Suicide rates among people with serious mental illness: a systematic review and meta-analysis

Xue-Lei Fu[1], Yan Qian[2], Xiao-Hong Jin[2], Hai-Rong Yu[2], Hua Wu[1], Lin Du[1], Hong-Lin Chen[3] and Ya-Qin Shi[1]

[1]School of Medicine, Nantong University, Nantong, Jiangsu, 226001 PR China; [2]Affiliated Hospital of Nantong University, Nantong, Jiangsu, 226001 PR China and [3]School of Public Health, Nantong University, Nantong, Jiangsu, 226019 PR China

Abstract

Background. People with serious mental illness are at great risk of suicide, but little is known about the suicide rates among this population. We aimed to quantify the suicide rates among people with serious mental illness (bipolar disorder, major depression, or schizophrenia).
Methods. PubMed and Web of Science were searched to identify studies published from 1 January 1975 to 10 December 2020. We assessed English-language studies for the suicide rates among people with serious mental illness. Random-effects meta-analysis was used. Changes in follow-up time and the suicide rates were presented by a locally weighted scatter-plot smoothing (LOESS) curve. Suicide rate ratio was estimated for assessments of difference in suicide rate by sex.
Results. Of 5014 identified studies, 41 were included in this analysis. The pooled suicide rate was 312.8 per 100 000 person-years (95% CI 230.3–406.8). Europe was reported to have the highest pooled suicide rate of 335.2 per 100 000 person-years (95% CI 261.5–417.6). Major depression had the highest suicide rate of 534.3 per 100 000 person-years (95% CI 30.4–1448.7). There is a downward trend in suicide rate estimates over follow-up time. Excess risk of suicide in males was found [1.90 (95% CI 1.60–2.25)]. The most common suicide method was poisoning [21.9 per 100 000 person-years (95% CI 3.7–50.4)].
Conclusions. The suicide rates among people with serious mental illness were high, highlighting the requirements for increasing psychological assessment and monitoring. Further study should focus on region and age differences in suicide among this population.

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Introduction

Suicide is a global phenomenon and accounts for 1.4% of all deaths worldwide (World Health Organization, 2021). Nearly 800 000 people die due to suicide annually (World Health Organization, 2021). Unlike many causes of death, suicide is not a result of a single process of disease (Gunnell & Lewis, 2005), it is an outcome of a complex multiple interaction, involving biological (such as genetics), psychological (such as certain personality traits), clinical (such as comorbid psychiatric illness), social and environmental factors (Turecki et al., 2019).

Serious mental illness is a diagnosable mental, behavioral, or emotional disorder that causes serious functional impairment and substantially interferes with or limit one or more major life activities (SAMHSA, 2020). People with serious mental illness live socially excluded, subject to the problems of impairment, discrimination, diminished social roles, unemployment, and lack of social networks (Richter & Hoffmann, 2019). Additionally, early-onset serious mental illness substantially worsens lifetime outcomes in the USA, leading to 10 fewer quality-adjusted life years, 24% higher medical spending and 48% lower earnings (Seabury et al., 2019). Serious mental disorders also bring high-income countries and low- and middle-income countries great societal costs, with losses equivalent to 0.3–0.8% of total national earnings (Levinson et al., 2010).

A recent US study (Schmutte, Costa, Hammer, & Davidson, 2021) reported a marked excess of suicide deaths in people with serious mental illness, compared to those with other or no known mental illness. A meta-analysis of suicide rates after discharge from psychiatric facilities has reported that the suicide rates for patients with affective disorder, psychosis, and mixed and other diagnosis were 524 per 100 000 person-years, 599 per 100 000 person-years, and 463 per 100 000 person-years, respectively (Chung et al., 2017). However, there are no accepted benchmarks for suicide rates among people with serious mental illness.

Considering the severity of the problem, an in-depth and comprehensive review of the current status is urgent, which will make an impact on suicide prevention at a global level. A synthesis of the existing literature about suicide rates would help quantify the extent of this issue

and guide future research and clinical guidance. This meta-analysis focuses on epidemiological evidence for suicide rates among people with serious mental illness (including bipolar disorder, major depression, or schizophrenia). We aimed to calculate a pooled estimate of suicide rate and determine the suicide rates regarding continents, psychiatric diagnosis, duration of follow-up, sex, and suicide methods.

Method

This systematic review and meta-analysis was conducted according to the Meta-analysis of Observational Studies in Epidemiology (MOOSE) (Stroup et al., 2000) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, Liberati, Tetzlaff, & Altman, 2009) standard.

Search strategy

PubMed and Web of Science were searched for relevant articles published in English from 1 January 1975 to 10 December 2020, with the various combinations of the terms *bipolar disorder, schizophrenia, major depression, serious mental illness, severe mental illness*, and *suicid*, mortalit*, death** (online Supplementary eTable 1). Reference lists of relevant review articles and all included articles were searched for additional eligible papers. Gray literature was not reviewed. Two investigators independently assessed titles, abstracts, and full-text publications. Any disagreements were resolved by discussion with a third investigator.

Inclusion and exclusion criteria

In this review, serious mental illness included bipolar disorder, major depression, and schizophrenia. We included studies that reported the number of suicides among people with bipolar disorder, major depression, or schizophrenia, and the number of person-years in which the suicides occurred. Studies were also considered eligible if they contained data from which the suicide rate could be derived using the reported rate, the mean length of patient follow-up, or the duration of follow-up. Eligible studies had to recruit at least 50 participants. There was no restriction on age. Studies of suicide attempts were excluded. When two studies reported overlapping samples from the same national registers, the study with earlier enrollment period was excluded. Case studies, case series, randomized controlled trial, cross-sectional study, qualitative studies, systematic reviews, and abstracts were not eligible.

Data extraction

Data were extracted by two investigators to ensure consistency, again with any discrepancies resolved by discussion with a third investigator. Key study characteristics included author names, year of publication, country of study, enrollment period, study design, age, proportion of female, psychiatric diagnosis, and sample size. For the calculation of suicide rates, the number of suicides and the person-years were extracted. In some publications, the number of person-years could be estimated using the number of suicides and reported suicide rate, or the reported duration of follow-up.

Quality assessment

Two raters independently appraised study quality. The quality of included articles was assessed using a tool specifically designed to

assess bias in prevalence studies (Hoy et al., 2012). This chosen tool addressed four domains of bias, including selection bias, non-response bias, measurement bias, and bias related to the analysis. It consists of 10 items, which are scored positively or negatively. According to the total score, each study was rated as low, moderate, or high risk of bias. Studies at high risk of bias were excluded from this meta-analysis.

Statistical analysis

Stata version 12.0 (StataCorp) was used to generate meta-analysis for suicide rates among people with serious mental illness. The suicide rate per person-year was the effect size measure. The pooled effect size was calculated using the metaprop command (Nyaga, Arbyn, & Aerts, 2014), which allows for the inclusion of studies with 0% or 100% prevalence proportions and avoids confidence intervals exceeding the 0–1 range. The Freeman-Tukey double arcsine transformation was performed to stabilize the variances (Nyaga et al., 2014). Study-specific 95% confidence intervals (CIs) were generated using the exact method. Random-effects meta-analysis was used due to the high expected heterogeneity between studies. The Q tests and I^2 statistics were used to assess heterogeneity across all studies (Higgins, Thompson, Deeks, & Altman, 2003). Publication bias was assessed by visual inspection of funnel plots and Begg's Test.

Subgroup analyses were conducted, using the following categorical study characteristics: (1) study of continents (Africa, Asia, Europe, North America, or Oceania); (2) psychiatric diagnosis (bipolar disorder, major depression, or schizophrenia); (3) duration of follow-up (0–10, >10–20, or >20 years); (4) sex (male or female); and (5) suicide methods (jumping, hanging, poisoning, or other). Changes in follow-up time and suicide rates were analyzed using a locally weighted scatter-plot smoothing (LOESS) curve, which produces a smooth fit to the data and reduces the influence of extreme outliers (Cleveland, 1979). For assessments of differences in suicide rates by sex, suicide rate ratio was estimated. Univariate meta-regression models were also conducted to assess the association between study characteristics (year of publication, mean age, proportion of female) and the pooled suicide rate estimate. Statistical tests were two-sided and a significance level of $p < 0.05$ was used throughout.

Results

A total of 5 014 records were identified through databases and reference searches, as shown in the PRISMA flow diagram (Fig. 1). After the removal of irrelevant title, abstracts, and duplicates, 354 articles remained for full review. Ultimately, 313 articles were excluded, leaving 41 that met eligibility (Abdel-Baki et al., 2011; Allebeck & Wistedt, 1986; Almeida, Hankey, Yeap, Golledge, & Flicker, 2018; Antolín-Concha et al., 2020; Björkenstam, Björkenstam, Hjern, Bodén, & Reutfors, 2014; Black & Fisher, 1992; Brown, Inskip, & Barraclough, 2000; Carlborg, Jokinen, Nordström, Jönsson, & Nordström, 2010; Ceskova, Prikryl, & Kasparek, 2011; Coryell & Young, 2005; Crump, Sundquist, Winkleby, & Sundquist, 2013; Dennehy et al., 2011; Díaz-Fernández, Frías-Ortiz, & Fernández-Miranda, 2020; Dutta et al., 2007; Hansson et al., 2018; Hayes, Marston, Walters, King, & Osborn, 2017; Høye, Jacobsen, & Hansen, 2011; Isometsä, Sund, & Pirkola, 2014; Kaplan, Harrow, & Clews, 2016; Kim et al., 2017; Kiviniemi et al., 2013; Limosin, Loze, Philippe, Casadebaig, & Rouillon, 2007; Lin, Chung,
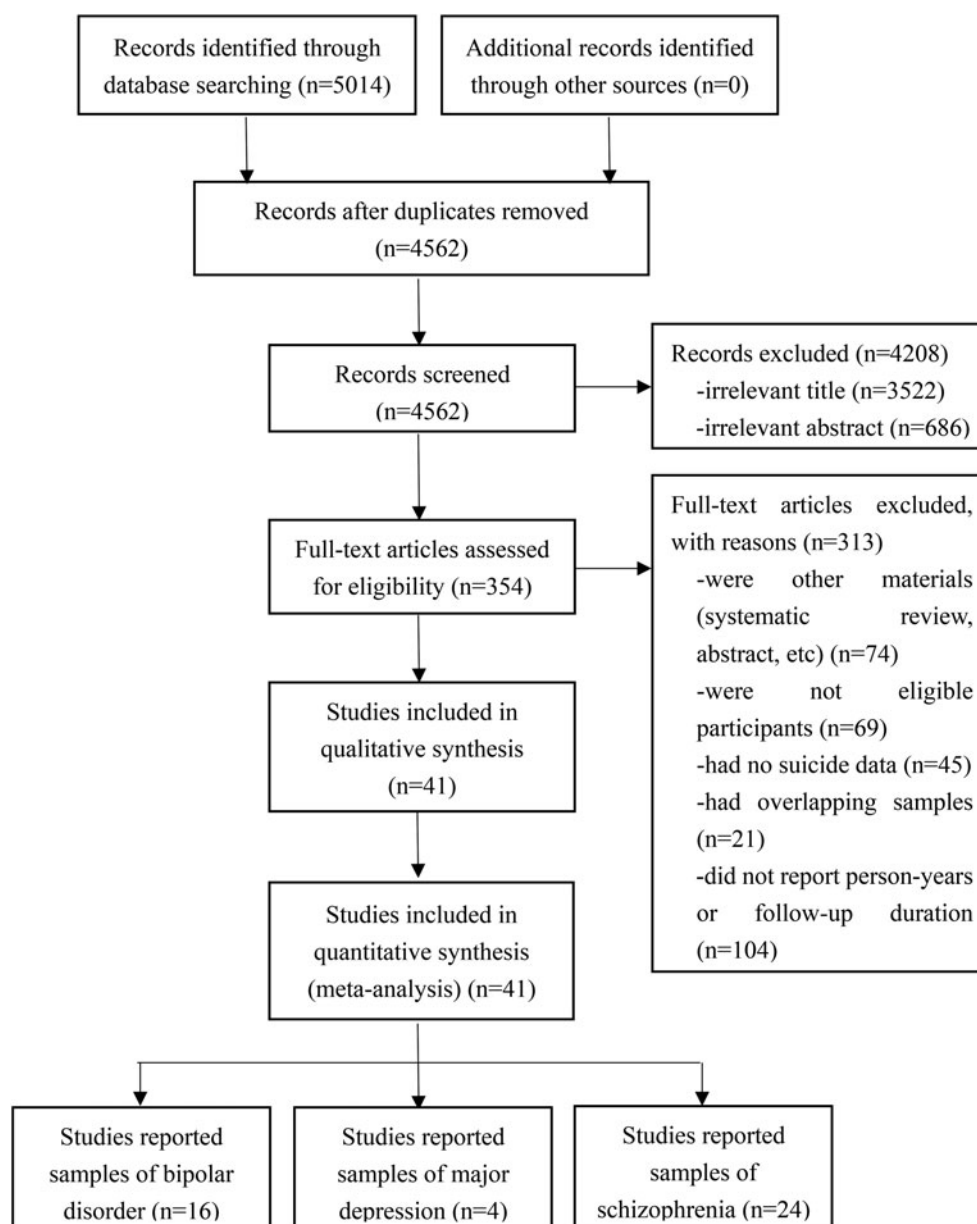
Fig. 1. Flowchart of searches for studies reporting rates of suicide among people with serious mental illness.

Chen, & Chien, 2019; Loas, Azi, Noisette, Legrand, & Yon, 2009; Lui, 2009; Newman & Bland, 1991; Olfson, Gerhard, Huang, Crystal, & Stroup, 2015; Oquendo et al., 2007; Osby, Brandt, Correia, Ekbom, & Sparén, 2001; Østergaard, Nordentoft, & Hjorthøj, 2017; Persons et al., 2018; Plans, Nieto, Benabarre, & Vieta, 2019; Ran et al., 2009; Schneider, Philipp, & Müller, 2001; Simon, Hunkeler, Fireman, Lee, & Savarino, 2007; Teferra et al., 2011; Tsai, Lee, & Chen, 1999; Tseng, Cheng, Lee, & Lee, 2006; Tsoi & Wong, 1991; Webb, Långström, Runeson, Lichtenstein, & Fazel, 2011; Wiersma, Nienhuis, Slooff, & Giel, 1998).

Study characteristics

The key characteristics are summarized in Table 1. The 41 studies reported 7 852 suicides during 6 531 931 person-years. The mean age of participants was reported in 26 studies, ranged from 21.9 to 72.3 years. The proportion of female participants in the study sample was reported in 36 studies, with a total of 640 277 female participants among 1 359 503 participants. The median duration of follow-up was 10.0 years (range 1.2–24.6 years; interquartile range 5.0–14.0 years). Two studies only enrolled adult men (Almeida et al., 2018; Ceskova et al., 2011).

The largest study (Olfson et al., 2015) in this meta-analysis included 1 138 853 cases, and the smallest study (Tseng et al., 2006) identified 67 cases. Many studies captured a representative sample using nationwide databases. The most frequently studied diagnostic outcome was schizophrenia (n = 24), followed by bipolar disorder (n = 16) and major depression (n = 4). The 41 studies included data from 18 countries and all studies were done in a single country. Seven samples were from Asian countries, 23 from mainland Europe, and nine from North America. There

Table 1. Key characteristics of the included studies

Author, year	Country	Period	Study design	Age, mean (s.d.)	Female (%)	Psychiatric diagnosis	No. of Suicides	No. of samples	Total No. of person-years	Suicide rate per 100 000 person-years
Antolín-Concha et al. (2020)	Finland	1996–2012	Retrospective	NR	53.1	Bipolar disorder	477	18 018	129 740	367.7
Díaz-Fernández et al. (2020)	Spain	2004–2007	Prospective	43.5 (9.8)	36.3	Schizophrenia	5	344	6880	72.7
Lin et al. (2019)	China	2007–2013	Retrospective	41.3 (11.9)	45.8	Schizophrenia	98	10 190	32 873	298.1
Plans et al. (2019)	Spain	1996–2016	Retrospective	38.9	NR	Bipolar disorder	14	313	3443	406.6
Almeida et al. (2018)	Australia	1996–1998	Prospective	72.3 (4.6)	0	Bipolar disorder	4	250	3200	125.0
Hansson et al. (2018)	Sweden	2004–2014	Prospective	47.8 (16.0)	62.3	Bipolar disorder	90	12 850	52 043	172.9
Persons et al. (2018)	USA	1978–1981	Prospective	36.3 (13.1)	58.0	Bipolar disorder	20	429	7693	260.0
Hayes et al. (2017)	UK	2000–2014	Retrospective	NR	46.9	Schizophrenia; bipolar disorder	33; 36	22 497; 17 341	82 900; 60 200	39.8; 59.8
Kim et al. (2017)	Korea	2002–2013	Retrospective	NR	NR	Schizophrenia	174	8847	97 315	178.8
Østergaard et al. (2017)	Denmark	1955–2011	Retrospective	28.9 (9.4)	44.5	Schizophrenia; bipolar disorder	1300; 249	35 625; 9279	405 329; 72 897	320.7; 341.6
Kaplan et al. (2016)	USA	NR	Prospective	NR	NR	Schizophrenia; bipolar disorder	15; 2	97; 53	1940; 1060	773.2; 188.7
Olfson et al. (2015)	USA	2001–2007	Retrospective	NR	46.4	Schizophrenia	2498	1 138 853	4 807 121	52.0
Björkenstam et al. (2014)	Sweden	NR	Prospective	22.9 (3.7)	57.2	Bipolar disorder	13	388	1668	779.4
Isometsä et al. (2014)	Finland	1987–2003	Retrospective	NR	NR	Bipolar disorder	466	13 581	94 715	492.0
Crump et al. (2013)	Sweden	2001–2002	Prospective	NR	59.2	Bipolar disorder	77	6618	41 703	184.6
Kiviniemi et al. (2013)	Finland	1998–2003	Prospective	33.8 (12.2)	42.2	Schizophrenia	122	6987	34 935	349.2
Abdel-Baki et al. (2011)	Italy	1983–1987	Retrospective	NR	28.9	Schizophrenia	10	142	710	1408.5
Ceskova et al. (2011)	Czech Republic	1996–	Retrospective	22.2 (5.2)	0.0	Schizophrenia	7	162	1620	432.1
Dennehy et al. (2011)	USA	NR	Prospective	39.6 (12.9)	56.9	Bipolar disorder	8	4360	5719	139.9
Høye et al. (2011)	Norway	1980–2006	Retrospective	35.2 (14.2)	38.3	Schizophrenia	49	1111	19 090	256.7
Teferra et al. (2011)	Ethiopia	NR	Prospective	NR	17.9	Schizophrenia	4	307	1535	260.6
Webb et al. (2011)	Sweden	1973–2004	Retrospective	NR	35.6	Schizophrenia	871	13 804	184 102	473.1

Carlborg et al. (2010)	Sweden	1973–1987	Prospective	32.2 (10.3)	65.6	Schizophrenia	18	244	6002	299.9
Loas et al. (2009)	France	1991–1995	Prospective	NR	NR	Schizophrenia	8	150	2100	381.0
Lui (2009)	China	2002–2006	Retrospective	21.9	44.4	Schizophrenia	8	234	611	1309.3
Ran et al. (2009)	China	1994–2004	Prospective	44.8 (15.6)	53.4	Schizophrenia	21	500	4426	474.5
Dutta et al. (2007)	UK	1965–1999	Prospective	18.8 (9.5)	56.6	Bipolar disorder	8	235	4422	180.9
Limosin et al. (2007)	France	1993	Prospective	39.3 (11.3)	36.2	Schizophrenia	141	3434	34 340	410.6
Oquendo et al. (2007)	USA	NR	Prospective	37.7 (11.9)	58.6	Major depression	4	314	628	636.9
Simon et al. (2007)	USA	1994–2001	Retrospective	38.4 (14.6)	65.5	Bipolar disorder	73	32 360	88 382	82.6
Tseng et al. (2006)	China	2000–2001	Prospective	49.2 (15.4)	71.9	Major depression	1	67	78	1278.8
Coryell and Young (2005)	USA	1976–1990	Prospective	38.8 (14.8)	67.5	Major depression	33	785	16 250	203.1
Osby et al. (2001)	Sweden	1973–1995	Retrospective	43.1 (14.4)	57.2	Bipolar disorder	672	15 386	170 615	393.9
Schneider et al. (2001)	Germany	NR	Prospective	39.8 (16.8)	68.6	Major depression	16	280	1400	1142.9
Brown et al. (2000)	UK	1981–1982	Prospective	NR	42.40	Schizophrenia	14	370	4810	291.1
Tsai et al. (1999)	China	1995–1996	Retrospective	45.3 (10.7)	62.0	Bipolar disorder	4	158	3018	132.5
Wiersma et al. (1998)	The Netherlands	1978–1979	Retrospective	NR	0.476	Schizophrenia	9	82	1230	731.7
Black and Fisher (1992)	USA	1970–1981	Retrospective	30.1 (10.7)	41.3	Schizophrenia	16	356	4601	347.8
Newman and Bland (1991)	Canada	1976–1985	Retrospective	37.3	41.4	Schizophrenia	97	3623	21 738	446.2
Tsoi and Wong (1991)	Singapore	1975	Prospective	NR	42.7	Schizophrenia	34	330	4950	686.9
Allebeck and Wistedt (1986)	Sweden	1971	Prospective	NR	51.9	Schizophrenia	33	1190	11 900	277.3

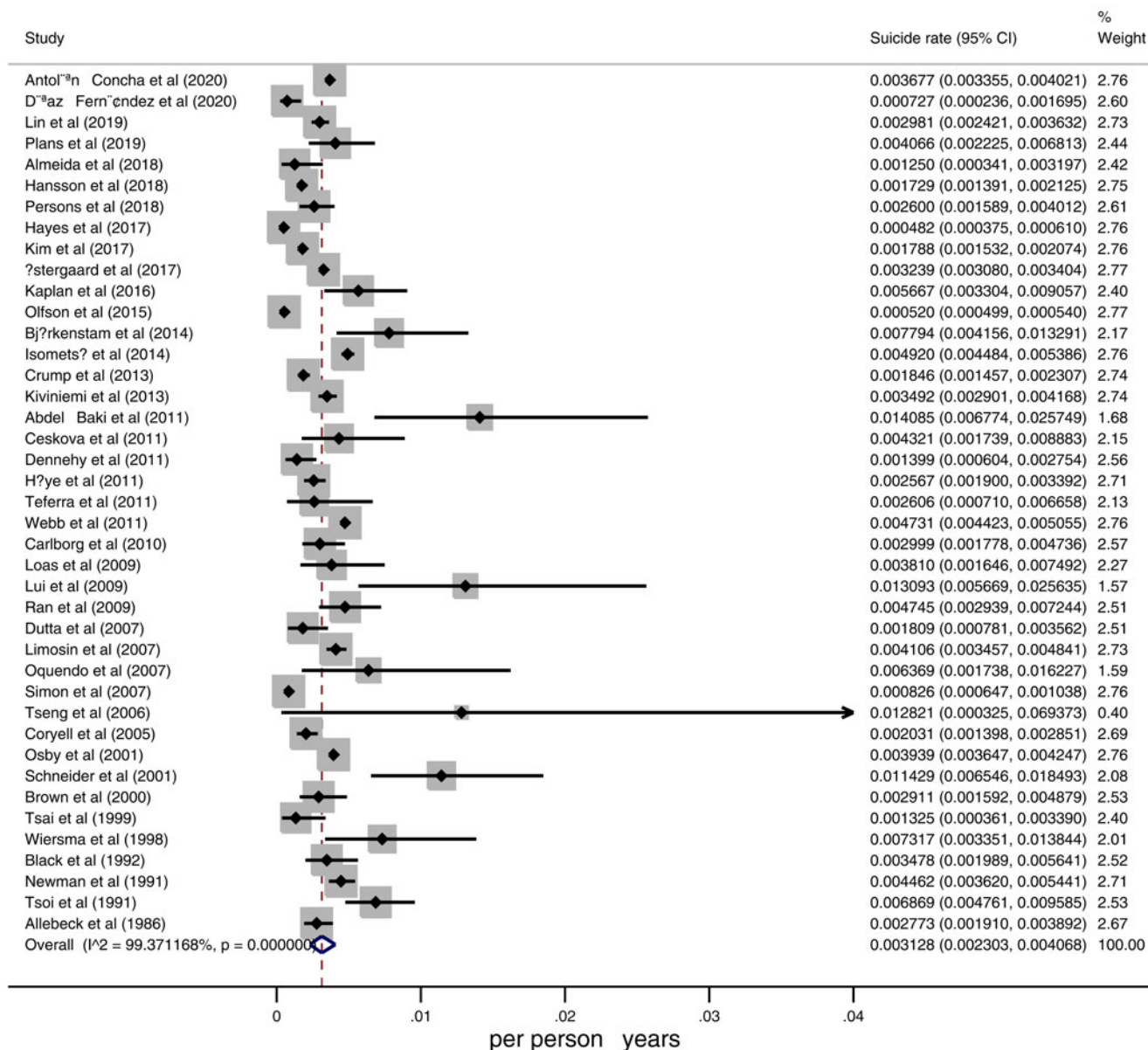| Study	Suicide rate (95% CI)	% Weight
Antol¨ªn Concha et al (2020)	0.003677 (0.003355, 0.004021)	2.76
D¨ªaz Fern¨¢ndez et al (2020)	0.000727 (0.000236, 0.001695)	2.60
Lin et al (2019)	0.002981 (0.002421, 0.003632)	2.73
Plans et al (2019)	0.004066 (0.002225, 0.006813)	2.44
Almeida et al (2018)	0.001250 (0.000341, 0.003197)	2.42
Hansson et al (2018)	0.001729 (0.001391, 0.002125)	2.75
Persons et al (2018)	0.002600 (0.001589, 0.004012)	2.61
Hayes et al (2017)	0.000482 (0.000375, 0.000610)	2.76
Kim et al (2017)	0.001788 (0.001532, 0.002074)	2.76
?stergaard et al (2017)	0.003239 (0.003080, 0.003404)	2.77
Kaplan et al (2016)	0.005667 (0.003304, 0.009057)	2.40
Olfson et al (2015)	0.000520 (0.000499, 0.000540)	2.77
Bj?rkenstam et al (2014)	0.007794 (0.004156, 0.013291)	2.17
Isomets? et al (2014)	0.004920 (0.004484, 0.005386)	2.76
Crump et al (2013)	0.001846 (0.001457, 0.002307)	2.74
Kiviniemi et al (2013)	0.003492 (0.002901, 0.004168)	2.74
Abdel Baki et al (2011)	0.014085 (0.006774, 0.025749)	1.68
Ceskova et al (2011)	0.004321 (0.001739, 0.008883)	2.15
Dennehy et al (2011)	0.001399 (0.000604, 0.002754)	2.56
H?ye et al (2011)	0.002567 (0.001900, 0.003392)	2.71
Teferra et al (2011)	0.002606 (0.000710, 0.006658)	2.13
Webb et al (2011)	0.004731 (0.004423, 0.005055)	2.76
Carlborg et al (2010)	0.002999 (0.001778, 0.004736)	2.57
Loas et al (2009)	0.003810 (0.001646, 0.007492)	2.27
Lui et al (2009)	0.013093 (0.005669, 0.025635)	1.57
Ran et al (2009)	0.004745 (0.002939, 0.007244)	2.51
Dutta et al (2007)	0.001809 (0.000781, 0.003562)	2.51
Limosin et al (2007)	0.004106 (0.003457, 0.004841)	2.73
Oquendo et al (2007)	0.006369 (0.001738, 0.016227)	1.59
Simon et al (2007)	0.000826 (0.000647, 0.001038)	2.76
Tseng et al (2006)	0.012821 (0.000325, 0.069373)	0.40
Coryell et al (2005)	0.002031 (0.001398, 0.002851)	2.69
Osby et al (2001)	0.003939 (0.003647, 0.004247)	2.76
Schneider et al (2001)	0.011429 (0.006546, 0.018493)	2.08
Brown et al (2000)	0.002911 (0.001592, 0.004879)	2.53
Tsai et al (1999)	0.001325 (0.000361, 0.003390)	2.40
Wiersma et al (1998)	0.007317 (0.003351, 0.013844)	2.01
Black et al (1992)	0.003478 (0.001989, 0.005641)	2.52
Newman et al (1991)	0.004462 (0.003620, 0.005441)	2.71
Tsoi et al (1991)	0.006869 (0.004761, 0.009585)	2.53
Allebeck et al (1986)	0.002773 (0.001910, 0.003892)	2.67
Overall (I^2 = 99.371168%, p = 0.0000000)	0.003128 (0.002303, 0.004068)	100.00

Fig. 2. Forest plot of pooled suicide rate among people with serious mental illness.

was one sample each from Africa and Oceania. Overall, no studies were deemed to be at high risk of bias, 15 (36.6%) were at moderate risk of bias, and 26 (63.4%) were at low risk of bias (online Supplementary eTable 2).

Meta-analysis

The pooled suicide rate among people with serious mental illness was 312.8 per 100 000 person-years (95% CI 230.3–406.8 per 100 000 person-years), with substantial heterogeneity ($I^2 = 99.4\%$; $p < 0.001$) (Fig. 2). Visual inspection of the funnel plot symmetry and Begg's Test ($p = 0.238$) suggested an absence of publication bias (online Supplementary eFig. 1). Meta-regression analysis found publication year ($p = 0.454$), mean age ($p = 0.870$), or proportion of female ($p = 0.687$) was not significantly associated with the pooled suicide rate (online Supplementary eFig. 2).

Europe was reported to have the highest pooled suicide rate [335.2 per 100 000 person-years (95% CI 261.5–417.6 per 100 000 person-years)], followed by Asia [295.9 per 100 000 person-years (95% CI 149.2–480.7 per 100 000 person-years)], Africa [260.6 per 100 000 person-years (95% CI 71.0–665.8 per 100 000 person-years)], North America [232.5 per 100 000 person-years (95% CI 131.8–359.5 per 100 000 person-years)], and Oceania [125.0 per 100 000 person-years (95% CI 34.1–319.7 per 100 000 person-years)] (Table 2).

The suicide rates of bipolar disorder were available from 16 studies and varied from 125.0 per 100 000 person-years (95% CI 34.1–319.7 per 100 000 person-years) in Oceania to 291.9 (95% CI 198.4–403.0 per 100 000 person-years) in Europe, with a pooled estimate of 237.0 per 100 000 person-years (95% CI 159.9–328.5 per 100 000 person-years). The suicide rates of major depression were available from four studies and varied

Table 2. Subgroup analyses according to study characteristics

	Suicide rate (per 100 000 person-years)	95% CI	Heterogeneity	*p* Value
Study of continents				
Africa	260.6	71.0–665.8	–	0.001
Asia	295.9	149.2–480.7	91.09%	0.000
Europe	335.2	261.5–417.6	97.91%	0.000
North America	232.5	131.8–359.5	97.43%	0.000
Oceania	125.0	34.1–319.7	–	0.001
Psychiatric diagnosis				
Bipolar disorder	237.0	159.9–328.5	97.81%	0.000
Schizophrenia	352.2	239.3–485.7	99.43%	0.000
Major depression	534.3	30.4–1448.7	88.34%	0.016
Duration of follow-up				
0–10y	319.2	209.7–448.5	99.16%	0.000
>10–20y	303.5	245.6–367.3	93.95%	0.000
>20y	226.0	167.1–293.4	–	0.000
Sex				
Male	368.0	206.5–572.4	99.19%	0.000
Female	170.2	78.2–290.9	98.73%	0.000
Suicide methods				
Jumping	1.8	0.0–20.9	77.05%	0.487
Hanging	18.0	1.0–49.0	76.03%	0.013
Poisoning	21.9	3.7–50.4	69.23%	0.002
Other	12.1	0.4–35.1	66.32%	0.020

from 180.3 per 100 000 person-years (95% CI 116.2–256.2 per 100 000 person-years) in North America to 1282.1 (95% CI 32.5–6937.3 per 100 000 person-years) in Asia, with a pooled estimate of 534.3 per 100 000 person-years (95% CI 30.4–1448.7 per 100 000 person-years). The suicide rates of schizophrenia were available from 24 studies and varied from 260.6 per 100 000 person-years (95% CI 71.0–665.8 per 100 000 person-years) in Africa to 421.1 (95% CI 244.3–642.6 per 100 000 person-years) in Asia, with a pooled estimate of 352.2 per 100 000 person-years (95% CI 239.3–485.7 per 100 000 person-years) (Table 2; online Supplementary eFig. 3).

The pooled suicide rate with a follow-up of 10 years or less was 319.2 per 100 000 person-years (95% CI 209.7–448.5 per 100 000 person-years) and decreased thereafter in studies with follow-up of 10–20 years [303.5 per 100 000 person-years (95% CI 245.6–367.3 per 100 000 person-years)] and over 20 years [226.0 per 100 000 person-years (95% CI 167.1–293.4 per 100 000 person-years)] (Table 2). Figure 3 showed a downward trend in the suicide rate estimates over time.

Seventeen studies reported suicide rates in males, with a pooled suicide rate of 368.0 per 100 000 person-years (95% CI 206.5–572.4 per 100 000 person-years). Fifteen studies reported suicide rates in females, with an estimate of 170.2 per 100 000 person-years (95% CI 78.2–290.9 per 100 000 person-years) (Table 2). For all serious mental illness, suicide rate ratios in males compared with females were available from 14 studies,
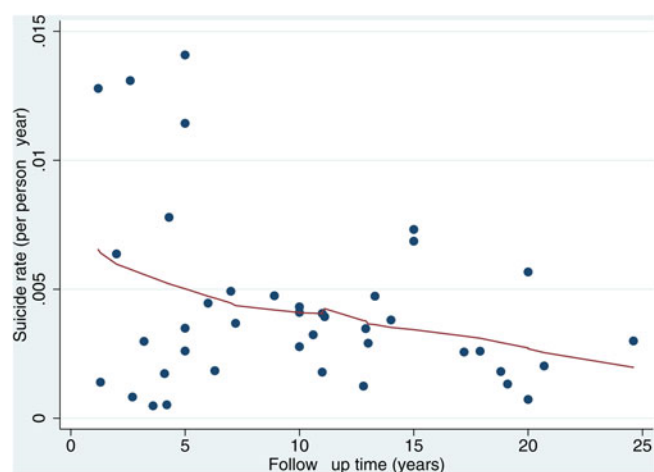
Fig. 3. Suicide rate estimates among people with serious mental illness over follow-up time.

with a pooled suicide rate ratio of 1.90 (95% CI 1.60–2.25). Excess risk in males was found for bipolar disorder [1.88 (95% CI 1.37–2.59)] and schizophrenia [2.01 (95% CI 1.60–2.53)] (online Supplementary eFig. 4).

There were 10 studies presenting data on suicide methods. The most common suicide method was poisoning [21.9 per 100 000

person-years (95% CI 3.7–50.4 per 100 000 person-years)], followed by hanging [18.0 per 100 000 person-years (95% CI 1.0–49.0 per 100 000 person-years)], other [12.1 per 100 000 person-years (95% CI 0.4–35.1 per 100 000 person-years)], and jumping [1.8 per 100 000 person-years (95% CI 0.0–20.9 per 100 000 person-years)] (Table 2).

Discussion

This study presented a meta-analysis of suicide among people with serious mental illness from 41 studies. The results of this meta-analysis indicated a pooled suicide rate estimate of 312.8 per 100 000 person-years. A previous study had found that the postdischarge suicide rate was 484 per 100 000 person-years (Chung et al., 2017), which is higher than our study. This is reasonable because the immediate risk of suicide after discharge is high (Haglund, Lysell, Larsson, Lichtenstein, & Runeson, 2019). However, people with serious mental illness have excess suicide rate relative to the general population. Compared with the general population, age-and-sex-standardized mortality ratio for suicide is increased by 5–10 times among people with serious mental illness (Das-Munshi et al., 2017). The suicide rate in the US general population is only 11.54 per 100 000 person-years (Nie et al., 2021). Even among cancer patients, the suicide rate is only 39.72 per 100 000 person-years (Du et al., 2020), highlighting the importance of addressing the mental health needs of this population. Additionally, we also found a downward trend in the suicide rate estimates over follow-up time and this result is consistent with Chung et al.'s research (Chung et al., 2017).

In our study, major depression has the highest pooled suicide rate while bipolar disorder has the lowest suicide rate. A systematic review and meta-analysis also found that the mean prevalence of bipolar disorder among suicide victims is markedly lower than the mean prevalence of major depressive disorder (Cho, Na, Cho, Im, & Kang, 2016). There are observed variations in suicide rates by continents, and Europe is leading in this comparison. The highest suicide rate in Europe is reasonable because this continent has the highest prevalence of heavy alcohol use (Peacock et al., 2018), which is a potent risk factor for suicide (Edwards, Ohlsson, Sundquist, Sundquist, & Kendler, 2020; Foster, 2013). Wide cross-national variations could be partly attributed to variations in the organization and provision of mental health service (Shah, Bhandarkar, & Bhatia, 2010) and underreporting and misclassification of suicide (partly related to legal and cultural factors) (Jacob et al., 2007).

Generally, males were found to have an excess risk of suicide in our study. Connecting suicidal individuals to mental health service is a critical component of suicide prevention efforts, but a previous study (Walby, Myhre, & Kildahl, 2018) has found that compared with females, males had significantly less contact with inpatient or outpatient mental health services. Conformity to traditional masculine norms and mental health-related stigma may be key deterrents for them to seek help (Clement et al., 2015; Seidler, Dawes, Rice, Oliffe, & Dhillon, 2016). Moreover, a lack of perceived need for services, preference for self-management, fear of hospitalization, and structural factors, such as time and finances, are also identified as barriers to mental health service utilization (Hom, Stanley, & Joiner, 2015).

It was also observed that poisoning is the most common suicide method for people with serious mental illness. Suicide methods often reflect specific socio-cultural, economic, and religious situations (Wu, Chen, & Yip, 2012). The agricultural Green Revolution introduces highly hazardous pesticides into poor rural communities and pesticide self-poisoning becomes the leading cause of suicide in low-income and middle-income countries (Karunarathne, Gunnell, Konradsen, & Eddleston, 2020), accounting for 14–20% of all global suicides (Mew et al., 2017). However, in the USA, firearms were the most commonly used suicide method among males with serious mental illness, while self-poisoning accounted for a majority of suicide deaths in females (Schmutte et al., 2021). Jumping was found to be the most common method of suicide among psychiatric patients in Korea (Park et al., 2013). Therefore, comparisons by continents and other characteristics are needed in further study.

Although publication year was not the source of heterogeneity from meta-regression, a downward trend in the suicide rate estimates was observed in recent decades. Similarly, a previous study (Naghavi, 2019) also revealed that age-standardized mortality rates for suicide have greatly reduced since 1990. In many countries, the government has realized the importance of suicide prevention and launched national prevention programs to encourage research, detection, treatment, and management of people at risk (Mann et al., 2005; van der Feltz-Cornelis et al., 2011; Zalsman et al., 2016). As the science of suicide prevention progresses and the number and quality of studies increase (Bolton, Gunnell, & Turecki, 2015), more and more nonpharmacologic and pharmacologic interventions are performed to prevent suicide and reduce suicide behaviors in at-risk people (D'Anci, Uhl, Giradi, & Martin, 2019).

Social support is a social network's provision of psychological and material resources, which can make individuals more resilient when they are exposed to traumas (Southwick et al., 2016). Family members should help young patients with first-episode psychosis to seek treatment (Martin et al., 2018). In addition, most individuals have health system contact prior to suicide, which means opportunities for suicide prevention in primary care or medical specialty settings (Ahmedani et al., 2014). Therefore, it is important to introduce various service changes related to ward safety, community services, training, and policy and guidance (Kapur et al., 2016; Leung, Chow, Ip, & Yip, 2019).

Strengths

Our study has a number of strengths. First, this is the first systematic review and meta-analysis of suicide rates among people with serious mental illness to have been conducted. Given the poor lifetime consequences of this disease and high risk of suicide of this population, a comprehensive picture of existing evidence of the suicide deaths among this population is extremely valuable. Second, several methods were employed to ensure the quality of this review. Databases were searched using a thorough string of keywords, along with the screening reference lists to limit the number of eligible articles missed. Articles were quality assessed using a valid and reliable checklist tool and were excluded if they were not of sufficient quality, ensuring that only the best quality articles were included.

Limitations

However, limitations in the review must be noted. First, substantial statistical heterogeneity was found across the included studies. Although subgroup analyses and meta-regression analyses were conducted, the source of heterogeneity was unable to be explained, which might be attributable to factors that were not

reported in the primary research. Second, almost all the research came from high-income economies of Asia, Europe, and North America, and our results might not be representative of suicide in low- and middle-income countries. Third, only four of the included studies reported suicide rates of major depression, limiting the generalizability of the suicide rate estimates. Fourth, the number of articles that reported suicide method is too small, so we cannot make further comparisons by continent or other study characteristics. Finally, there is a lack of reporting of age data in the majority of the included studies, which needs further research in this topic.

Conclusions

This study found that people who have serious mental illness were at great risk of suicide, calling for the implementation of psychological assessment and monitoring. Measures to prevent suicidal pesticide ingestions are required to reduce the risk of self-poisoning. To better understand the epidemiology of suicides in this population, additional work is necessary to delineate region and age differences in suicide deaths among people with serious mental illness.

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