of the studies in the first section did not use any known validated measurement tool for assessing OCD status (McKune *et al*., 2021).

Unlike the first section, in which the studies mainly used the Y-BOCS to determine the state of OCD (Ahmed *et al*., 2021; El J uan *et al*., 2020; Othman *et al*., 2021; Højgaard *et al*., 2021), the studies in the second (Munk *et al*., 2020; Ferreira *et al*., 2021; Meda *et al*., 2021; Moreira *et al*., 2021; Taher *et al*., 2021) and third sections (AlHusseini *et al*., 2021; Samuels *et al*., 2021) mainly used obsessive-compulsive inventory-revised (OCI-R). Noteworthy that none of the articles in the first section used OCI-R.

Considering that studies mainly used two different instruments, the difference in the methods for examining OCD may have acted as a risk bias and caused imprecise in the reported results. A study by Sulkowski et al compared the clinician ratings on the Y-BOCS-SC for 112 OCD patients with their self-report ratings on the OCI-R. They reported good internal consistency reliabilities (alphas) for the six OCI-R symptom scales. In the Y-BOCS-SC, three of five scales had good reliabilities (alphas > .80); however, alphas for two other scales (symmetry/ordering and sexual/religious symptom scales) were inadequate. The total scores of the two instruments were highly correlated with their corresponding 'checking' scales, but no individual symptom scale was identified as an indicator of the overall presence of OCD symptoms. Comparing the two OCD measurement instruments, scales assessing symmetry/ordering, washing/contamination, and hoarding correlated well. However, regarding the other scales, lower correlations were monitored which indicates differences in symptom coverage by the two instruments. In addition, they compared Y-BOCS-SC and OCI-R scores to OCD symptom severity measures and self-report measures of depression (BDI-II) and anxiety (STAI-T). Most of the Y-BOCS-SC and OCI-R symptom scales had low correlations with the BDI-II and STAI-T; however, obsessing scale of OCI-R was well correlated with the STAI-T. Unfortunately, the comparison of these two methods and their correlation has been neglected and further studies are needed to provide a better view (Sulkowski *et al*., 2008).

In total, 10 studies reported that they used the Chi-square test to assess the correlation between demographic factors and OCD symptom severity (Abba-Aji *et al*., 2020; Ji *et al*., 2020; Juan *et al*., 2020; Zheng *et al*., 2020; Aftab *et al*., 2021; Ahmed *et al*., 2021; Alateeq *et al*., 2021; AlHusseini *et al*., 2021; Ferreira *et al*., 2021; Taher *et al*., 2021). In general, this test was the most popular test used by studies to assess the mentioned correlation. Especially in the studies related to the second (Zheng *et al*., 2020; Aftab *et al*., 2021; Alateeq *et al*., 2021; Ferreira *et al*., 2021; Taher *et al*., 2021) and third sections (Abba-Aji *et al*., 2020; Ji *et al*., 2020; AlHusseini *et al*., 2021). One of the studies in the first section did not clarify what tool they did use to assess the mentioned correlation (Darvishi *et al*., 2020).

Regarding the study population, the second and third sections have the most credibility in this area, because half of the studies conducted in these sections selected their study population from the general population (AlHusseini *et al*., 2021; Samuels *et al*., 2021). In the second section, out of 10, five studies selected their sample from the general population (Alateeq *et al*., 2021; Zhang *et al*., 2020; Zheng *et al*., 2020; Dehkordi *et al*., 2021; Moreira *et al*., 2021), and in the third section, two (AlHusseini *et al*., 2021; Samuels *et al*., 2021) out of four. The first section has a weaker condition in this area so that out of nine studies, only three studies selected their sample from the general population (Ahmed *et al*., 2021; El O thman *et al*., 2021; Fontenelle *et al*., 2021), which is one of the weaknesses of this section. Articles that did not select their sample from the general population, naturally, used a more limited group. Thus, reduces the generalizability of these studies. Also, in some studies, the included population was purely hospital staff (Doctors and Nurses) (Juan *et al*., 2020), and Physicians (Ferreira *et al*., 2021) which according to several studies they may be at more risk than the general population and may have

https://doi.org/10.1017/neu.2023.15 Published online by Cambridge University Press

affected the results and acted as a risk bias (Ahmed *et al.*, 2021; Lamiani *et al.*, 2021).

In several studies, the recruited population was larger than the calculated population, thus increasing the reliability of these studies (Ahmed *et al.*, 2021; Alateeq *et al.*, 2021). Also, in a number of studies, the recruited population was proportional to the calculated population (Aftab *et al.*, 2021; El O thman *et al.*, 2021), and a number of studies did not provide information about the sample size calculation.

Three studies indicated that they used the snowball method to recruit their needed population and therefore it was not possible for them to determine how many subjects received the questionnaire and refused to answer them (Zheng *et al.*, 2020; Ahmed *et al.*, 2021; El O thman *et al.*, 2021).

In nearly all studies, the number of female participants was more than males, and this inequality was significant in 17 articles (Abba-Aji *et al.*, 2020; Abuhmaidan & Al-Majali, 2020; Darvishi *et al.*, 2020; Aftab *et al.*, 2021; Alateeq *et al.*, 2021; AlHusseini *et al.*, 2021; El O thman *et al.*, 2021; Ji *et al.*, 2020; Juan *et al.*, 2020; Munk *et al.*, 2020; Zhang *et al.*, 2020; Zheng *et al.*, 2020; Dehkordi *et al.*, 2021; Højgaard *et al.*, 2021; Meda *et al.*, 2021; Moreira *et al.*, 2021; Taher *et al.*, 2021) including three articles that considered male gender as a risk factor (Abba-Aji *et al.*, 2020; Ji *et al.*, 2020; AlHusseini *et al.*, 2021). All four studies in the third section had more female participants than males (Abba-Aji *et al.*, 2020; Ji *et al.*, 2020; AlHusseini *et al.*, 2021; Samuels *et al.*, 2021). This inequality may have acted as a risk bias and needs to be considered. However, in two studies, the rate of male participants was higher (Mazza *et al.*, 2020; Ferreira *et al.*, 2021) and in one of them which considered female gender as a risk factor, the difference was remarkable with nearly two-thirds of the participants being male (Mazza *et al.*, 2020).

The smallest size of the study population belonged to a study in the second section with 30 people participating (which reduces the validity of the study) (Davide *et al.*, 2020), and the biggest one belonged to a cohort study in the third section with more than 13 000 people participating in its first survey (Ji *et al.*, 2020). It is worth mentioning that all four studies in the third section were among the studies with the most participants (with a participation rate of more than 2000), which adds to the credibility of this section (Abba-Aji *et al.*, 2020; Ji *et al.*, 2020; AlHusseini *et al.*, 2021; Samuels *et al.*, 2021). The study population range of studies in the first section varies from 150 (Darvishi *et al.*, 2020) to 2182 (Zhang *et al.*, 2020), in the second section 30 (Davide *et al.*, 2020) to 2900 (Alateeq *et al.*, 2021; Dehkordi *et al.*, 2021), and in the third section 2117 (Samuels *et al.*, 2021) to 13 478 (in one of the study's surveys) (Ji *et al.*, 2020).

The age range of study participants varies and should be considered. In two studies belonging to the first section, the age range of the participants was generally under 18 years old (Darvishi *et al.*, 2020; McKune *et al.*, 2021), and in six cases, it was generally above 18 years old (Abuhmaidan & Al-Majali, 2020; Juan *et al.*, 2020; Mazza *et al.*, 2020; Ahmed *et al.*, 2021; Fontenelle *et al.*, 2021). In two of our articles, they did not mention the age range of participants, but the mean age was 31.32 ± 11.11 (El O thman *et al.*, 2021) and 39.66 years (Højgaard *et al.*, 2021), respectively. About the age range of study participants in the second section, most studies in this section have studied the young population so that either the mean age is less than 30 or the main population of the study is under 30 years (Munk *et al.*, 2020; Zheng *et al.*, 2020; Aftab *et al.*, 2021; Alateeq *et al.*, 2021; Meda *et al.*, 2021; Taher *et al.*, 2021). One of the studies in this section did not mention the age range or mean age of the participants, but according to the information given about the educational status of the participants, it seems that the subjects were over 18 years old (Dehkordi *et al.*, 2021). And finally, all four studies in the third section were performed generally among individuals with more than 18 years. By noting this fact, of course, some factors that are related to age are also different. For example, given that the participants in several studies were under the age of 18 (Darvishi *et al.*, 2020; McKune *et al.*, 2021), the marriage and employment rates are very low. Moreover, marital status, the rate of employment, and history of mental illnesses may also have played a role and affected the obtained results and should be checked to see if they are risk bias.

The highest score in our qualitative analysis of cross-sectional studies (Newcastle–Ottawa quality assessment scale) was 9 points which were awarded to one of the articles in the second section (Ferreira *et al.*, 2021). Proper comparability is one of the strengths of this study and it was the only one that provided information on non-respondents. Also, several studies in this analysis have received 8 points (Ahmed *et al.*, 2021; Alateeq *et al.*, 2021; AlHusseini *et al.*, 2021; El Z hang *et al.*, 2020; Zheng *et al.*, 2020; Othman *et al.*, 2021; Fontenelle *et al.*, 2021), which can be attributed to good comparability.

The lowest score in this evaluation was 5 points, due to the weakness in the selection of the study and is placed in the first section. This study also had the lowest number of participants with 30 people among all studies (Darvishi *et al.*, 2020). There were also three cohort studies, all of which scored 6 points in our qualitative analysis. It should be noted that there was only one cohort article in each section (Ji *et al.*, 2020; Mazza *et al.*, 2020; Meda *et al.*, 2021). The highest score obtained by cross-sectional studies in the first and second sections was 8 (Ahmed *et al.*, 2021; El O thman *et al.*, 2021; Fontenelle *et al.*, 2021), and 9 (Ferreira *et al.*, 2021) points respectively. And the lowest scores were 5 (Darvishi *et al.*, 2020), and 6 (Davide *et al.*, 2020; Dehkordi *et al.*, 2021; McKune *et al.*, 2021) points, respectively. Noteworthy that all four cross-sectional articles in the third section, scored well on the Newcastle–Ottawa scale. Two cross-sectional studies received 7 points (Abba-Aji *et al.*, 2020; Samuels *et al.*, 2021) and the other scored 8 points (AlHusseini *et al.*, 2021). The results of the qualitative analysis were similar in the three sections and there was no significant difference.

As mentioned, 21 of the 24 articles included in the study used a cross-sectional method to conduct their study, which is not a very appropriate method due to its nature. In addition, three studies used the cohort study method to perform their study, which is a more appropriate method for examining the relationship between gender and OCD during the COVID-19 pandemic, and therefore these studies are more valid (Ji *et al.*, 2020; Mazza *et al.*, 2020; Meda *et al.*, 2021). However, since these three studies were divided into three sections, and each had only one cohort study, and all these studies also scored the same in our qualitative analysis (6 points), so this issue cannot be used to prioritise one section over another.

It is worth mentioning that none of our cross-sectional studies have compared the respondents and non-respondents properly and therefore all but one (Ferreira *et al.*, 2021) missed a point in the selection part of the Newcastle–Ottawa quality assessment scale. Also, most of the studies used the self-report method to present their outcomes and consequently they lost another point in this mentioned assessment.

https://doi.org/10.1017/neu.2023.15 Published online by Cambridge University Press

Limitation

There were several limitations in this review including the limitation of studies, variation in data collection, and methods of assessing the correlation between demographical variables and OCD symptom severity and studied population.

As mentioned in the discussion, in pre-pandemic articles, the symptoms of OCD were widely compared between men and women, but in the current study, our references never accurately compared the symptoms of men and women, and only had a general comparison. Therefore, it was not possible for us to accurately compare the symptoms of obsessions and compulsions between men and women during the COVID-19 pandemic.

Also, the databases used in this systematic review were limited to three databases: PubMed, Scopus, and Web of Science. To reduce the potential risk of bias due to the limited number of databases, we reviewed references of our included articles to retrieve potential missing studies. But due to the novelty of the subject, the number of duplicate articles is high, and we could not find new studies through this way. However, we recommend future studies consider more databases for their research after conducting studies that specifically examine the signs and symptoms of OCD in men and women. It also needs to be mentioned that the search was conducted only on articles in English and some studies online were demonstrated.

Also, regarding the meta-analysis conducted in this study, we encountered serious limitations. The primary goal of this study was to conduct a meta-analysis for each of the classifications based on the objectives of the studies (prevalence), geographical regions, and the sample groups of the studies. However, due to the limitations mentioned below, conducting the meta-analysis was limited only to studies that investigated the prevalence of OCD during the COVID-19 pandemic.

The 24 studies that were reviewed in this study had many heterogeneities, so it was impossible to perform a general meta-analysis. In order to reduce heterogeneity, studies were divided into several groups. The first division was based on the objectives of the studies, where the studies that investigated the prevalence of OCD were placed in one group. The second division was based on geographical regions and the third division was based on the study sample group. One of the limitations that we encountered in the second and third classifications was the different objectives of the studies conducted in each of the geographical regions or sample groups. For example, the studies that were conducted in the Middle East or Europe or among the general population dealt with different aspects of OCD, and it was not possible to design a specific research question. Also, studies used different and various methods to assess OCD status, and therefore it was not possible to unify their methods. Also, one of the most important limitations that we encountered in all the classifications was that none of the studies were specifically designed with the aim of examining the differences between the two genders in relation to OCD during the COVID-19 pandemic. This point greatly limited the possibility of expanding the meta-analysis. For example, in the section related to the prevalence of OCD, it was not possible to examine any side factors, because the studies never differentiated between the two genders in presenting their information, and for example, when presenting information related to the occupational status of their sample, they limited themselves to providing information on the main sample group.

Another serious limitation was the small number of studies after dividing them into different subgroups. For example, there were only two studies in the subgroup related to under 18 years old students, and performing a meta-analysis under these conditions would damage its validity. Therefore, the meta-analysis was limited to examining different aspects of the prevalence of OCD during the COVID-19 pandemic.

Regarding the meta-analysis conducted to investigate the prevalence of OCD, there were limitations that caused the heterogeneity of the analysis to be 99.07%. The first limitation was the small number of studies that investigated this relationship. The prevalence of OCD during the COVID-19 pandemic was examined by seven studies, and only five of them differentiated the prevalence of OCD between the two genders. The next limitation was the difference in the method used to investigate OCD status, which studies used different methods (5 methods in 7 studies). Another limitation was the difference in the sample groups of the studies, for example, the study group was selected from students (under 18 years old), university students, and the general population. Future studies can help the progress of this field by considering and overcoming the limitations raised in this systematic review.

Conclusion

This systematic review, as the first one to investigate the gender differences in OCD during the Covid-19 pandemic, found that seemingly the female gender has been more vulnerable to OCD during the pandemic. The meta-analysis results revealed a 41.2% overall prevalence of OCD during the COVID-19 pandemic and 47.1% and 39.1% OCD prevalence for female and male genders, respectively. Although the prevalence of OCD was higher in females compared to males, this difference was not statistically significant. In the students (under 18 years old), and hospital staff, the female gender may have acted as a risk factor. However, in the following demographic subgroups, gender was not identified as a risk factor: medical students, university students, and possibly the general population. In none of the categories, the male gender was clearly identified as a risk factor regarding OCD. When it comes to geographical regions, studies conducted in the Middle East show a more significant role for the female gender regarding OCD. However, in European studies, the relationship was more gender independent. Generally, studies considered OCD to be gender-dependent, overcome those declared gender-independent in this systematic review. Further studies must be performed considering the risk biases mentioned in this study especially those that compare the symptoms of OCD in men and women.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/neu.2023.15

Acknowledgements. We want to sympathise with the victims of the recent earthquake that occurred in the city of Khoy (Xoy) in the West Azerbaijan province of Iran on 28 January 2023. We also want to express our sympathies to the victims of the massive earthquake that occurred in Türkiye and Syria affecting more than 20 million people on 6 February 2023. We dedicate our work to all those who suffered from these earthquakes, and our hearts remain with the victims of these tragic incidents. YOU ARE NOT ALONE!

We also want to draw attention to Lake Urmia located in north-western Iran, West and East Azerbaijan provinces, which suffers from severe environmental conditions and is on the verge of drying up, thus endangering the lives of tens of millions of people living in the area, and affecting at least five countries (Iran, Iraq, Azerbaijan, Armenia, and Türkiye). We need all the help we can get to prevent a large-scale environmental disaster.

Author contributions. EJ, study conception, data gathering, article writing (abstract, method, results, discussion, limitation, conclusion, table 1,2,3,4,5,6, figure 1,2,3,4), and article editing.

AA, data gathering, article writing (introduction, results, table 2,3,4).

MR, data gathering, article writing (method), article editing.

RB, data gathering, article writing, meta-analysis.

Financial support. None.

Conflict of interest. None.

Competing interests. The authors declare that they have no competing interests.

Availability of data and material. All data used for this study are gathered and illustrated in the file.

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