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Are stressful life events prospectively associated with increased suicidal ideation and behaviour? A systematic review and meta-analysis

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Abstract

Background: Stressful life events are a risk factor for suicidal ideation and behaviour, but the strength and nature of this association is unclear. This review examined the prospective relationship between stressful life events and subsequent suicidal ideation and behaviours.

Methods: Five databases were searched from inception to April 2019. Eligible studies included observational, quantitative longitudinal cohort studies with adult or adolescent samples. A random-effects meta-analysis model was used to examine the prospective relationship between stressful life events and subsequent suicidal ideation and behaviours. Sub-group analyses examined moderating factors.

Results: Eight studies were identified in the systematic review, and seven studies comprising 2,639 participants were included in the meta-analysis. Six studies investigated suicidal ideation and one investigated suicidal behaviours. Stressful life events were associated with a 37% higher odds of subsequently reported suicidal ideation and behaviours combined (Odds Ratio (OR): 1.37, 95% CI: 1.10 to 1.70), and a 45% increased risk for suicidal ideation (OR: 1.45, 95% CI: 1.20 to 1.75). This association was stronger in males, young adults, and studies with shorter term follow-up.

Limitations: The analyses indicated statistical heterogeneity was high (I^2 = 76. 48, 95% CI: 55.0 to 87.7%) and there was evidence of publication bias.

Conclusions: Stressful life events were shown to increase the risk of subsequently reported suicidal ideation and behaviours. These findings suggest that the experience of stressful life events should be incorporated into clinical suicide risk assessments and suicide interventions could include a component on developing resilience and adaptive coping to stressful life events.

Keywords: Stressful life events; suicidal ideation; suicidal behaviours; meta-analysis

1. Introduction

Suicide is a serious public health concern, causing around 800,000 deaths worldwide each year (WHO, 2018). While suicide has a relatively low base rate (WHO, 2014), suicidal ideation and behaviours are more common (Bertolote et al., 2005; McManus et al., 2016; Nock et al., 2008a, 2013); for every suicide there are twenty-five others who make a suicide attempt (IASP, 2017). Suicidal ideation and behaviours during early life can also predict unfavourable outcomes in other areas of adult life, increasing the likelihood of mental health problems, such as mood disorders, anxiety disorders and other axis I disorders, increase problem behaviours, impact functioning, lower self-perception, and dysfunctional relationships in adulthood (Fergusson et al., 2005; Goldman-Mellor et al., 2014; Herba et al., 2007; Kerr & Capaldi, 2011; Reinerz et al., 2006). Early experiences of suicidal ideation and behaviours have also been found to impact on physical health, including increasing the risk of ischemic heart disease, cardiovascular disease, metabolic syndrome and elevated inflammation later in life (Goldman-Mellor et al., 2014; Larsen et al., 2010; Shah et al., 2011).

Suicidal ideation and behaviours involve a complex interaction of many different factors. Understanding factors which increase the risk of suicidal ideation and behaviours, especially those which are attributable to the environment and conditions outside of one's control, could help inform psychological risk assessments and psychological interventions. It could also guide the extent to which they should focus on resilience building and proactive approaches. The experience of stressful life events is one risk factor which has received considerable research interest (Beautrais et al., 1997; Casey et al., 2006; Chang et al., 2010; Christensen et al., 2014; Cole et al., 1992; King et al., 2001; Lin et al., 2018; Oquendo et al., 2014; Özer et al., 2002; Panadero et al., 2018; Paul, 2018; Rew et al., 2016; Schillani et al., 2009; Stone et al., 2014; Turvey et al., 2002; Wong et al., 2008). Stressful life events have been defined as objective occurrences likely to require change to readjust to everyday life (Holmes & Rahe, 1967), and are independent of subjective appraisal (Grant et al., 2003). They are everyday regular occurrences experienced on an irregular basis, such as the death of a loved one, the loss of employment, or being a victim of crime (Holmes & Rahe, 1967; Sarason et al., 1978; Brugha & Cragg, 1990). The literature distinguishes stressful life events as dependent and independent, i.e. events which are at least partially influenced by the behaviour or an aspect

of the individual, and events which occur regardless of the individual's behaviour or characteristics (Liu & Miller, 2014).

There have been three significant reviews of the literature which have investigated the associations between the experience of stressful life events and suicidal ideation and behaviours which have suggested these are linked (Franklin et al., 2017; Liu & Miller, 2014; Serafini et al., 2015). However, due to methodological limitations of these reviews, the nature and strength of this association remains unclear and there are three clear questions that still need addressing.

The first is whether stressful life events prospectively predict increases in subsequent suicidal ideation and behaviours. Investigating the association at different points in time, as opposed to cross-sectionally, would clarify that suicidal ideation and behaviours do not simply increase perceptions of stressful life events; rather experiences of stressful life events temporally precede increased experiences of suicidal ideation and behaviours. While establishing the presence of a prospective relationship cannot be regarded as evidence of causality, it would suggest that individuals experiencing stressful life events could subsequently be more vulnerable to suicidal ideation and behaviours.

The second is regarding the strength of the association. Of the three current reviews in this area, two were narrative reviews (Liu & Miller, 2014; Serafini et al., 2015). While evidence for an association was suggested, these reviews were unable to provide any evidence regarding the magnitude of this association. The only review which has sought to meta-analyse the strength of the association did not describe the details of how stressful life events were defined or operationalised (Franklin et al., 2017). Similarly, the timeframe in which both stressful life events and suicide were individually measured and followed-up was not reported, nor were potential moderators of stressful life events and suicide ideation and behaviour outcomes considered (Franklin et al., 2017).

The third question concerns whether there is a significant association between stressful life events and suicidal ideation and behaviours when the concept of stressful life events is not confounded by the inclusion of traumatic life events. Traumatic life events are distinctly different from stressful life events, as they consider events which put either the individual or someone close to them at risk of serious harm, death, or threaten one's personal integrity

(APA, 2000). Stressful life events, on the other hand, consider everyday regular occurrences experienced on an irregular basis, and they are likely to be more common and widespread than traumatic life events. Evidence suggests stressful life events are independently associated with suicidal ideation and behaviours (e.g. Campos et al., 2016; Kang et al., 2014; Woodhead et al., 2014), indicating they are important in their own right. However, the previous three reviews did not distinguish between traumatic and non-traumatic stressful life events, and there is currently no systematic synthesis which has investigated non-traumatic, stressful life events.

Prominent models of suicide include or consider the role of stressful life events to increase vulnerability to suicidal ideation and behaviours (Johnson et al., 2008; O'Connor, 2011). For example, the Schematic Appraisals Model of Suicide (SAMS; Johnson et al., 2008) conceptualises stressful life events as contextual factors which become suicidogenic in the context of cognitive biases, i.e., when events are appraised in terms of defeat and entrapment. Together, these perceptions reflect appraisals of loss or failure without a sense of escape or a route forwards (Taylor et al., 2010). The Integrated Motivational-Volitional model (IMV; O'Connor, 2011, O'Connor & Kirtley, 2018) specifically considers the experience of stressful life events as contributing to a context in which vulnerability to suicidal ideation and behaviours may increase (i.e., the pre-motivational phase) and heighten the sensitivity to appraisals of defeat. A more recently proposed model of suicide, the Ideation-to-Action Framework (Klonsky & May, 2015) focuses on the experience of pain rather than stressful life events per se as the initiating factor in the process of developing suicidal ideation and behaviours. However, 'pain' is broadly conceptualised in this framework, and stressful life events could be viewed as being one possible cause of pain.

Understanding the strength and variability of the association between stressful life events and suicide ideation and behaviour could inform understanding of how different aspects of these models are linked and interact (O'Connor & Nock, 2014). That is, while the experience of stressful life events are conceptualised in each of these models, the importance of this aspect in relation to the other factors within the models is unclear. Furthermore, a finding of no significant association or a lack of power would contradict these models and indicate the need for theoretical revision. Understanding of the role of stressful life events as a risk factor for suicidal ideation and behaviours could also be important clinically. Ascertaining the strength of the prospective relationship between stressful life events and suicidal ideation and

behaviours could help inform psychological risk assessments, psychological interventions and the extent to which these should focus on resilience building and proactive approaches.

Therefore, the purpose of this systematic review was to address these issues by investigating in a meta-analysis the prospective association between experiencing stressful life events and subsequent suicidal ideation and behaviours. In particular, there were two specific research questions:

1. What is the strength of the prospective relationship between the experience of stressful life events and subsequent suicidal ideation and behaviours?
2. Which factors moderate this relationship?

2. Methods

The review followed the Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) statement (Moher et al., 2009) (see eTable 1 in the supplement), and the review protocol was prospectively registered with PROSPERO. (CRD42018100041) (see eMethods 1 in the supplement).

2.1 Ethical considerations

The review analysed data that was publicly available in journal articles and directly from article authors, therefore did not require ethical approval or patient consent.

2.2 Search strategy and data sources

We searched five electronic bibliographic databases (MEDLINE, PsycINFO, EMBASE, CINAHL, and Cochrane) from inception until October 2018, updated to April 2019. The search strategy included combinations of three key blocks of terms ('life events', 'suicide', 'longitudinal') using a combination of medical subject headings (MeSH terms) and text-words (see eMethods 2 in the supplement). Additionally, reference lists of eligible studies and previous systematic reviews were scanned for potentially includable studies.

2.3 Eligibility criteria

Studies were eligible for inclusion in the current review if they met the following criteria, adapted from the Liu and Miller (2014) review.

- Population: Adults or adolescents aged ≥14 years.

- Design: Observational, quantitative, longitudinal cohort studies which provided data on the association between stressful life events and a subsequent aspect of suicidal ideation and behaviours were included.
- Outcome: Studies in which quantitative data of the association between stressful life events and suicidal ideation and behaviours (i.e., suicidal thoughts, suicide plans, suicidal behaviour and suicide) were reported. Stressful life events were defined as the experience of objective occurrences reported by the participant or informant. The measure of stressful life events was credible when validated and covered multiple forms of events; modified measures were also included when based on a single validated measure. No restrictions were placed around the measurement of suicidal ideation or behaviours.
- Context: Studies conducted in any setting that were English language and in peer-reviewed journals were included.

Studies which measured a single stressful life event, childhood stressful life events in adults, or trauma experiences, abuse or maltreatment were excluded, as were studies which measured non-suicidal self-injury (NSSI) and self-harming behaviours that did not involve suicidal intent. Studies in languages other than English were excluded.

2.4 Study selection

Search results were exported to Endnote version X8.2 (Clarivate Analytics, Philadelphia, USA) and duplicates were removed. Study selection was undertaken in two stages. Initially, titles and abstracts of identified studies were screened, and then full-texts of retained studies were accessed and further screened against the inclusion and exclusion criteria. A proportion of the titles and abstracts (10%) were independently reviewed (E.H. & J.J.) and interrater reliability was moderate (k = 0.768) according to McHugh (2012). Disagreements were resolved by discussion. E.H. screened the remaining titles and abstracts. Fifty percent of full-texts were screened by E.H. and two independent reviewers (S.W. & A.H.), and interrater reliability was strong (k=0.805). Disagreements were resolved by discussion. The remaining full-text screening was completed by E.H. When data needed for eligibility decisions were not readily available, corresponding authors were contacted by email to request study data.

2.5 Data Extraction

A data extraction form was devised by adapting Cochrane's Public Health Group Data Extraction and Assessment Template in Excel 2013 (Microsoft Corp., Redmond, Washington). In order to pilot the form, two of the eight included studies were chosen at random and data was extracted by the lead reviewer (E.H.). The database was then sent to a second reviewer (A.H.) together with the original papers. A.H. reviewed the papers and the data extracted into the database by the first author to ensure accuracy and consistency. Quantitative data on the association between stressful life events and subsequent suicide ideation and behaviour was extracted in a separate Excel file for the meta-analysis. All data was extracted by E.H. and checked by J.J. Discrepancies were resolved through discussion. The following information was extracted from eligible studies:

- Participants: age, gender, socio-demographics, mental health diagnosis, previous history of suicide ideation and behaviour, treatment or intervention outside of the study;
- Study: sample size, country, setting, participant population, length of follow-up assessment, stressful life events measure, suicide ideation and behaviour measure, methodological quality;
- Outcome: aspect of suicide ideation and behaviour.

2.5 Methodological quality of the studies

Relevant components from the Effective Public Health Practice Project (EPHPP) quality assessment guidance (Thomas et al., 2004) for the assessment of observational studies were used in this review and meta-analysis. The following criteria were used to conduct the quality assessment of the eligible studies. The grading of quality was based on the overall rating across four domains, where each satisfying domain resulted in one point (i.e., the maximum score therefore being four). The quality appraisal key criteria were:

1. A 70% or greater response rate from eligible participants at baseline
2. Control for a minimum of three important confounding factors in the analysis which comprised a combination of demographic characteristics (e.g. age, gender) and clinical characteristics relevant to suicidal ideation and behaviours (e.g. mental health diagnosis, previous history of suicide)
3. The use of valid and reliable data collection measures (where not described by the study, the literature of the measure will be looked at)

4. A 70% or greater response rate from eligible participants at follow-up.

Studies which received a score of three or more were considered high quality and more likely to produce reliable results. The majority of these criteria have been used in previous research to assess the methodological quality of observational studies (Blakemore et al., 2014; Panagioti et al., 2015). All eligible studies were independently reviewed by E.H. and checked by J.J., with disagreements resolved by discussion.

2.7 Data Analysis

The results were synthesised using meta-analysis. The primary outcome of this review was the effect size of the association between stressful life events and mode of suicidal ideation and behaviours (suicidal ideation, plan, attempts and completed suicides). Odds ratios (ORs) together with the 95% confidence intervals (CIs) from each eligible study were presented using the Comprehensive Meta-Analysis (CMA) software (version 3; Borenstein et al, 2014). Odds ratios (ORs) were chosen to pool results across the studies as this was the most commonly reported effect size in the primary studies, and it is typically used in prospective studies (Borenstein et al., 2009). Where ORs and their standard errors were not reported in the primary reports, we used the necessary transformations in CMA from various metrics as recommended by the Cochrane Handbook (Higgins & Green, 2011) to obtain ORs. In this review, OR >1 indicate that stressful life events associated with increased risk for suicidal ideation and behaviours, OR <1 indicate that stressful life events associated with a lower risk for suicide ideation and behaviour; OR=1 indicate no association between stressful life events and suicide ideation and behaviour. When the 95% confidence intervals did not include 1, the association was statistically significant. Where studies reported both adjusted and unadjusted analysis, effect sizes adjusted for potentially confounding variables were selected. A significant degree of heterogeneity was expected and for this reason the individual ORs across the studies pooled using DerSimonian-Laird inverse variance weighting random effects models (Harris et al, 2008). Where a small number of studies were identified by the systematic review, additional meta-analyses were conducted to adjust for the limited data available (Guolo & Varin, 2017), using the Hartung-Knapp-Sidik-Jonkman method in R (IntHout, Ioannidis & Borm, 2014).

Heterogeneity was quantified using the I^2-statistic and the associated test-based 95% CIs. I^2 values of 25%, 50%, and 75% correspond to low, moderate, and high heterogeneity,

respectively (Higgins et al., 2003). Pre-specified subgroup analyses were performed to understand the association between stressful life events and suicidal ideation (e.g., whether the strength of this relationship changed when taking into account the impact of participant age and gender; and length of follow-up assessment). A sensitivity analysis was undertaken to test the stability of the results across the studies with lower risk of bias ratings. Publication bias was examined by inspecting the symmetry of funnel plots and the statistical significance of the Egger's test (Egger et al, 1997).

3. Results

The search strategy identified 3,754 records. Two additional records were identified through reference list scanning. After duplicates were removed, the remaining 2,237 titles and abstracts were screened for eligibility; 173 of these were retained for full-text screening. Eight papers met the inclusion criteria (Campos et al., 2016; Chan et al., 2014; Joiner & Rudd, 2000; Kang et al., 2014; Mazza & Reynolds, 1998; Tyssen et al., 2004; Tyssen et al., 2001; Woodhead et al., 2014). Two papers reported on the same study at different timepoints; both papers were included in Table 2, but only one paper was included in the analyses and reporting to avoid double counting (Tyssen et al., 2001). Figure 1. shows the flow of studies through the search process. Unpublished data for eligibility decisions were provided by five authors (Chan et al., 2014; Kang et al., 2014; Mazza & Reynolds, 1998; Tyssen et al., 2001; Woodhead et al., 2014). A table of contacts with corresponding authors is provided in eTable 2 in the supplement.

3.1 Characteristics of the studies and participants

Key descriptive data from the studies included are presented in Table 1. Study characteristics and details of data extracted are provided in Table 2. The seven studies included nine independent comparisons on 2,639 participants, published between 1998 and 2016. The majority of studies measured suicidal ideation as the outcome (n = 6); only one study looked at suicidal behaviours as the outcome. Studies were conducted across five different countries and three continents; North America (n = 3), Europe (n = 2), and Asia (n = 2). Overall, the proportion of female to male participants was approximately equal (54% female); seven comparisons were majority female (i.e., greater than 50% females), while two comparisons were majority male. The mean age in the individual studies ranged from 15.5 to 72.2 years, giving a combined mean age of 37.23 years. There were five comparisons in which mean age was below 37.23 years, and four comparisons where the mean age was above 37.23 years.

Length of follow-up assessment in individual studies ranged from one month to 13 years; six comparisons had follow-up assessments less than or equal to a year later, whereas in the other three comparisons length of follow-up assessment was greater than a year later. Five studies were conducted with non-clinical populations; three with the general population, one with high school students, and one with medical students.

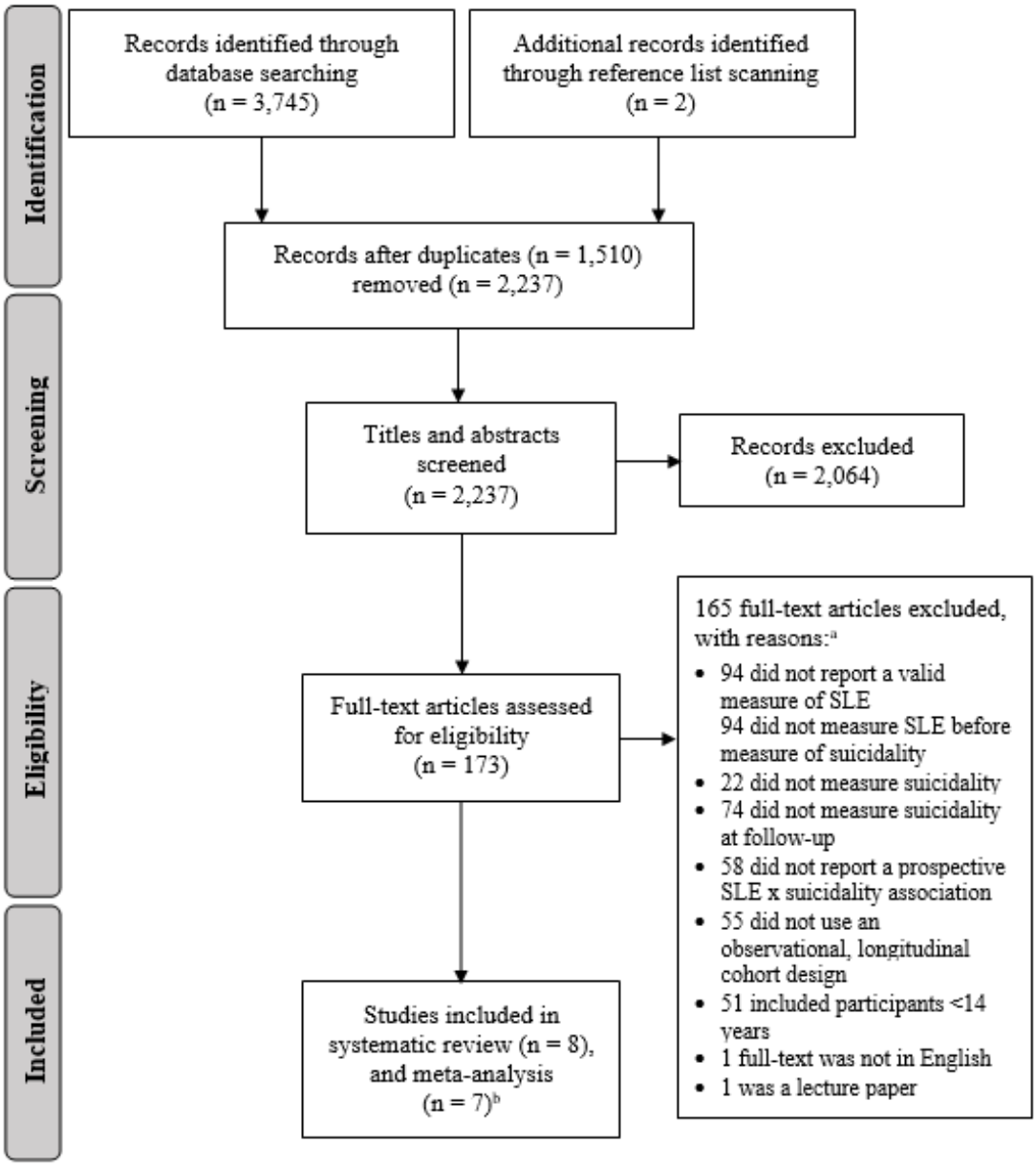

Figure 1. Flowchart of studies included in the review.

[a]Some studies were excluded for more than one reason so the listed studies do not equal 165.
[b]Two papers reported on the same study at different timepoints, only the paper with the larger sample size was included in the analyses and reporting.

The two studies conducted with clinical populations included one with psychiatric inpatient participants, and one with participants accepted to take part in a military medical suicide

treatment research study. The reporting of socio-demographic characteristics, common mental health diagnoses and history of suicidal ideation and behaviours was varied and inconsistent between studies, therefore, they could not be synthesised in the review.

Table 1. Descriptive data of studies included in meta-analyses.

Category	Characteristics	N = 7 studies
Study and population	Sample size (range)	2,639 (66 to 909)
	Mean Age	37.23
	% Female[a]	54.3%
	Continent	
	North America	3 (43%)
	Europe	2 (28.5%)
	Asia	2 (28.5%)
Methodological quality (N = 8 studies)	Response rate at baseline >70%	4 (50%)
	Control for confounding variables	5 (63%)
	Valid and reliable measures	1 (12.5%)
	Response rate at follow-up >70%	6 (75%)
Outcomes	Suicidal ideation	6 (86%)
	Suicidal plans	0 (0%)
	Suicide attempt	1 (14%)
	Suicide	0 (0%)

[a] Some papers did not report socio-demographic data of participants whose data was included in the analyses. All these papers state participants included in the analyses did not significantly differ in socio-demographics from those not included in the analyses, therefore the authors calculated the gender distribution from the percentage reported in the paper.

Table 2. Characteristics of studies, populations and outcomes included in the review.

First author, year	Population (country)	N	Female, no. (%)	Mean age (SD)	Measure of SLE	Aspect of suicidal ideation/behaviour (measure)	Length of follow-up assessment	Quality assessment score
Campos, 2016	General population (Portugal)	195	104 (53%)	34.88 (12.49)	Modified Life Experiences Survey	Suicidal ideation (single item from Suicide Behaviors Questionnaire-Revised)	Three months	3
Chan, 2014[a]	Psychiatric inpatient (Malaysia)	66	28 (56%)	43.8 (12.1)	Malay version of Social Readjustment Rating Scale	Suicide attempt (questions from the Structured Clinical Interview for DSM-IV, and clinical records)	One year	1
Joiner, 2000[a]	Military medical settings (USA)	249	45 (18%)	22 (2.5)	Modified Life Experience Survey	Suicidal ideation (Modified Scale for Suicidal Ideation)	One month	2
Kang, 2014[a]	General population data (South Korea)	909	527 (58%)	72.2 (5.9)	Modified List of Threatening Experiences	Suicidal ideation (questions from the Geriatric Mental State diagnostic schedule)	Two years	3
Mazza, 1998	High school population (USA)	374	202 (54%)	15.5 (1.02)	Life Events List-Revised	Suicidal ideation (Suicidal Ideation Questionnaire)	One year	1

First author, year	Population (country)	N	Female, no. (%)	Mean age (SD)	Measure of SLE	Aspect of suicidal ideation/behaviour (measure)	Length of follow-up assessment	Quality assessment score
Tyssen, 2001	Medical students (Norway)	371	208 (56%)	28 (2.8)	Modified Social Readjustment Rating Scale	Suicidal ideation (single question)	One year	3
Tyssen, 2004[b]	Medical students (Norway)	327	176 (54%)	28 (2.8)	Modified Social Readjustment Rating Scale	Suicidal plans (single question)	Two-three years	2
Woodhead, 2014[c]	General population (USA)	475	318 (61%)	44.4 (10.7)	Modified Health and Daily Living Form	Suicidal ideation (single question)	Thirteen years	1

[a] These papers report socio-demographic data at baseline, not follow-up. As the papers state participants lost to follow-up did not significantly differ in socio-demographics from participants who completed follow-up, the authors calculated the gender distribution at follow-up from the percentage reported in the paper.

[b] This paper was not included in the meta-analysis, to avoid double counting as it uses the same data as the Tyssen et al. (2001) paper.

[c] This paper reports socio-demographic data at follow-up, not participants included in analyses. As the paper states participants included in the analyses did not significantly differ in socio-demographics from participants at follow-up, the authors calculated the gender distribution for those included in the analyses from the percentage reported in the paper.

3.2 Characteristics of stressful life event and suicide ideation and behaviour measures

Studies measured stressful life events using a variety of tools. The most commonly used were the Life Experiences Survey (n = 2; Sarason et al., 1978) and the Social Readjustment Rating Scale (n = 2; Holmes & Rahe, 1967). The other measures used were the List of Threatening Experiences (Brugha & Cragg, 1990), the Life Events List-Revised (Gersten et al., 1974; Reynold, 1982), and The Health and Daily Living Form (Moos et al., 1992). All measures were modified versions of the original measure and used a self-report approach. Two studies used measures which included both negative and positive events, while the rest only measured the experience of negative events (n = 5). Measures were scored either by the number of events experienced (n = 5), or by totalling the scaled severity scores (n = 2). The time-frame covered by the measures was the last 12 months (n = 6); one study did not state the time-frame used.

A range of approaches were used to measure suicidal ideation and behaviours. Studies mainly looked at suicidal ideation (n = 6) and one study had suicidal behaviours as an outcome. None of the studies measured suicidal plans or completed suicide as an outcome. The type of measure used by studies varied. The main approach used was a single-item measurement (n = 3), for example "Have you ever during the last year thought of taking your own life, even if you would not really do it?" (Tyssen et al, 2001). Other approaches used included an interview-approach (n = 2), such as the Modified Scale for Suicidal Ideation (Miller et al., 1986), and a self-report approach (n = 1), such as the Suicidal Ideation Questionnaire (Reynolds, 1988). One study appeared to use a combination of questions from a structured clinical interview and professional observations (i.e., clinical notes). Measures were scored by dichotomous 'yes/no' responses (n = 3), summing of multiple scaled responses (n = 2), or using a single scaled score (n = 2). The time-frame covered by measures varied; two studies considered the previous 12 months, three studies asked about the last month, and one study focused on current experiences. The time-frame used was not stated by one study.

3.3 Methodological quality characteristics

In terms of the individual quality criteria, four studies reported a response rate of 70% or greater, five studies adjusted for confounders in the analyses, one study used valid and reliable measures, and six studies reported response rates of 70% or greater at follow-up. Three studies met at least three of the four quality criteria, indicating high overall quality; the

other four studies met one or two quality criteria. None of the studies met all four criteria or zero of the criteria (see eTable 3 in the supplement).

3.4 Meta-Analyses: Stressful life events and suicidal ideation and behaviours

Stressful life events were associated with a statistically significantly increased risk for suicidal ideation and behaviours (Figure 2), but the heterogeneity measure was high (9 comparisons: OR = 1.37, 95% CI = 1.10 to 1.70, I^2 = 76. 48 (test-based 95% CI: 55.0 to 87.7)%, p = 0.005). This indicates a 37% increased risk of suicide ideation and behaviour for people experiencing stressful life events. The adjusted Hartung-Knapp-Sidik-Jonkman analysis found this association was still statistically significant (OR = 1.215, 95% CI: 1.010 to 1.462). No studies reported that stressful life events were related to significantly lower levels of suicidal ideation or behaviours.

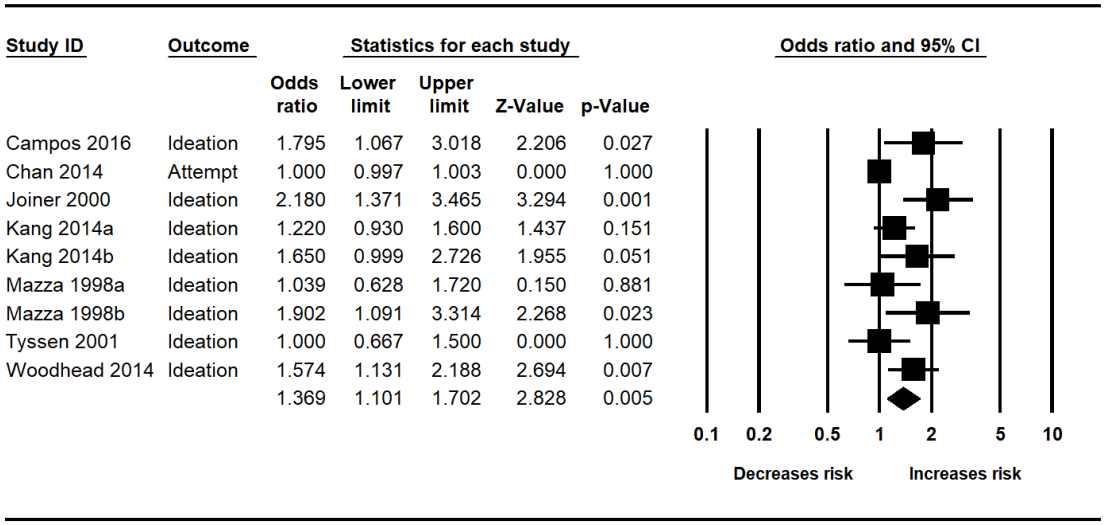

Figure 2. Forest plot for the main analysis of the association between stressful life events and suicidal ideation and behaviour.

When analyses were run for suicidal ideation and behaviour outcomes separately, the effects of stressful life events were slightly higher for suicidal ideation and heterogeneity was lower (8 comparisons: OR = 1.45, 95% CI = 1.20 to 1.75, I^2 = 38.53 (0 to 72.9)%, p=0.0001 – Figure 3). This indicates a 45% increased risk of suicidal ideation for people experiencing stressful life events. The adjusted Hartung-Knapp-Sidik-Jonkman analysis found this association was still statistically significant (OR = 1.459, 95% CI: 1.201 to 1.772). As only one study investigated suicide behaviours, a meta-analysis of this outcome was not possible.

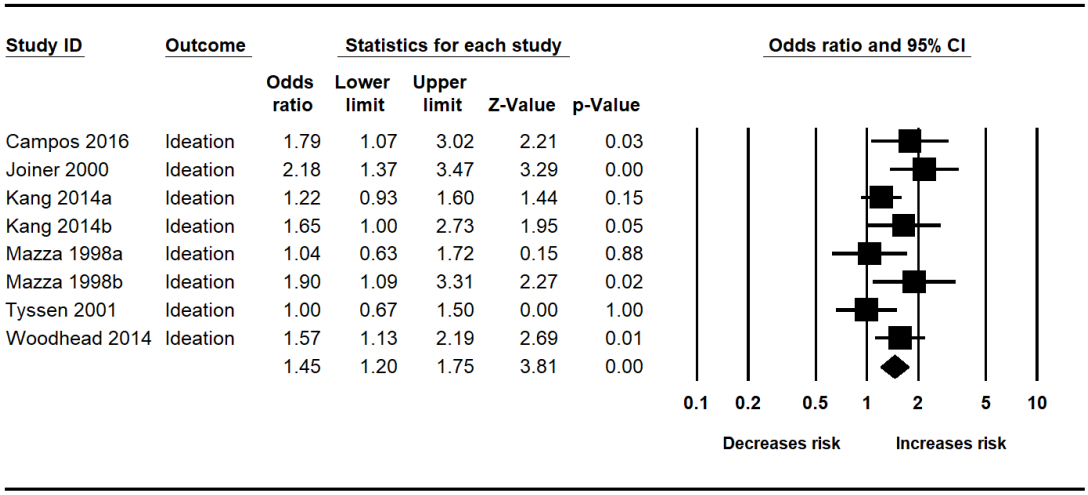

Figure 3. Forest plot for the main analysis of the association between stressful life events and suicidal ideation.

3.5 Subgroup Analyses

Subgroup analyses were performed to understand the association between stressful life events and suicide ideation.

Age (mean). The summary effect size of stressful life events was associated with a higher risk for suicidal ideation for those below the mean age of 37.23 years old (5 comparisons; OR = 1.48, 95% CI = 1.06 to 2.07, I^2 = 57.60 (0 to 84.3)%, p = 0.02), when compared those above the mean age (3 comparisons; OR = 1.39, 95% CI = 1.15 to 1.69, I^2 = 0 (0 to 89.6)%, p = 0.001 – Figure 4). This indicates a 48% increased risk of suicide ideation and behaviour for younger adults experiencing stressful life events, compared with older adults where risk was 39% greater.

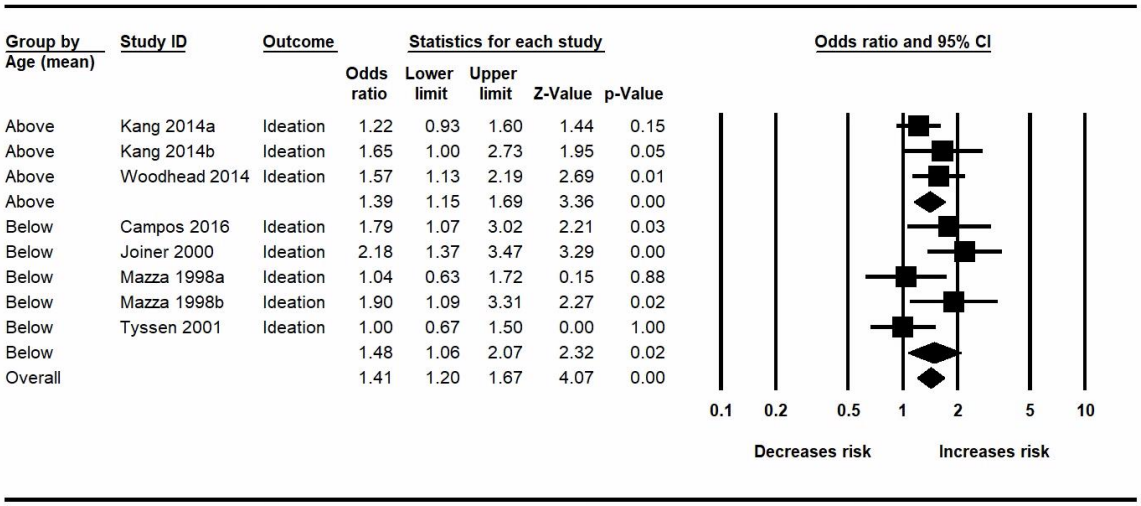

Figure 4. Subgroup analysis of the association between stressful life events and suicidal ideation analysed by age.

Gender majority. The summary effect size of stressful life events was associated with a higher risk for suicidal ideation for males (2 comparisons; OR = 2.06, 95% CI = 1.44 to 2.94, I^2 = 0 (0 to 82.1)%, p = 0.0001), when compared to females (6 comparisons; OR = 1.32, 95% CI = 1.11 to 1.58, I^2 = 19.10 (0 to 63.8)%, p = 0.002 – Figure 5). This indicates that the relative risk of suicidal ideation for males was twice as high when experiencing stressful life events, compared with females where risk was 32% higher.

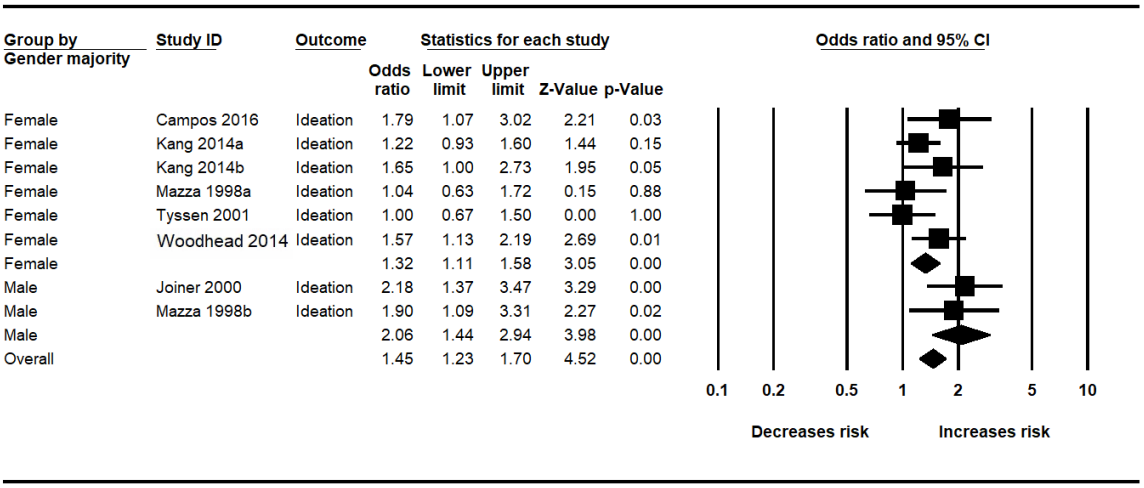

Figure 5. Subgroup analysis of the association between stressful life events and suicidal ideation analysed by gender majority.

Length of follow-up. The summary effect size of stressful life events was associated with increased risk for suicide ideation less than or equal to a year later (5 comparisons; OR = 1.48, 95% CI = 1.06 to 2.07, I^2 = 57.61 (0 to 84.3)%, p = 0.02 , when compared to greater than a year later (3 comparisons; OR = 1.39, 95% CI = 1.15 to 1.69, I^2 = 0 (0 to 89.6)%, p = 0.0008– see Figure 6). When suicidal ideation was measured less than or equal to a year later, previously reported stressful events were associated with a 48% greater risk of reporting suicide ideation. Risk reduced to 39% higher when suicidal ideation was measured a year or more later.

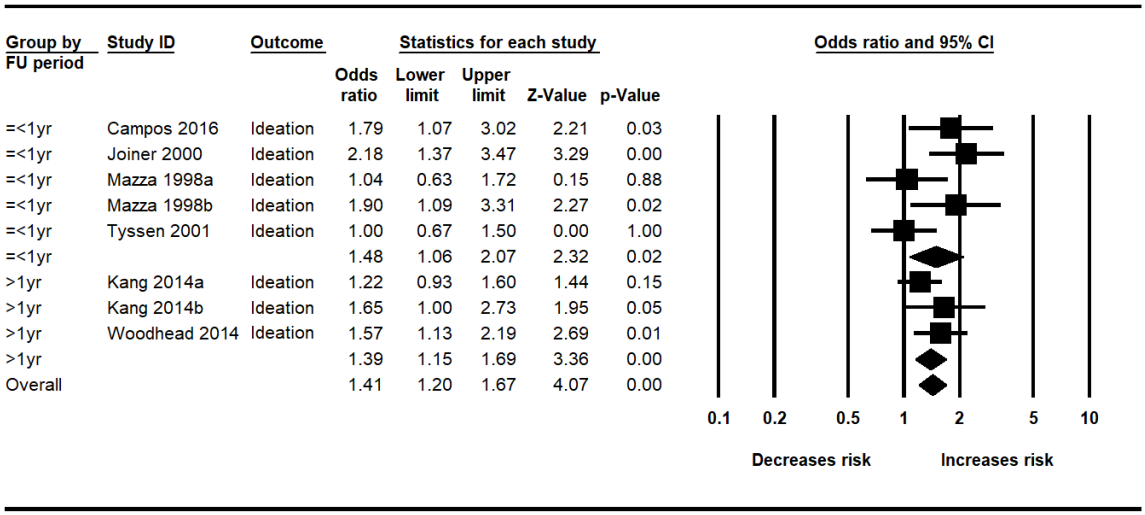

Figure 6. Subgroup analysis of the association between stressful life events and suicidal ideation analysed by length of follow-up.

3.6 Sensitivity analyses

When a leave-one-out approach (Higgins & Green, 2011) was performed, the main finding for stressful life events and suicidal ideation and behaviours fluctuated in strength, from 1.29 to 1.45, but all remained statistically significant. This indicates that the presence of an association was not driven by any single study, however some studies had a greater impact on the strength of the association more than others. A forest plot is provided in eFigure 1 in the supplement. A similar result was obtained when only the three studies (four comparisons) with sufficient methodological quality scores (appointed 3+ out of 4 quality assessment criteria) were retained in the analyses (OR = 1.31, 95% CI = 1.03 to 1.66, I^2 = 27.71 (0 to 73.0)%, p = 0.03). A forest plot is provided in eFigure 2 in the supplement.

3.7 Publication bias

Random-effects funnel plot asymmetry of observed comparisons (see eFigure 3 in the supplement) and a significant fixed-effects Egger test indicated that the results might have been influenced by publication bias (regression intercept = 1.76, SE = 0.42, p = 0.004). The funnel plot and Duval and Tweedie's trim and fill analysis (Duval & Tweedie, 2000) indicated that while there were no missing studies from the right of the mean, there may have been three missing studies to the left of the mean. Inclusion of the three missing studies may have resulted in a non-significant association between stressful life events and suicidal ideation and behaviour (OR = 1.19, 95% CI = 0.99 to 1.43).

4. Discussion

The main aim of this systematic review and meta-analysis was to explore the prospective relationship between stressful life events and subsequent suicidal ideation and behaviours. This review found that the experience of stressful life events was associated with a significantly increased risk for suicidal ideation, but the evidence base was too limited to test the relationship between stressful life events and suicidal behaviours. None of the studies included in the analysis used suicidal plans or completed suicide as an outcome.

Subgroup analyses indicated that the relative risk of suicidal ideation for males was twice as high when experiencing stressful life events, compared with females where risk was 32% higher. The relationship between stressful life events and suicidal ideation was also significantly stronger in younger adults (i.e., samples below the mean age of 37 years) when compared to older adults, where risk decreased from 48% to 39% higher, respectively. Experience of stressful life events was also found to potentially increase the risk of suicidal ideation when stressful life events were experienced in the last year or less. Risk was still increased when stressful life events were experienced more than a year ago, but to a lesser extent.

4.1 Comparisons with previous research and reviews

This is the first systematic review and meta-analysis to look exclusively at the prospective relationship between stressful life events and subsequent suicidal ideation and behaviours. However, the findings are in line with two previous narrative systematic reviews on the broader association between stressful life events and an aspect of suicidal ideation and behaviours (Liu & Miller, 2014; Serafini et al., 2015), and one meta-analytic review of risk factors for suicidal thoughts and behaviours (Franklin et al., 2017).

Unlike the current review, the two previous narrative systematic reviews (Liu & Miller, 2014; Serafini et al., 2015) considered both traumatic and non-traumatic life events together within their definition of negative life events. Conflating these two constructs is likely to have masked the true association between non-traumatic stressful life events and suicidal ideation and behaviours, particularly considering the considerable evidence-base there is around the relationship between trauma and suicidal ideation and behaviours (Bahraini et al., 2013; Hor & Taylor, 2010; Krysinska & Lester, 2010; O'Connor et al., 2018; 2020; Wethington et al., 2008). The current review did not include traumatic events within its definition of stressful

life events; as such the present findings highlight the impact of (non-traumatic) stressful life events on suicidal ideation and behaviours and identify these as risk factors in and of themselves. Unfortunately, the meta-analytic review by Franklin et al. (2017) did not report how stressful life events were defined within their meta-analysis, so a direct comparison of findings within this regard is not possible.

This review also extends previous reviews by focusing exclusively on prospective studies. This allowed the temporal relationship between stressful life events and suicidal ideation and behaviours to be investigated. Liu and Miller (2014) reported substantial temporal overlap between the measurement of stressful life events and suicidal ideation and behaviours in several of the studies they reviewed. This methodological limitation was controlled for in the current review, which required the measurement of suicidal ideation and behaviours to be taken in a follow-up period subsequent to stressful life events measures. This distinction allowed greater confidence in considering the experience of stressful life events as a risk factor (i.e., longitudinal predictor).

This meta-analytic review quantified the strength and variability of the relationship between stressful life events and suicidal ideation. The findings indicated that while the experience of stressful life events was associated with a significant increased risk of suicide ideation, there were other factors which influenced or interacted with this relationship and stressful life events should be considered in the context of other suicidal ideation risk factors. Unfortunately, the review was not able to quantify the relationship between stressful life events and suicidal behaviours due to the limited number of studies found.

The current review also extends on a previous meta-analysis (Franklin et al., 2017) by exploring potential moderating factors of the prospective relationship between the experience of stressful life events and subsequent suicidal ideation. It found that gender significantly moderated the relationship between stressful life events and suicide ideation, with the strength of the association being higher in males than females. While it is important to keep in mind the small number of comparisons in each group (females: n = 7; males: n = 2) used within the analyses, this finding could further aid the understanding of the role of gender within suicidal ideation. Previous research suggests females are at higher risk of suicidal ideation, plans and attempts, and males are at greater risk of completed suicide (Nock et al.,

2008b; ONS, 2017). However, the findings of this review indicate when experiencing stressful life events, males are at higher risk of suicidal ideation.

The review found stressful life events were associated with a stronger risk for suicidal ideation for those below the mean age of 37.23 years old when compared with those above the mean age. This finding supports a previous meta-analysis on cortisol levels (which is released when experiencing stress) and suicidal behaviour. O'Connor et al. (2016) found a similar positive association regarding the younger sample subgroups, whereby suicidal behaviours were associated with greater cortisol levels in studies where the mean sample age was below 40 years.

Additionally, the review found that the risk of experiencing suicidal ideation in response to stressful life events may begin to reduce as the period of time since the stressful life events increases (i.e. when length of follow-up assessment was greater than one year). While further research is needed to corroborate this finding, it is broadly consistent with previous suicide research (Liu & Miller, 2014) and models of suicide (O'Connor, 2011) which suggest stressful life events are more proximal, as opposed to distal, risk factors of suicide ideation and behaviour.

The present review found no negative associations reported between stressful life events and suicidal ideation and behaviours. This finding is similar to two previous reviews (Liu & Miller, 2014; Serafini et al., 2015). While both reviews identified positive associations, and Liu and Miller (2014) also found some studies reporting no association between stressful life events and suicidal ideation and behaviours, neither review reported any negative or inverse associations between stressful life events and suicidal ideation and behaviours. This finding may further support the argument for the assumptions made within publication bias analysis not being suitable within the context of this research area.

4.2 Considerations for models of suicidal ideation and behaviours

The findings of this review are consistent with predictions generated by current prominent models of suicide ideation and behaviour. For example, the SAMS (Johnson et al., 2008) may view the findings of this review as a result of stressful life events becoming suicidogenic in the context of cognitive biases, activating the suicide schema. The experience of multiple stressful life events could contribute to intolerable emotional or situational states, in which

thoughts of suicide could become seen as a strategy of escape. The IMV model (O'Connor, 2011, O'Connor & Kirtley, 2018) predicts that the experience of life events may increase vulnerability to suicidal ideation. The findings of this review also fit with this prediction; stressful life events were found to increase the risk of suicide ideation and behaviour. While life events are included in the pre-motivational phase of the model, the experience of stressful life events may also have the potential to impact on the motivational phase; the varied nature of stressful life events may alter or heighten appraisals around social or financial support, coping, dependency, belongingness, and thoughts of the future, all of which the IMV model contribute to suicidal ideation. Similarly, the findings also appear consistent with the Ideation-to-Action Framework (Klonsky & May, 2015), where the experience of stressful life events can be conceptualised as a cause of pain, triggering the development of suicidal ideation.

4.3 Implications for clinicians and researchers

Within the theoretical context of the models of suicidal ideation and behaviours, the findings have implications for suicide risk assessment and interventions provided by clinical psychologists and other mental health professionals.

Clinicians should explore recent and past experiences of stressful life events as part of suicide risk assessments, as the findings of this review suggests these will increase subsequent risk of suicidal ideation, potentially for shorter term as well as an enduring period of time (i.e., over a year). While the use of stressful life event measures may not always be appropriate within the therapeutic setting, the evidence around these measures could be used to guide a clinician's approach. Combining a checklist style approach to aid information gathering, with the ability to seek further contextual and appraisal information as necessary, may allow the clinician to better assess the individual's risk of suicide ideation and behaviour. It is important to note that research has found risk assessments are not effective in predicting who will end their life by suicide (Large et al., 2016; Lopez-Morinigo et al., 2018), therefore risk assessment alone should not be used to guide the provision of care or determine who receives suicide interventions.

Recommendations for psychological suicide interventions from the findings of the review are limited due to the restricted selection of fixed moderators available from the data reported by the primary studies. A suggestion for interventions could include adding a component which

focuses on developing resilience and adaptive coping for future stressful life events. Increasing the range of responses and appraisals available to an individual when stressful life events are experienced may reduce vulnerability to suicide ideation and behaviour in the future. These suggestions are consistent with the majority of models of suicide ideation and behaviour, which place the experience of stressful life events as the initiating stressor or precipitating event, but focus on the interpretation and appraisal of these events (Johnson et al., 2008; O'Connor, 2011). They are also consistent with current evidence-based suicide risk assessments and interventions (Pratt et al., 2015). However, future research would first need to explore the impact of resilience and coping ability on suicide ideation and behaviour after the experience of stressful life events before this suggestion could be supported. Our findings also suggest that reduction of exposure to stressful life events could be one route for interventions to take. While this may be beyond the scope of most psychological interventions, these findings could inform social policy focused on suicide reduction.

The review highlights several limitations in the current evidence base, which could be addressed in future research. First, only one study measured suicide attempts as an outcome (Chan et al., 2014), and there is a need for primary studies to investigate whether stressful life events are a risk factor for other aspects of suicidal ideation (i.e. suicide plans) and behaviours particularly given that evidence of a potential association between stressful life events and suicide has been suggested by a previous meta-analysis (Franklin, et al., 2017).

Second, there is a need to improve the methodological quality of primary studies. None of the studies included in the meta-analysis met all the methodological quality criteria used, with the majority of studies not meeting the valid and reliable measure criterion due to the use of modified or potential bias measures to assess both the experience of stressful life events and an aspect of suicidal ideation and behaviours. With regards to stressful life events measures, further research should consider updating the measures to account for societal and contextual changes; most measures which are in use today were developed prior to 1992. With regards to suicidal ideation and behaviour measures, future research should focus on the use of validated and reliable measures, as opposed to the use of single-item measures, alongside the development of common terminology and operationalised definitions, to improve the consistency and application of the evidence-base (Batterham et al, 2015; Ghasemi et al., 2015). Another consideration may include the explicit or prioritised use of interview-based approaches when the experience of suicidal ideation and behaviour is the primary focus of the

research. Finally, recent research has identified that the stress response system (i.e., the hypothalamic pituitary adrenal axis) is dysregulated in individuals vulnerable to suicide (cf., O'Connor et al., 2017; 2020). Therefore, future investigations ought to explore further the links between stressful life events, cortisol levels and suicide risk using prospective designs.

4.4 Strengths and Limitations

This systematic review and meta-analysis had several strengths. The review was designed, performed and reported following the guidance of the Cochrane handbook for systematic reviews (Deeks et al., 2011) and, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009). A pre-specified protocol was registered on the PROSPERO database and exhaustive searches methods were performed. When checked against the Measurement Tool to Assess Systematic Reviews (AMSTAR; Shea et al., 2007), the review met nine out of the 11 items indicating the review was of sound methodological quality. Various measures were taken when designing and developing the search strategy to ensure it would comprehensively identify all relevant literature, such as checking search terms against those used by pervious reviews. This high sensitivity produced over 2,000 results (i.e., low precision) as anticipated (Higgins & Green, 2011). Another strength of the findings is the large number of participants (n = 2,639) included in the meta-analysis.

The review was limited by high levels of heterogeneity between studies. This was likely due to homogeneity present across the included studies with considerably different populations, length of follow-up, country, as well as the diverse measures used to assess stressful life events and suicidal ideation and behaviour. Even though the review attempted to account for this large amount of variance within the analyses, the small number of studies included in the review meant that the secondary analyses were limited. Visual inspection of the random-effects funnel plot indicated asymmetry, with three missing studies to the left of the mean suggested; the fixed-effect Egger test also identified evidence of publication bias in the review. However, four out of the nine comparisons included in the review did not find an association between stressful life events and suicidal ideation and behaviours. There may also be an argument for assuming it would be highly unlikely to find the experience of stressful life events reducing the risk of suicidal ideation and behaviour in a research or clinical setting.

5. Conclusion

This systematic review and meta-analysis found that stressful life events were prospectively associated with a subsequently increased risk for suicidal ideation. This association was higher in males, young adults and studies with short term follow-up. Further research is needed to determine whether stressful life events are associated with other aspects of suicide ideation and behaviour.

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