



## Climate change, trauma and mental health in Italy: a scoping review

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### ABSTRACT

**Background:** Climate change is having significant impacts on health and mental health across Europe and globally. Such effects are likely to be more severe in climate change hotspots such as the Mediterranean region, including Italy.

**Objective:** To review existing literature on the relationship between climate change and mental health in Italy, with a particular focus on trauma and PTSD.

**Methods:** A scoping review methodology was used. We followed guidance for scoping reviews and the PRISMA Extension for Scoping Reviews (PRISMA-ScR) checklist. We searched for literature in MEDLINE, Global Health, Embase and PsycINFO. Following screening, data was extracted from individual papers and a quality assessment was conducted. Given the heterogeneity of studies, findings were summarized narratively.

**Results:** We identified 21 original research articles investigating the relationship between climate change and mental health in Italy. Climate change stressors (heat and heatwaves in particular) were found to have several negative effects on various mental health outcomes, such as a higher risk of mortality among people with mental health conditions, suicide and suicidal behaviour and psychiatric morbidity (e.g. psychiatric hospitalization and symptoms of mental health conditions). However, there is little research on the relationship between climate change and trauma or PTSD in the Italian context.

**Conclusions:** More attention and resources should be directed towards understanding the mental health implications of climate change to prevent, promote, and respond to the mental health needs of Italy and the wider Mediterranean region.

### Cambio climático, trauma y salud mental en Italia: una revisión del alcance

**Antecedentes:** El cambio climático está teniendo un impacto significativo en la salud y la salud mental en Europa y a nivel mundial. Es probable que tales efectos sean más severos en los puntos críticos del cambio climático, como la región del Mediterráneo, incluida Italia.

**Objetivo:** Revisar la literatura existente sobre la relación entre el cambio climático y la salud mental en Italia, con un enfoque particular en trauma y TEPT.

**Métodos:** Se utilizó una metodología de revisión del alcance. Seguimos la guía para las revisiones de alcance y la lista de verificación de la Extensión PRISMA para las Revisiones de Alcance (PRISMA-ScR). Se realizaron búsquedas de literatura en MEDLINE, Global Health, Embase y PsycINFO. Después de la selección, se extrajeron los datos de los artículos individuales y se realizó una evaluación de calidad. Dada la heterogeneidad de los estudios, los resultados se resumieron de forma narrativa.

**Resultados:** Identificamos 21 artículos de investigación originales que investigan la relación entre el cambio climático y la salud mental en Italia. Se encontró que los factores estresantes del cambio climático (el calor y las olas de calor en particular) tienen varios efectos negativos en varios resultados de salud mental, como un mayor riesgo de mortalidad entre las personas con afecciones de salud mental, suicidio y comportamiento suicida, y morbilidad psiquiátrica (p. ej., hospitalización psiquiátrica y síntomas de trastornos de salud mental). Sin embargo, hay poca investigación sobre la relación entre el cambio climático y el trauma o el TEPT en el contexto italiano.

**Conclusiones:** Se debe dirigir más atención y recursos hacia la comprensión de las implicancias del cambio climático en la salud mental para prevenir, promover y responder a las necesidades de salud mental de Italia y la región mediterránea en general.

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### 关键词

气候变化, 心理健康, 创伤, PTSD, 意大利

### HIGHLIGHTS

- Climate change stressors in Italy were found to have detrimental impacts on various mental health outcomes, such as psychiatric mortality and morbidity.
- Little research on the relationship between climate change stressors and PTSD exists in Italy.

## 意大利的气候变化、创伤和心理健康：一项范围综述

**背景：** 气候变化正在对整个欧洲和全球的健康和心理健康产生重大影响。在包括意大利在内的地中海地区等气候变化热点地区,这种影响可能更为严重。

**目的：** 综述意大利气候变化与心理健康之间关系的现有文献,特别关注创伤和 PTSD。

**方法：** 使用范围综述方法。我们遵循范围综述指南和 PRISMA 范围综述扩展 (PRISMA-ScR) 清单。我们检索了 MEDLINE、Global Health、Embase 和 PsycINFO 中的文献。筛选后,从单篇论文中提取数据并进行质量评估。鉴于研究的异质性,叙述性地总结了研究结果。

**结果：** 我们确定了 21 篇原创文章,考查意大利气候变化与心理健康之间的关系。气候变化应激源(尤其是热浪和热浪)被发现对各种心理健康结果有一些负面影响,例如患有心理健康病症的人有更高的死亡风险、自杀和自杀行为以及精神疾病病况(例如,因精神病住院和心理健康病症的症状)。然而,在意大利背景下,关于气候变化与创伤或 PTSD 之间关系的研究很少。

**结论：** 应将更多的关注和资源用于了解气候变化对心理健康的影响,以预防、促进和应对意大利和更广泛地中海地区的心理健康需求。

### 1. Introduction

Climate change is having widespread health impacts in Europe and across the world. According to the Lancet Countdown in Europe, climate change is already affecting health across the European region through more frequent and extreme weather events, changes in the environmental suitability for infectious diseases, and alterations to water and food systems (Romanello et al., 2021a). Rising temperatures have led to increasingly intense heatwaves over the past decades in Europe, such as the 2003 heatwave which has been linked to 70,000 excess deaths in Europe (Robine et al., 2008). It has been estimated that one out of three deaths related to heat in Europe between 1990 and 2018 can be attributable to anthropogenic global warming (Vicedo-Cabrera et al., 2021). These impacts are in line with the global consequences of climate change on human health (Romanello et al., 2021b).

Despite widespread attention to the physical health impacts of climate change in Europe, less attention has been paid to its mental health consequences. This reflects a general trend in the literature on the topic (Charlson et al., 2021; Romanello et al., 2021b). Nonetheless, there is a growing body of evidence linking climate change and mental health worldwide (Lawrance, Thompson, Fontana, & Jennings, 2021). Across multiple countries both in and outside of Europe, a variety of climate change stressors have been associated with several worsened mental health outcomes from heightened symptoms of mental health problems to increased mortality and hospitalization rates among people with pre-existing mental health conditions (see Charlson et al., 2021 for a review of the global evidence on climate change and mental health). Climate change stressors have also been linked to trauma and post-traumatic stress disorder, for example by making exposure to trauma via extreme weather events more widespread (Augustinavicius et al., 2021).

Within the European context, the Mediterranean region has been deemed particularly vulnerable to climate change with the region being considered a

climate change ‘hotspot’ and warming 20% faster than the global average (UNEP, 2020). This is reflected in the Mediterranean region being more at risk of heat-related health issues than other European regions (Kendrovski et al., 2017). Italy specifically is vulnerable to several climate change-related stressors; due to its heterogeneous geographical conformation spanning multiple types of habitats and local climates, these include heatwaves, floods, landslides, wildfires, sea-level rise, coastal erosion, droughts and water stress, biodiversity loss, ocean acidification, desertification, and ice melt and avalanches.

In recent years, Italy has been particularly affected by climate change events. On Wednesday 11th of August 2021, one of the highest temperatures (48.8°) ever registered in Europe was recorded in the south of Italy (Pianigiani, 2021). Similarly, according to the European Forest Fire Information System (EFFIS), Italy was the European country with the highest number of recorded wildfires and largest burnt areas in 2021 (EFFIS, 2021). When considering the impact of climate change on the Italian population, one needs to consider other concomitant factors, such as the high prevalence of elderly people (who are more vulnerable to heat and heatwaves), the economic reliance on agriculture and tourism – highly sensitive to climate change – and the high risk of other natural hazards such as earthquakes and volcanic eruptions.

However, despite the relevance of climate change for this geographical area, there is little research specific to Italy or to the Mediterranean region on mental health and climate change (Aguglia et al., 2019; Di Giorgi, Michielin, & Michielin, 2020; Di Nicola et al., 2020; Oudin Åström et al., 2015; Preti, Lentini, & Maugeri, 2007; Rotgé, Fossati, & Lemogne, 2014). This is again in contrast with the attention given to physical health (Ministero della Salute, 2019; World Health Organization, 2018).

In this paper, we aim to provide a review of the original research literature on the relationship between climate change stressors and mental health

in Italy. When available, we will provide information on trauma and post-traumatic stress disorder (PTSD) (Augustinavicius et al., 2021). While this paper uses Italy as a case study, many of the findings are likely to apply to several European countries within the Mediterranean region with similar risks and vulnerabilities such as Greece, Spain, Croatia, and Albania or to the Middle East and North Africa region. The ultimate objective of the current paper is to encourage more research and policy action on the intersection between climate change and mental health in Italy and the wider Mediterranean region.

## 2. Methods

The review followed the PRISMA Extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018) (see Appendix A for PRISMA-ScR checklist). We used the Joanna Briggs Institute manual for scoping reviews (Peters et al., 2020) as methodological guidance. To identify original research on mental health, trauma and climate change in Italy the following online databases were accessed and searched via Ovid: MEDLINE, Global Health, Embase and PsycINFO. The search was conducted on the 1st of October 2021 and any papers published up to that date were included (no restriction was made for publication date). The search strategy covered three broad categories: (i) climate change and climate change stressors (search adapted from Berrang-Ford et al., 2021); (ii) mental health (including trauma and PTSD) and (iii) Italy (including all Italian regions with both English and Italian spelling). The complete search strategy is reported in Appendix B. Additional studies were identified through backward and forward citation of all included studies using Google Scholar.

Following automatic removal of duplicates on Ovid, all articles identified were imported into Rayyan (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016), where additional duplicates were manually removed. On Rayyan, the first author (AM) conducted an initial screening of abstract and titles, followed by full-text screening. If papers were not available in the public domain ( $n = 2$ ), the authors were contacted to obtain a copy. Papers were screened against a set of pre-specified inclusion and exclusion criteria (see a detailed description of criteria in Appendix C).

A standardized data charting sheet was created in Excel to extract relevant information from the selected studies. The table included author information, publication year, language, location in which study was conducted (city and region when available), time span of data collection, study design, type of analysis (i.e. qualitative, quantitative, or mixed methods), study population, sample size, climate change exposure, mental health outcome, key findings, and mention of trauma or PTSD (conducted by

systematically searching the document for 'trauma', 'PTSD', 'DPTS', 'post-traumatic', 'posttraumatic'). Data was extracted by one author (AM).

The methodological quality of all studies was assessed using the NIH Quality Assessment Tool for Case-Control Studies and the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (National Institute of Health, 2021). Studies were rated as being either 'poor', 'fair', or 'good' guided by the questions posed by the quality assessment tools. Studies of all qualities were included in the review due to the exploratory nature of scoping reviews.

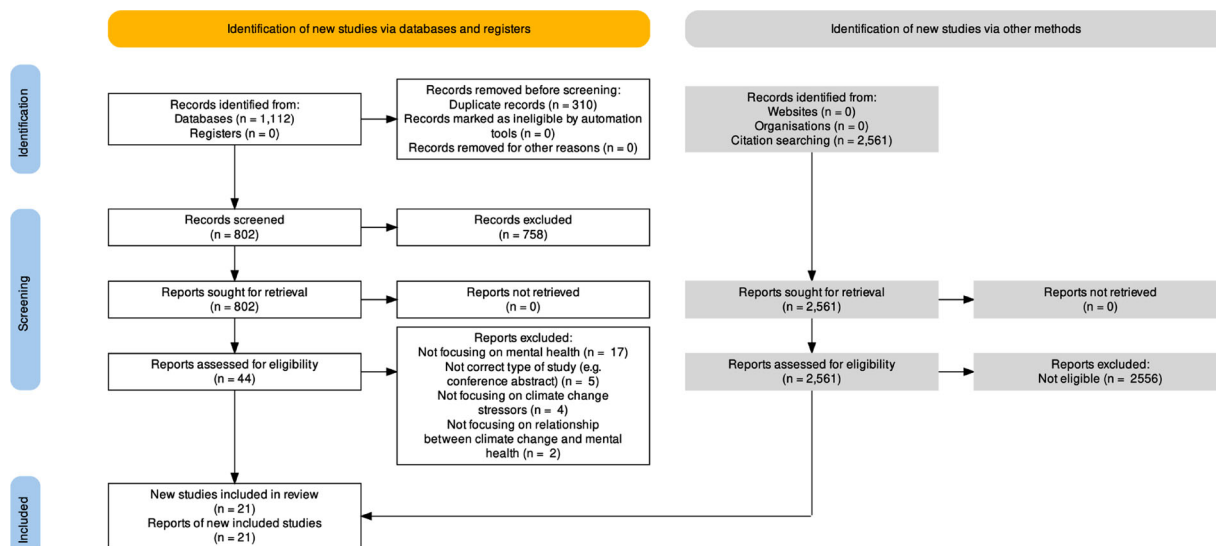
Due to the heterogeneity of findings, quantitative data was synthesized narratively rather than through meta-analytic techniques. Characteristics of all studies were summarized in tabular form. Additionally, studies are summarized in text by clustering them according to type of climate exposure (i.e. temperature, extreme weather events, and general climate change). The PRISMA flow diagram was created using PRISMA 2020: R package and ShinyApp for making PRISMA 2020 flow diagrams (Haddaway et al., 2022).

## 3. Results

We identified 21 original studies focusing on the relationship between climate change and mental health in Italy (see PRISMA flow chart below in Figure 1). The search produced 1112 results, of which 310 were duplicates and 802 underwent title and abstract screening. This process led to the exclusion of 758 papers and left 44 papers for full-text review against our eligibility criteria. This led to the identification of 16 papers that qualified for our review. Reasons for the exclusion of the 28 papers are shown in Figure 1. A list of the studies excluded after full-text screening with individual reason for exclusion is reported in Appendix D. Screening 2561 papers through forward and backward citation of the eligible studies identified an additional 5 papers.

### 3.1. Characteristics of included studies

Detailed information on each study is provided in Appendix E. The oldest paper had been published in 1997 and the most recent in 2021. Most papers ( $n = 19$ ) had been published in English with only two papers being published in Italian. In terms of geographical distribution (see Figure 2), most studies had been conducted in the Northern regions of Italy (i.e. Piemonte,  $n = 7$ ; Emilia Romagna,  $n = 5$ , Lombardia,  $n = 5$ ) or in the region of the capital city Rome (i.e. Lazio,  $n = 7$ ). Some studies had also been conducted in Tuscany ( $n = 4$ ), Sicily, ( $n = 2$ ), Veneto ( $n = 2$ ) and Liguria ( $n = 2$ ). All other regions had been studied

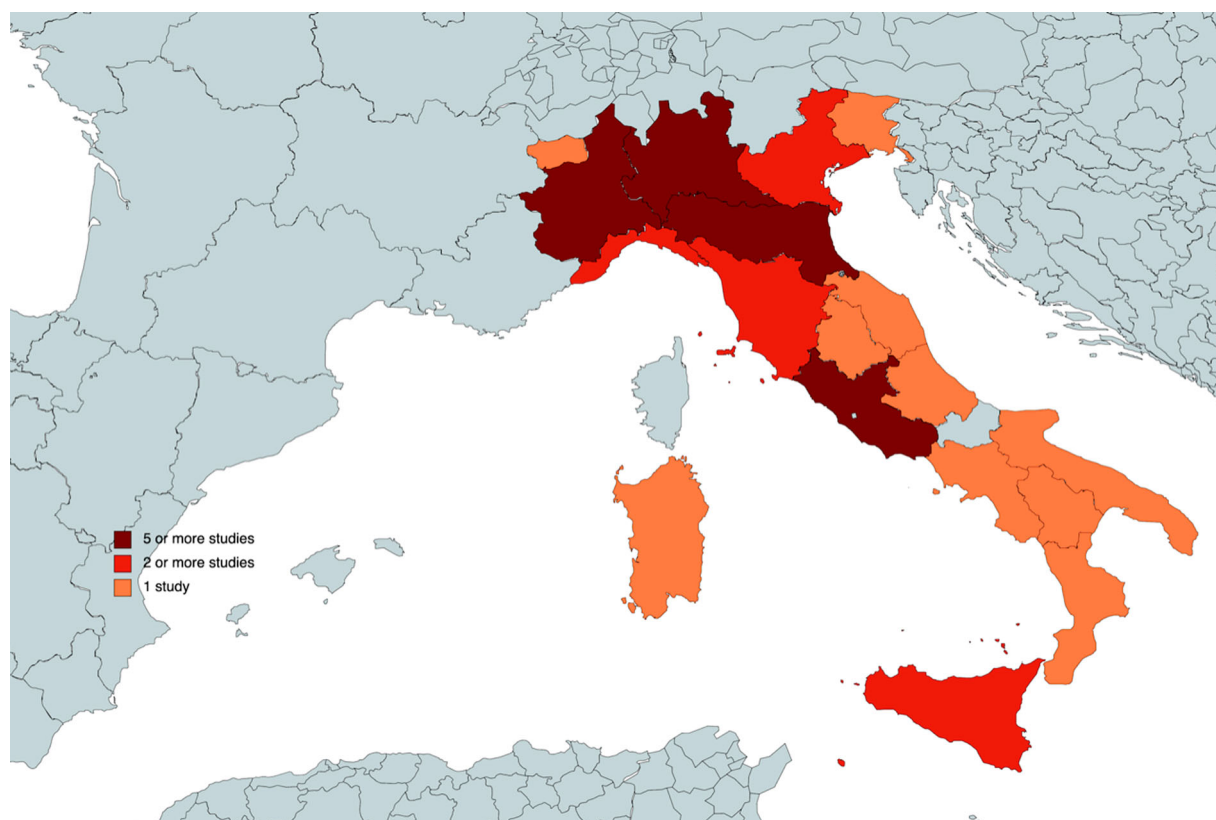


**Figure 1.** PRISMA flow diagram of study selection.

only once. Four studies focused on the entire of Italy. No study had been conducted in the Molise and Trentino-Alto Adige regions.

In terms of study design, most studies had a cross-sectional, repeated cross-sectional, or time-series study design ( $n = 13$ ), and a minority had a case-cross-over design ( $n = 4$ ), a case-control design ( $n = 2$ ) or a cohort study design ( $n = 2$ ). All studies used quantitative analysis, except for one study that used mixed

methods. In terms of climate change exposure, most studies focused on temperature (often using temperature together with another environmental variable such as humidity to calculate a heat index or to determine heatwave periods) ( $n = 17$ ), with a minority of studies focusing on exposure to floods or risk of floods ( $n = 3$ ), and one paper focusing on general perception of climate change (see [Appendix E](#) for more precise description of exposure in each study).



**Figure 2.** Geographical location of included studies. Latium = 7, Piedmont = 7, Emilia-Romagna = 5, Tuscany = 4, Sicily = 2, Veneto = 2, Liguria = 2, Calabria = 1, Sardinia = 1, Basilicata = 1, Campania = 1, Apuglia = 1, Abruzzo = 1, Marche = 1, Umbria = 1, Friuli-Venezia Giulia = 1, Aosta Valley = 1.

Conversely, in terms of outcomes, the most common outcome was mortality among patients with mental health conditions ( $n = 7$ ), followed by death by suicide and suicide attempts ( $n = 6$ ), symptoms of mental health conditions (e.g. PTSD, depression, anxiety) ( $n = 3$ ), psychiatric hospitalizations or psychiatric visits to the emergency department ( $n = 3$ ), and other outcomes (e.g. worry in relation to future floods or emergency calls for mental health conditions) ( $n = 2$ ).

### 3.2. Relationship between climate change exposure and mental health

The relationships identified between climate change exposure and mental health outcome are presented below. Results are presented separately for different types of climate change exposures.

### 3.3. Temperature

Most studies focused on the relative risk of mortality among people with mental health conditions exposed to heat or heatwaves. Most of these studies found that people with mental health conditions are at higher risk of mortality than the general population when exposed to heat or heatwaves. One case-crossover study conducted on deaths registered in three Italian cities found that, in all cities, people with previous mental health conditions (i.e. depression and psychosis), were at higher risk of dying during hot days (de'Donato et al., 2008). Similarly, a time-series study on cause-specific mortality in four Italian cities illustrated how the greatest excess mortality as a result of the 2003 heatwave was observed for central nervous system, circulatory, and respiratory diseases and metabolic/endocrine and psychological illnesses (Micheleozzi et al., 2005). One cohort study focusing on heat wave-related mortality among older adults in Rome found higher risk of dying among those previously hospitalized for a psychiatric disorder (Schifano et al., 2009). Another case-crossover study also focusing on older adults exposed to high temperatures when in care facilities in four Italian cities found that psychiatric disorders were among the most important effect modifiers in the relationship between heat exposure and death (OR = 2.05; 1.44–2.93) (Stafoggia et al., 2008). One other case-crossover study by the same author in the same context (but focusing on the general adult population) also identified previous psychiatric disorders as effect modifiers (OR = 1.69; 1.39–2.07) (Stafoggia et al., 2006). An additional study conducted in Bologna also identified the highest probability of dying due to an increase in temperature among patients with depression and cognitive decline (Stivanello et al., 2020). Only one cohort study failed to find evidence for increased mortality among susceptible subgroups (including participants with

psychiatric disorders) during heatwaves in Rome (despite finding increased risk for the psychiatric subgroup in Stockholm) (Oudin Åström et al., 2015).

Another common mental health outcome considered in relation to temperature was suicide (including both suicide attempts and death by suicide). One time-series study using national data on suicide and suicide attempts spanning 1974–1994 identified a significant positive relationship between the mean monthly distribution of deaths by suicide and the mean monthly values of temperature (both maximum and minimum) (Preti, 1997). A similar time-series study collected data from the same period from 17 Italian towns in different regions but found a negative relationship between deaths by suicide with mean yearly temperature values (both maximum and minimum). Two time-series studies using national data on suicide and suicide attempts between 1984 and 1995 showed a significant positive relationship of higher temperature with violent suicides (Preti & Miotto, 1998) and suicide attempts (Preti & Miotto, 2000), particularly among males. One subsequent time-series study using a similar approach with national suicide data spanning approximately 30 years from 1974 to 2003 also found that increasing anomalies in monthly average temperatures were associated, among males, with a higher monthly suicide mean from May to August and to a lesser extent in November and December (but a reverse relationship was identified for January and inconsistent findings were reported for females) (Preti et al., 2007). Finally, one time-series study conducted in Genova (Liguria), noted a peak in hospitalizations for suicide attempts (SA) that was typically found in late spring and early summer and attributed by the authors to global warming (Giacomini et al., 2022). The authors however did not find a statistically significant increase in the number of SA cases between 2013 and 2018. Overall, these studies seem to indicate preliminary evidence for the association between higher temperatures with deaths by suicide and suicide attempts. However, the evidence remains mixed with possible differential impacts between males and females identified in one study and ambiguity concerning the impact of seasonality versus that of climate in certain studies.

A few additional mental health outcomes were considered in the context of heat and temperature. Two case-control studies using data from psychiatric hospitalization in Orbassano (Piedmont) from 2003 to 2005 identified an association between admission of patients with bipolar disorder (compared to patients admitted with other diagnoses) with maximum temperature (Aguglia et al., 2019) as well as a significant association between maximum and medium temperature with involuntary psychiatric admissions (Aguglia et al., 2020). Another study focusing on psychiatric

visits to emergency units in Messina (Sicily) between 2005 and 2010 reported mixed findings concerning the correlation between temperature with anxiety, mood disorders, and psychosis in different seasons (Settineri et al., 2016). Finally, a time-series study using data on emergency calls in Florence (Tuscany) between June and August 2005 reported an association between the hottest conditions and increases in calls specifically for psychiatric conditions, when considering the entire summer period (Petralli et al., 2012).

### 3.4. Extreme weather events

Three studies focused on floods with two studies focusing on individuals directly exposed to floods in Cardoso (Tuscany) and one study focusing on individuals living in an area at risk of flooding in the Aosta Valley. Of the two studies on direct flood exposure, one cross-sectional study focused on disaster rescue squads ( $N = 34$ ) and identified, 7 years following the flood, 11.8% of the sample as having full PTSD, 11.8% as having subthreshold PTSD with impairment, and 17.6% as having subthreshold PTSD without impairment (Di Fiorino et al., 2004). The other cross-sectional study focused on disaster survivors ( $N = 61$ ) 8 years following the flood and reported that 45.9% of the sample had full PTSD, 35.8% had subthreshold PTSD, and 21.3% had no PTSD (Di Fiorino et al., 2005). Finally, one cross-sectional study focused on worry about possible future floods and landslides in at risk communities ( $N = 407$ ) and found that people were particularly worried about harm to oneself and loved ones and that there was a positive correlation between level of worry and degree of preventative behaviours implemented (Miceli et al., 2010).

### 3.5. Climate change perceptions

One cross-sectional study focused on migrants ( $N = 100$ ) from African countries in Italy (countries with high or extreme vulnerability to climate change) and identified a significant but weak association ( $r = 0.23$ ) between perception of climate change and emotional disorders (Di Giorgi et al., 2020).

### 3.6. Trauma and PTSD

When systematically searching through the included papers, only four papers (19% of all papers) mentioned trauma and/or PTSD. Of these, only two studies collected original data on PTSD (Di Fiorino et al., 2004, 2005). In one study (Di Fiorino et al., 2004) PTSD diagnosis was assessed using the Clinician-Administered PTSD Scale for DSM-IV and in both studies (Di Fiorino et al., 2004, 2005) PTSD symptoms were assessed using the Davidson Trauma

Scale. The remaining two studies (Di Giorgi et al., 2020; Giacomini et al., 2022) mentioned trauma as one of the negative consequences of climate change on mental health in their introductions. The findings from these four studies are summarized in the sections above.

### 3.7. Quality of studies

Most studies were deemed to be of 'fair' quality ( $n = 13$ ), with five studies being rated as 'good' and three as 'poor'. Common methodological issues included: not controlling for possible confounders, poor measurements of the climate change exposure or of the mental health outcome, and no discussions around statistical power. More precise information on the quality assessment can be found in Appendix F.

## 4. Discussion

This represents the first review to outline the original literature on the relationship between climate change and mental health in Italy. We identified 21 original studies highlighting the negative impacts that climate change is having on mental health. The most robust finding was the increased risk of death among people with mental health conditions when exposed to anomalously high temperature and heatwaves. This finding is in line with existing literature from other European countries, like the United Kingdom (Page et al., 2012) and Sweden (Rocklöv et al., 2014), as well as with the global literature (Charlson et al., 2021; Liu et al., 2021).

Various studies also seemed to indicate a relationship between heat and suicide (both suicide attempts and death by suicide). Evidence from other European countries such as Germany (Müller et al., 2011) and the UK (Page et al., 2007) also identified a positive association between higher environmental temperatures and suicidal behaviour (but see work by Helama et al., 2013 on the effect of suicide prevention policy in mitigating this relationship in Finland). However, not all reviewed studies found a positive relationship between heat and suicide. This is in line with global evidence showing mixed findings concerning the relationship between ambient temperature and suicide (Florido Ngu et al., 2021; Kim et al., 2019). Other studies in our review identified heat and heatwaves as being associated with mental health morbidity (e.g. admission to psychiatric hospital, emergency calls for psychiatric conditions, psychiatric visits to the emergency unit). This again is consistent with findings from other European countries such as Portugal (Almendrea et al., 2019) and Sweden (Carlsen et al., 2019).

In terms of extreme weather events, a small number of studies focused on the detrimental impact of floods on mental health (particularly in relation to PTSD).

This is line with substantial evidence on the negative consequences of floods on mental health in other European countries such as the UK (French et al., 2019) and Spain (Fontalba-Navas et al., 2017). The lack of evidence on other types of extreme weather events such as wildfires was surprising, especially given the widespread nature of wildfires in Italy and evidence from other European countries such as Greece (Adamis et al., 2011) and Spain (Caamano-Isorna et al., 2011). Future research should attempt to address this research gap by investigating the impact on mental health of other extreme weather events such as wildfires, storms, landslides and avalanches. Given the strong tradition of research on mental health and disasters such as earthquakes in Italy (Chierzi et al., 2014; Stratta et al., 2016), Italian researchers and academic institutions are well-placed to address this gap in the evidence.

Another surprising aspect of this review is the dearth of research explicitly focusing on climate change and trauma or PTSD, except for two studies on floods (Di Fiorino et al., 2004, 2005). However, despite the lack of primary evidence, various associations likely exist between the topics covered in the reviewed literature and traumatic stress (Augustinavicius et al., 2021). For example, exposure to highly stressful experiences such as the sudden and unexpected death by suicide of a family member or an involuntary psychiatric admission may in certain situations qualify as exposure to trauma and constitute a risk factor for PTSD (Martinaki et al., 2021; Mitchell & Terhorst, 2017). While robust evidence exists on the association between disasters such as floods and PTSD (Neria et al., 2008), future research should investigate the link between trauma and PTSD with a broader range of climate change stressors (e.g. droughts, heatwaves) as well as the possible interaction between the mental health consequences of climate change (e.g. higher psychiatric hospitalizations due to heat) and trauma.

The current paper has several practical implications for Italy and for European countries with similar geographical profiles. For example, since 2005 Italy has established a heat health watch warning system (HHWS) which can predict up to 3 days in advance weather conditions which might pose a public health threat in 27 cities (Ministero della Salute, 2019). As part of this warning system, people with mental health conditions are considered an at-risk population. The current findings support this and highlight the importance for public health messaging to target this population group during heatwaves and for resources to be directed towards their protection. This is likely to apply to other European countries (16 of which have a heat-health warning system), especially those with geographical characteristics similar to Italy such as Greece and Spain (Casanueva et al., 2019). In general,

this paper highlights the need for more consideration to the mental health impacts of climate change stressors in Italy and in the Mediterranean region in general with a focus on prevention, promotion, and response in both policy, research, and clinical practice (e.g. raising awareness among health professionals about mental health impacts of adverse climatic events).

The current paper also holds several limitations. Various papers presented a range of methodological shortcomings such as not controlling for possible confounders as well as flaws in the measurement of climate change exposure and mental health. While these methodological issues are common in the general climate change and mental health literature (Masazza et al., n.d.), they indicate the need for our results to be interpreted cautiously. Another limitation is the dearth of research on the Southern region of Italy despite this region being more likely to experience certain climatic stressors (e.g. heatwaves), indicating that some results might not be generalizable to the whole country. Additionally, the high heterogeneity of climate change exposures (from heat to extreme weather events) makes aggregating the evidence on climate change complex given that different types of exposures may be more likely to result in different types of outcomes (e.g. extreme weather events such as floods being more likely to result in PTSD than other types of chronic and slow-creeping exposures). Following examples from other reviews, we decided to address this issue by summarizing findings according to the type of exposure (Charlson et al., 2021; Cianconi et al., 2020). Finally, in certain studies, the distinction between climate, weather, and seasonality was often not clarified by the authors.

Climate change is already having substantial impacts on health across the European context. This review highlights how these impacts include mental health consequences as well, using Italy as a case study. As temperatures and other climate change stressors increase in intensity and frequency across the European continent, it is paramount to understand the pathways linking climate change to mental health and to identify possible responses to protect psychological wellbeing and respond to growing mental health needs. As the Mediterranean region will be at the forefront of this challenge, this paper represents a first step in this direction.

### Author contributions

AM and VA conceptualized the study. AM conducted the scoping review and drafted the manuscript. VA and REF commented on the manuscript.

### Data availability statement

All extracted data are reported in [Appendix E](#).

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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## Appendices

### Appendix A. Preferred Reporting Items for Systematic review and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist

Section	Item	PRISMA-ScR checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a scoping review.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3–4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g. population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
<b>METHODS</b>			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g. a Web address); and if available, provide registration information, including the registration number.	N/A
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g. years considered, language and publication status), and provide a rationale.	5 and 33
Information sources*	7	Describe all information sources in the search (e.g. databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	31–32
Selection of sources of evidencet	9	State the process for selecting sources of evidence (i.e. screening and eligibility) included in the scoping review.	5
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g. calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	6
Critical appraisal of individual sources of evidence	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	6
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	6
<b>RESULTS</b>			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	6–8
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	9–14
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	14
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	35–39
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	9–14
<b>DISCUSSION</b>			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	15–16
Limitations	20	Discuss the limitations of the scoping review process.	16
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	16–17
<b>FUNDING</b>			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	18

### Appendix B: Complete MEDLINE search strategy used.

Construct	Search terms
Climate change	climate change OR global warming OR greenhouse effect OR temperature* OR precipitat* OR rainfall OR heat ind* OR extreme heat event* OR heat-wave OR heatwave OR extreme-cold* OR drought* OR sea surface temperature* OR snowmelt* OR flood* OR storm* OR cyclone* OR hurricane* OR typhoon* OR sea-level OR wildfire* OR wildfire* OR forest-fire* OR coast* erosion OR coastal change*
Mental health	mood OR mental disorder* OR anxiety OR depress* OR trauma* OR PTSD OR posttraumatic stress disorder OR post-traumatic stress disorder OR psychosomatic OR somatoform OR anxious OR anguish OR distress OR emotional stress OR emotional stresses OR wellbeing OR well-being OR common mental disorder* OR CMD OR mental trauma OR mental change* OR mental confusion OR mental defect OR mental defects OR mental disorder OR mental disorders OR mental disturbance OR mental disturbances OR mental ill health OR mental illness* OR mental insufficienc* OR mental symptom* OR mentally ill OR mental distress* OR neuropsychiatric OR

(Continued)

**Appendix B: Continued.**

Construct	Search terms
Italy	neuropsychiatric disorder* OR psychiatric diagnosis OR psychiatric disease* OR psychiatric disorder* OR psychiatric illness* OR psychiatric symptom* OR psychic disease* OR psychic disorder* OR psychic disturbance* OR psychologic disorder* OR psychologic disturbance* OR psychological disorder* OR psychological disturbance* OR psychological distress* OR psychological distress OR psychological stress* OR psychopathology OR stress OR somatoform OR somatic Italy OR Abruzzo OR Aosta Valley OR Valle D-Aosta OR Apuglia OR Puglia OR Basilicata OR Calabria OR Campania OR Emilia-Romagna OR Friuli-Venezia Giulia OR Lazio OR Liguria OR Lombardy OR Lombardia OR Marche OR Molise OR Piedmont OR Piemonte OR Sardinia OR Sardegna OR Sicily OR Trentino OR South Tyrol OR Alto Adige OR S#dtirol OR Tuscany OR Toscana OR Umbria OR Veneto

Note. This same search strategy was used using Ovid advance search functionality and selecting the following databases: MEDLINE, Global Health, Embase and PsycINFO. A separate search on MEDLINE using the MeSH terms 'Climate change', 'Mental health' and 'Italy' resulted in two publications and did not lead to any new results being identified.

**Appendix C: Inclusion and exclusion criteria.**

Inclusion criteria	Exclusion criteria
Study in English or Italian language	Study not in English or Italian language
Study conducted in Italy (including study conducted in multiple countries including Italy when data is presented on Italy specifically)	Study not conducted in Italy (or conducted in Italy but aggregated with other countries)
Study on original research	Study not on original research (e.g. commentary, theoretical paper, systematic review, etc.)
Study on climate change or climate change related stressors (e.g. heatwave, floods, wildfires, storms, etc.)	Study not focusing on climate change stressors (e.g. excluded studies on earthquakes and other disasters not related to climate change; studies looking at seasonal changes in temperature; temperature not generated by climate, e.g. by wearing personal protective equipment or temperature in controlled environments such as offices, occupational sites such as factories and industrial sites; studies only focusing on air pollution)
Study on mental health (e.g. psychological distress, symptoms of mental health problems, psychiatric disorders)	Study not focusing on mental health (e.g. physical consequences such as heat stroke and heat/thermal stress, physical trauma, cognitive performance, psychological reactions during natural hazards, neurological conditions such as dementia, violence and aggression)
Study looking at the relationship between climate change and mental health	Study not focusing on the relationship between climate change and mental health (e.g. study looking at psychometric properties of mental health instruments in the context of a flood)
Study is peer-reviewed	Study is not peer-reviewed (e.g. conference abstracts)
Study focuses on humans	Study does not focus on humans (e.g. animals and plants)
No time restriction	N/A

**Appendix D: Papers excluded following full-text assessment (with reason).**

Study	Reason for exclusion
Alessandrini et al. (2011)	Not focusing on mental health
Åström et al. (2013)	Not correct type of study (e.g. conference abstract)
Attili et al. (2011)	Not correct type of study (e.g. conference abstract)
Bellini et al. (2015)	Not correct type of study (e.g. conference abstract)
Bernardini et al. (2020)	Not correct type of study (e.g. conference abstract)
Ciancio et al. (2007)	Not focusing on mental health
Conti et al. (2005)	Not focusing on mental health
Cornali et al. (2004)	Not focusing on mental health
Craparo et al. (2013)	Not focusing on relationship between climate change and mental health
de Lisio et al. (2005)	Not focusing on mental health
Crisci et al. (2021)	Not focusing on mental health
Ellena et al. (2020)	Not focusing on mental health
Froni et al. (2007)	Not focusing on relationship between climate change and mental health
Galati et al. (2003)	Not focusing on mental health
Healy (2003)	Not focusing on mental health
Idzikowska (2011)	Not focusing on mental health
Iniguez et al. (2016)	Not focusing on mental health
Marcheggiani et al. (2019)	Not correct type of study (e.g. conference abstract)
Mastrangelo et al. (2007)	Not focusing on mental health
Michelozzi et al. (2004)	Not focusing on mental health
Morabito et al. (2006)	Not focusing on mental health
Morabito et al. (2012)	Not focusing on mental health
Panno et al. (2017)	Not focusing on climate change stressors
Royé et al. (2021)	Not focusing on mental health
Saccinto et al. (2013)	Not focusing on climate change stressors
Scocco et al. (2008)	Not focusing on climate change stressors
Sotgiu & Galati (2007)	Not focusing on mental health
Tonetti et al. (2012)	Not focusing on climate change stressors

**Appendix E:** Descriptive information on studies included in scoping review.

Author and year	Location	Study period	Study design	Analysis	Study population	Sample size	Exposure	Outcome	Study quality
Aguglia et al. (2019)	Orbassano (Piemonte)	September 2013–August 2015	Case-control study	Quantitative	Patients from psychiatric inpatient unit	730	Temperature and solar radiation (including data on medium & maximum wind, minimum, medium, and maximum temperature, humidity, barometric pressure, solar radiation, rain, and hours of sunshine, windchill and humidex)	Hospitalization in patients with bipolar disorder vs patients with other psychiatric disorders	Fair
Aguglia et al. (2020)	Orbassano (Piemonte)	September 2013–August 2015	Case-control study	Quantitative	Patients from psychiatric inpatient unit	730	Temperature and solar radiation (including data on medium & maximum wind, minimum, medium, and maximum temperature, humidity, barometric pressure, solar radiation, rain, and hours of sunshine, windchill and humidex)	Involuntary hospitalizations	Fair
Aström et al. (2015)	Rome (Lazio)	15th May–15th September 2000–2008	Cohort study	Quantitative	Population aged above 50 as well as susceptible groups (participants with particular ICD diagnoses, e.g. participants with psychiatric disorders)	1,106,511	Temperature (using mean, maximum, minimum, and maximum apparent temperature (MAT)) and heatwaves (defined as two consecutive days with temperature exceeding the 95th percentile of the MAT)	Mortality in susceptible groups (including participants with a psychiatric disorder)	Good
De'Donato et al. (2008)	Milan (Lombardia), Rome (Lazio), and Turin (Piemonte)	Milan (1999–2003); Rome (1998–2001) and Turin (1997–2003)	Case-crossover	Quantitative	Population aged 35 + of Rome, Milan, and Turin	188,407 (52,908 in Milan, 83,253 in Rome, 52,246 in Turin)	Temperature (air temperature, dew point temperature, and sea-level barometric pressure)	Mortality in sub-groups (including people with psychosis and depression)	Good
Di Giorgi et al. (2020)	Treviso, Oderzo, e Vittorio Veneto (Veneto)	One time point (not specified)	Cross-sectional	Mixed methods	Migrants from African countries in Italy (50 participants from country with extreme vulnerability to climate change and 50 participants from country with high vulnerability to climate change)	100	Perception of climate change (sum score of a number of questions in a semi-structured interview)	Emotional disorders (calculated by adding together PHQ-9 and GAD-7 and then dividing by 2)	Poor
Di Fiorino et al. (2004)	Cardoso (Toscana)	One time point (7 years after flood (2003))	Cross-sectional	Quantitative	Disaster rescue squads	34	Flood	Full and sub-threshold PTSD	Poor
Di Fiorino et al. (2005)	Cardoso (Toscana)	One time point (8 years after flooding (2004))	Cross-sectional	Quantitative	Population exposed to flood	61	Flood	PTSD symptoms	Poor
Giacomini et al. (2022)	Genova (Liguria)	August 2013–July 2018	Time series or repeated cross-sectional	Quantitative	Patients admitted for suicide attempts	432	Temperature (ambient temperature)	Hospitalization for suicide attempts	Fair

(Continued)

## Appendix E: Continued.

Author and year	Location	Study period	Study design	Analysis	Study population	Sample size	Exposure	Outcome	Study quality
Miceli et al. (2010)	Valle Torrente Lys (Valle D'Aosta)	One time point (5 years after flooding and landslide, (2005))	Cross-sectional	Quantitative	Populations living in area prone to flooding and landslides	407	Flood risk	Worry around possible future floodings and landslides	Fair
Michelozzi et al. (2005)	Bologna (Emilia-Romagna), Milan (Lombardia), Rome (Lazio), and Turin (Piemonte)	1st June- 31st August 2003	Time series or repeated cross-sectional	Quantitative	Population living in Bologna, Milan, Rome, and Turin and that died (looking at deaths)	12,741 deaths (approximately due to low resolution of table)	Temperature (2003 heatwave)	Mortality in sub-groups (people with psychological illness)	Fair
Petralli et al. (2012)	Florence (Toscana)	1st June- 31st August 2005	Time series or repeated cross-sectional	Quantitative	Population in Florence (looking at emergency calls)	13,357 emergency calls	Temperature (air temperature, air pressure)	Emergency calls divided per type of disease (including psychiatric disease)	Fair
Preti et al. (2007)	Italy	1974–2003	Time series or repeated cross-sectional	Quantitative	Population in Italy that died by suicide	97,743	Temperature (focusing on monthly anomalies in Italian average temperature with respect to the climatological mean)	Suicide	Fair
Preti and Miotto (1998)	Italy	1984–1995	Time series or repeated cross-sectional	Quantitative	Population in Italy that died by suicide	43,755	Climatic indicators: mean, maximum, minimum temperature, mean degree of humidity, mean rainfall, mean daylight	Suicide	Fair
Preti and Miotto (2000)	Italy	1984–1995	Time series or repeated cross-sectional	Quantitative	Population in Italy admitted to hospital because of suicide attempt	27,456	Temperature (mean maximum and minimum temperatures)	Hospitalization for attempted suicide	Fair
Preti, 1997	Italy	1974–1994	Time series or repeated cross-sectional	Quantitative	Population in Italy that either died of suicide or that had a suicide attempt	115,022 (68,153 suicides and 46,869 attempts)	Climatic indicators (max and min temperature; mean degree of humidity, mean and max rainfall, mean daylight, mean exposure to the sun)	Suicides and attempted suicides	Fair
Preti (1998)	Udine (Friuli Venezia Giulia), Torino (Piemonte), Milano (Lombardia), Venezia (Veneto), Bologna (Emilia Romagna), Genova (Liguria), Perugia (Umbria), Firenze (Toscana), Ancona (Marche), Pescara (Abruzzo), Roma (Lazio), Bari (Puglia), Napoli (Campania), Potenza (Basilicata), Cagliari (Sardegna), Catanzaro (Calabria), Palermo (Sicilia)	1974–1994	Time series or repeated cross-sectional	Quantitative	Population in 17 Italian cities who had died by suicide	22,564	Climatic indicators (min and max temperature; humidity grade; min and max rainfall; sunlight exposure; percentage of exposure to the sun)	Suicide	Fair
Schifano et al. (2009)	Rome (Lazio)	2005–2007	Cohort study	Quantitative	Residents of Rome aged 65 years old or older	651,195	Temperature (heatwave episodes defined used maximum apparent temperature)	Mortality in susceptible groups (including participants with a psychiatric disorder)	Fair

(Continued)

Appendix E: Continued.

Author and year	Location	Study period	Study design	Analysis	Study population	Sample size	Exposure	Outcome	Study quality
Settinieri et al. (2016)	Messina (Sicily)	January 2005–December 2010	Time series or repeated cross-sectional	Quantitative	Psychiatric patients accessing Emergency Unit	6565	Meteorological conditions (state of sky, temperature, and atmospheric pressure)	Psychiatric visit to emergency unit (categorized by admitting diagnosis)	Fair
Stafoggia et al. (2006)	Bologna (Emilia-Romagna), Milan (Lombardia), Rome (Lazio), and Turin (Piemonte)	Bologna (2000–2003), Milan (1999–2003), Rome (1998–2001), and Turin (1997–2003)	Case-crossover	Quantitative	Population over 35 years of age that had died from all noninjury causes	205,019	Environmental variables (temperature, relative humidity/dew point temperature, barometric pressure), used mean apparent temperature as the exposure variable	Mortality in susceptible groups (including people with psychosis and people with depression)	Good
Stafoggia et al. (2008)	Bologna (Emilia-Romagna), Milan (Lombardia), Rome (Lazio), and Turin (Piemonte)	Bologna (2000–2003), Milan (1999–2003), Rome (1998–2004), and Turin (1997–2003)	Case-crossover	Quantitative	Population over 65 years of age who had been hospitalized two days before death and thus was inside a care facility when exposed to hot weather	228,596	Environmental variables (temperature, humidity, and barometric pressure), using apparent temperature (composite index combining information from air temperature and humidity)	Mortality in susceptible groups (including people with psychosis and people with depression)	Good
Stivanello et al. (2020)	Bologna (Emilia-Romagna)	2004–2017 (summers)	Case cross-over	Quantitative	Population over 18 years old, resident in Bologna and who died during the summer period (15th May–30th September) of the years 2004–2007	48,305 deaths	Mean apparent daily temperature (Tapp): calculation with mean temperature and dew point	Mortality in susceptible groups (including participants with schizophrenia and other functional psychosis, mania and bipolar affective disorder, depression, neurotic disorders, disorders of personality and behaviour, alcoholism and substance abuse, dementia and cognitive decline)	Good

**Appendix F:** Details on quality assessment (conducted using NIH Study Quality Assessment Tools: <https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools>).

Criteria	Yes (n, %)	No (n, %)	Other (CD, NR, NA) (n, %)
NIH Assessment Tool for Observational Cohort and Cross-Sectional Studies (n = 19)			
1. Was the research question or objective in this paper clearly stated?	18 (95%)	1 (5%)	0
2. Was the study population clearly specified and defined?	18 (95%)	1 (5%)	0
3. Was the participation rate of eligible persons at least 50%?	0	3 (16%)	16 (84%)
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	16 (84%)	3 (16%)	0
5. Was a sample size justification, power description, or variance and effect estimates provided?	3 (16%)	16 (84%)	0
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	7 (37%)	11 (58%)	1 (5%)
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	12 (63%)	7 (37%)	0
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g. categories of exposure, or exposure measured as continuous variable)?	13 (68%)	2 (11%)	3 (16%)
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	15 (79%)	3 (16%)	1 (5%)
10. Was the exposure(s) assessed more than once over time?	4 (21%)	1 (5%)	14 (74%)
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	17 (89%)	2 (11%)	0
12. Were the outcome assessors blinded to the exposure status of participants?	3 (16%)	0	16 (84%)
13. Was loss to follow-up after baseline 20% or less?	0	0	19 (100%)
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	7 (37%)	12 (63%)	0
NIH Assessment Tool for Case-Control Studies (n = 2)			
1. Was the research question or objective in this paper clearly stated and appropriate?	2 (100%)	0	0
2. Was the study population clearly specified and defined?	2 (100%)	0	0
3. Did the authors include a sample size justification?	1 (50%)	1 (50%)	0
4. Were controls selected or recruited from the same or similar population that gave rise to the cases (including the same timeframe)?	2 (100%)	0	0
5. Were the definitions, inclusion and exclusion criteria, algorithms or processes used to identify or select cases and controls valid, reliable, and implemented consistently across all study participants?	2 (100%)	0	0
6. Were the cases clearly defined and differentiated from controls?	2 (100%)	0	0
7. If less than 100 percent of eligible cases and/or controls were selected for the study, were the cases and/or controls randomly selected from those eligible?	0	0	2 (100%)
8. Was there use of concurrent controls?	0	2 (100%)	0
9. Were the investigators able to confirm that the exposure/risk occurred prior to the development of the condition or event that defined a participant as a case?	0	2 (100%)	0
10. Were the measures of exposure/risk clearly defined, valid, reliable, and implemented consistently (including the same time period) across all study participants?	2 (100%)	0	0
11. Were the assessors of exposure/risk blinded to the case or control status of participants?	2 (100%)	0	0
12. Were key potential confounding variables measured and adjusted statistically in the analyses? If matching was used, did the investigators account for matching during study analysis?	0	2 (100%)	0