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Review article

A meta-analysis of the prevalence of different functions of non-suicidal self-injury

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ABSTRACT

Background: A broad variety of different functions can underlie acts of Non-suicidal self-injury (NSSI). Whilst research so far has identified many of the commonly reported functions, no reliable estimates of prevalence currently exist for these different NSSI functions. Understanding the prevalence of NSSI functions represents a key to better understanding the phenomenology of NSSI and addressing the differing needs of the NSSI population. We conducted a systematic review and meta-analysis of the prevalence of NSSI functions in community and clinical samples.

Method: A literature search of electronic databases PsycINFO, Medline, and Web of Science from date of inception to March 2017 was undertaken. A pre-specified framework for categorising different functions of NSSI was used to collate data from across studies. A random-effects meta-analysis of prevalence was then undertaken on these data.

Results: Intrapersonal functions (66–81%), and especially those concerning emotion regulation were most commonly reported by individuals who engage in NSSI (63–78%). Interpersonal functions (e.g., expressing distress) were less common (33–56%).

Limitations: The review was limited to English-language articles. Reviewed articles were inconsistent in their measurement of NSSI. Inconsistency within pooled prevalence estimates was high when moderators were not accounted for.

Conclusions: Findings indicate that intrapersonal functions of NSSI are most common and are present for the majority of participants. This finding supports dominant emotion-regulation models of NSSI, and the use of interventions that work to improve emotion-regulation ability. However, interpersonal functions remain endorsed by a substantial portion of participants.

1. Introduction

Non-suicidal self-injury (NSSI) is most commonly defined as deliberate and intentional damage to one's body without suicidal intent (Klonsky, 2007a; International Society for the Study of Self-Injury, 2007) and methods include cutting, hitting, scratching and burning oneself (Muehlenkamp and Gutierrez, 2004). NSSI has been associated with a broad array of self-reported functions, including emotion-regulation, self-punishment or communication of distress (Edmondson et al., 2016; Klonsky, 2007b). Those endorsing different underlying functions will have different needs in terms of support and intervention. However, to date there is no reliable estimate of the prevalence of the different functions of NSSI. Such prevalence estimates would be valuable in providing a better understanding of the phenomenology of NSSI and the identification of dominant subgroups in terms of shared functions.

NSSI has been a long-standing concern for health professionals and is an increasing focus of clinical research (Zetterqvist et al., 2013). NSSI is common, with a lifetime prevalence of 13–17% in adolescents and young adults (Swannell et al., 2014) and there is evidence to suggest that NSSI is associated with a range of psychological difficulties including depression, anxiety and post-traumatic stress disorder (Bentley et al., 2014). NSSI can have adverse effects on family and interpersonal relationships (Tan et al., 2014). NSSI also represents a risk factor for

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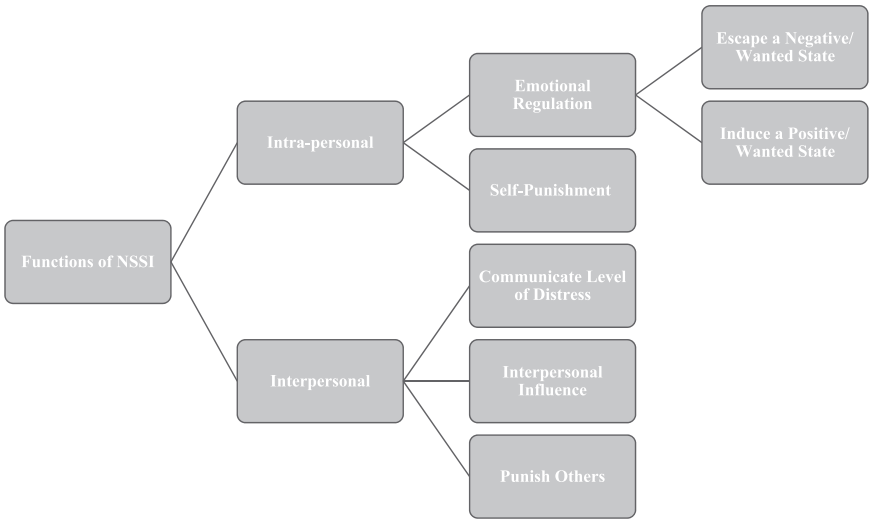

Fig. 1. System for categorizing non-suicidal self-injury functions.

later suicidal behaviour (OR = 4.27; Ribeiro et al., 2016) despite protection from suicide being one reported function of the behaviour (Klonsky, 2007b). This relationship can be explained by the Interpersonal Theory of suicide, as even where NSSI acts a short-term response for coping with suicidal feelings, it may ultimately increase the risk of suicide through processes such as developing an individual's capacity to engage in self-injury (i.e., an acquired capability; Joiner et al., 2012).

The need to intervene and support those struggling with NSSI is clear. However, attempts to apply theoretical models or interventions are limited by the broad range of functions underlying this behaviour. Many theoretical models of NSSI, for example, centre on the emotion-regulation or avoidance function of NSSI (e.g., Chapman et al., 2006; Hasking et al., 2016; Tantam and Huband, 2009). These models may fit well for individuals where the dominant motive driving NSSI is regulating difficult emotions, but may fit less well for someone whose primary function concerns self-punishment or the communication of distress. Different models of understanding NSSI may be better suited in these instances (e.g., Nock, 2009). Likewise, for interventions like Dialectical Behaviour Therapy (DBT; Linehan, 2015) or Emotional Regulation Group Therapy (ERGT: Andover and Morris, 2014), which are often used with NSSI, the improvement of emotional tolerance and regulation is a key lever through which reductions in NSSI are achieved, and may not be as suitable where emotional-regulation is not a function of an individual's NSSI. It has been noted elsewhere that interventions directed at specific functions of NSSI may be particularly helpful (Nock and Prinstein, 2004). Establishing a reliable estimate of the prevalence of the various functions of NSSI therefore has various advantages: it enables us to consider what proportion of those engaging in NSSI may be best served by a particular therapeutic approach, which in turn provides an idea of training requirements regarding different therapies within services; it gives us a better picture of the dominant subgroups (with potentially distinct clinical needs) that may exist amongst those with NSSI in terms of function; it helps to inform public health awareness and prevention campaigns by assuring these accurately map on to the dominant subgroups of individuals engaging in NSSI; and ultimately it provides a better understanding of the phenomenology of NSSI, giving a further insight into the psychological and social mechanisms that contribute to NSSI.

Narrative reviews of published studies have highlighted affect regulation as the most frequently reported function of NSSI, followed by self-punishment and interpersonal influence (Edmondson et al., 2016; Klonsky, 2007b). Notably the most recent review by Edmondson et al. (2016) concerns self-harm more broadly rather than NSSI specifically, and therefore an up-to-date review of the functions of NSSI is lacking. Furthermore, outcomes from these narrative reviews are limited. Whilst these reviews highlight the broad range of both interpersonal (communicate distress, influence others, seek support) and intrapersonal functions (emotion-regulation, avoidance of aversive affect, self-punishment) that may underlie acts of NSSI, they do not give a pooled estimate of prevalence. Instead reviews have been limited to focusing on the prevalence estimates of individual studies (Klonsky, 2007b) or on the number of papers where a specific function is endorsed (i.e., rather than number of participants endorsing that function; Edmondson et al., 2016). Similar, narrative reviews do not account for the varying precision of prevalence estimates across studies (i.e. giving too much weight to studies with small samples). No previous reviews have pre-registered protocols, which also creates a risk of selective reporting bias (Liberati et al., 2009).

Meta-analysis provides a means of pooling prevalence data from across studies to provide a more precise estimate than any individual study can achieve. In this review to accommodate differences in the terms and labels used to describe functions we used a top-down approach, identifying categories (and subcategories) of functions *a priori* based on the existing literature and using this framework to guide data collection. These categories were further agreed upon through discussion within the research team, with the focus being on the common functions of NSSI. Firstly, functions were divided into two main categories; intrapersonal functions and interpersonal functions, based on theoretical and empirical models of NSSI. Research including factor analytic studies has supported this two-factor model of NSSI functions (Klonsky et al., 2015; Turner et al., 2012). We adopted this two-factor model in categorising functions, contrasting the relative prevalence of intra and inter-personal functions before considering more specific functions within these super-ordinate categories (See Fig. 1).

Intrapersonal functions encompassed emotion-regulation, a widely supported function in the literature whereby NSSI serves the purpose of regulating distressing or aversive thoughts or emotions, through escape, avoidance, replacement or direct modification of these states. We further subdivided this function into attempts to escape unwanted or aversive states and attempts to induce a positive or desired state. This distinction reflects the idea that both positive and negative reinforcement loops may underlie the emotion-regulation function of NSSI (Nock, 2009, 2010; Nock and Prinstein, 2004). Anti-dissociation, or escape from a dissociated state can also be considered in terms of generating a desired state (Klonsky, 2007b). Self-punishment was included as a separate function to emotion-regulation that has also been repeatedly identified in past research (Edmondson et al., 2016; Klonsky, 2007b). Whilst self-punishment may involve some implicit regulation of emotions we also felt it was distinct to functions with the more overt

goal of modifying internal state, as it appears tied to specific emotional states (e.g. shame) and implies a distinct view of the self (e.g., as flawed or bad; Schoenleber et al., 2014). Interpersonal functions were sub-divided into attempts to communicate distress or difficult emotions (see Nock, 2008), attempts to influence others behaviour, and attempts to actively hurt or punish others. These functions are apparent from previous reviews (Edmondson et al., 2016; Klonsky, 2007b). Communication of distress is a more passive function, which does not involve producing a specific reaction or feeling in others, unlike the functions around influencing or punishing others. Within this review we do not treat these functions as mutual exclusive categories, as individuals typically report multiple particular functions underlying their NSSI (Klonsky, 2007b; Lloyd-Richardson et al., 2007). However, even where multiple functions exist there is a value in knowing the functions clients are most likely to report in order to ensure clinical staff are adequately trained in working and intervening with NSSI with these most prevalent functions.

The aims of this study were to systematically review the literature concerning the functions of NSSI in clinical and community samples, and pool this data to produce an estimated prevalence for the main functions of NSSI. In this review we included data from non-clinical samples and those in touch with mental health services, recognising that there is a continuum of severity of NSSI and that many individuals who engage in NSSI remaining living in the community (Whitlock et al., 2010). By focusing on both community-based samples (including undergraduate or school based samples as well as broader community-based samples) and clinical samples (i.e. samples defined by contact with mental services or receipt of diagnosis intervention for psychological difficulties) allows a contrast of the prevalence of functions between these two dominant groups.

To maintain the focus of the review we excluded samples of prisoners/forensic and military/veterans. Notably, the particular characteristics of these groups (e.g., elevated exposure to violence, links to specific institutions) may interact with functions of NSSI and mean they would be better served by separate, focused reviews on this topic.

2. Method

2.1. Search strategy

A protocol for this review was pre-registered (CRD42015025962). Changes from protocol are listed in Appendix I. Due to differences in terms used to describe self-harm without suicidal intent (i.e. deliberate self-harm [DSH], self-injury, NSSI), a broad range of search terms were used. The electronic databases of PsycINFO, Medline, and Web of Science were searched from inception up to October 2015, using the key words: ("self harm*" or "self injur*" or "DSH" or "NSSI" or "self cut*" or "self burn*") AND ("reason*" or "function*" or "motiv*"). This search was then updated for the period October 2015 up to March 2017.

Initially, abstracts and titles were screened to determine eligible articles. This was followed by reviewing full-texts of remaining articles. All screening was completed in parallel by two members of the research team. In the case of conference abstracts without available full articles, authors were contacted via email to retrieve any published or unpublished material. References within selected articles were also hand-searched for further eligible studies. This was complimented by hand-searches of recently published reviews regarding functions of NSSI, including Edmondson et al. (2016) and Klonsky (2007a, 2007b). We recognise that many increasingly popular assessments of NSSI also incorporate an assessment of functions, and so data on NSSI functions may be held by research groups even when not reported in papers. Therefore, for all studies identified October 2015 to March 2017, where it was possible that eligible NSSI function data existed based on the measures used in the study, we contacted the authors to request any published or unpublished NSSI function data (this last step represents a change from the protocol). These extra checks were limited to this search period for reasons of feasibility due to the large number of correspondence required. Seventy-four requests were made resulting in 32 responses. Fifteen of these authors provided data or direction to where data could be located.

2.2. Inclusion and exclusion criteria

For inclusion, studies were required to a) be in the English language, b) define NSSI as a deliberate non-suicidal act involving actual or potential tissue damage and c) report direct data on functions of NSSI (including self-reported reasons or motivations for NSSI). Studies measuring self-harm (i.e. including suicidal acts) were included if NSSI data was separately reported. Studies were excluded if they a) did not contain quantitative data, b) used exclusively forensic/prisoner or veteran/military participant samples.

2.3. Data extraction

Extraction of study data was undertaken independently by a member of the research team using a pre-specified data-collection form, and then double checked by a second reviewer, with all disagreements resolved by consensus through discussion with the third author. Extraction information included; type of study design, characteristics of participants, study measures and prevalence data related to NSSI functions. Data concerning NSSI functions had to be in a frequency format to be included in the meta-analyses. Where NSSI function data was presented in an unsuitable format that could not be converted into a frequency the study authors were contacted to request data in a format suitable for the meta-analysis.

The current study explicitly focused on the most commonly reported functions of NSSI. While various less common functions are reported across studies, their infrequency makes any estimates of prevalence unstable. Therefore, for this review NSSI functions were aggregated using a top-down approach, exploring the prevalence of functions/motives for NSSI within a series of pre-determined categories (see Fig. 1). Firstly, functions were divided into two main categories; intrapersonal functions and interpersonal functions, based on theoretical and empirical models of NSSI (Turner et al., 2012). For each of these main categories, sub-categories were then identified based on the most common reported functions from existing studies. For example, for interpersonal functions, one sub-category identified was *communicating level of distress*. This included functions such as "to let others know how desperate I am" and "to show my pain to others".

The following decision rules were adopted to determine which data on NSSI functions were used in the meta-analysis:

1) Where multiple functions were reported that all corresponded to one of our pre-determined categories (e.g., "to avoid distress" and "to escape negative feelings") the category with the largest rate of endorsement was used. Notably because of the hierarchical organisation of our pre-determined function categories, this meant that the same data (e.g. prevalence of endorsement for "to escape bad feelings") might be used in the meta-analysis for several different function categories (e.g. intrapersonal functions, emotion-regulation, and escape undesirable state).
2) For continuous or Likert-type scales we used the following decision-rule where possible for determining what level of rating would be classed as endorsement of a function: ratings equal to or greater than "sometimes" (or equivalent anchor wording) were taken as endorsement of that function. This meant that, for example, functions rated as "a little" or "rarely" were not taken to indicate endorsement for that individual. For studies where it was not possible to apply this decision-rule (e.g. where data were not provided) and the authors used a different rule or the rule they used is unclear we conducted a sensitivity analysis to determine if excluding such studies impacted on prevalence rates.

3) For the majority of studies rates of endorsed functions of NSSI were reported at an item-level and therefore data were extracted at this item-level. However, an exception was the Inventory of Statements About Self-Injury (ISAS; Klonsky and Glenn, 2009). For this scale we extracted subscale-level endorsement rates where this data were available or was successfully requested. This is because the ISAS contains a set of 13 well-specified, lower-level subscales.

2.4. Risk of bias

The risk of bias for included studies was assessed independently by two members of the research team using a tool adapted from the Agency for Healthcare Research and Quality (Williams et al., 2010). This tool was adapted and used previously in a review of self-harm in populations at risk of psychosis (Taylor et al., 2015). The tool rates whether a series of quality criteria and methodological safeguards against bias were met, or did not meet quality criteria in a number of key methodological areas. Disagreements between raters were discussed and resolved by the research team.

2.5. Data synthesis and analysis

Meta-analyses of prevalence were performed using STATA version 14 (StataCorp, 2015) via the Metaprop command (Nyaga et al., 2014). Proportions were subjected to a double arcsine transformation to stabilise the variance, following the recommendations of Barendregt et al. (2013). A random-effects model was chosen in advance due to expected differences between studies in the definition and measurement of NSSI and differences in participant characteristics. Inconsistency was estimated by calculating the I^2 statistic which describes the proportion of total variance across studies that is due to heterogeneity rather than sampling error (Higgins and Thompson, 2002; Higgins et al., 2003). An $I^2 > 75\%$ could be considered as indicating a "high" degree of inconsistency (Higgins et al., 2003).

Meta-analyses were undertaken separately for each function. Prevalence rates for different functions could not be directly compared since participants typically endorse multiple functions and so data are not independent. Meta-analyses were also conducted including only studies using the ISAS or the Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997), as this enables an estimate of prevalence when consistent measurement is used. Meta-regression was used to test whether prevalence estimates were affected by a) measure used (FASM, ISAS, other), adolescent sample (versus adult), university student samples (versus other), clinical inpatient samples (versus other). Meta-regressions were conducted using the Knapp-Hartung variance estimator (Harbord and Higgins, 2008). These meta-regressions were not planned in the initial protocol. To avoid excess number of analyses we limited meta-regressions to the overall intrapersonal and interpersonal function categories only. Publication bias was not anticipated since primary hypotheses never related to the specific prevalence of NSSI functions, and it was therefore deemed unlikely that the likelihood of a study being published would hinge on the specific prevalence of certain functions of NSSI.

3. Results

3.1. Study characteristics

The results of the literature search are presented in Fig. 2. Forty-six studies, containing $k = 53$ independent samples were included in the meta-analysis. A summary of study characteristics is presented in Table 1. All studies employed a cross-sectional design with the exception of one longitudinal study (Zanarini, Frankenburg, and Ridolfi et al., 2013). The majority of studies took place in North America/Canada ($k = 28$) followed by Europe ($k = 13$), Asia (k = 3), Australia ($k = 2$) and Africa ($k = 1$). Seven studies recruited participants from school/colleges (in the UK and Europe college is distinct to and typically precedes University) and 11 from university populations. Seventeen studies recruited participants from psychiatric inpatient units or outpatient clinics with two of these specialising in the treatment of borderline personality disorder (Brown et al., 2002; Kliendienst et al., 2008) and another in eating disorders (Claes et al., 2010). The remaining studies recruited from the community ($k = 9$), online youth forums and social networking sites ($k = 2$). The majority of studies had a greater number of female participants than male participants. The reviewed studies used several self-report measures to determine NSSI functions. Many studies ($k = 16$) used non-validated measures which included questionnaires derived by study authors and adaptations/ initial translations of existing questionnaires. In terms of validated tools, the Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997) was the most commonly used across studies ($k = 12$).

3.2. Risk of bias

The assessment of risk of bias is presented in Table 2. Overall, risk of bias was low with regards to the data that were the focus of this review. Notably, for unpublished data sets the information was not always available to ascertain the risk of bias associated with these data. Potential risk of self-selection bias associated with heavily self-selected samples (e.g. students responding to flyers or online adverts) was a recurrent issue. This could potentially impact prevalence rates if certain subgroups of individuals who engage in NSSI are more likely to participate in research. A lack of information in relation to missing data was also common. For a number of these studies, missing data was apparent but there were no details provided in relation to how this was managed (e.g. use of imputation strategies to minimize bias). This is problematic as missing data may have affected the representativeness of samples or led to bias in results (e.g. if those endorsing a certain function were more likely to have missing data). However, missing data appeared minimal (i.e. < 20%) for a large proportion of studies (see Table 2). A less prevalent issue was the use of adapted or revised measures of ascertaining NSSI or NSSI functions. These modified measures have unknown or less well established psychometric properties and may lack validity (e.g. reduced content validity). However, the majority of studies still employed widely used and validated tools to assess NSSI and associated functions.

3.3. Meta-analysis

Meta-analyses of prevalence were conducted separately for each of the nine pre-specified function categories. The results of these meta-analyses are reported in Table 3. In initial meta-analyses three samples were notable outliers, having particularly low endorsement rates for NSSI functions (Hilt, Nolen-Hoeksema & Cha, 2008; Hilt and Pollak, 2012; Vashling et al., 2015). All three of these samples featured children and particularly young adolescents (aged 9–14 years), which may account for the diverging results. Consequently we excluded these studies form the main meta-analyses but provide separate meta-analyses of these three samples together in Appendix II.

Inconsistency as judged by the I^2 statistic was high across studies. This finding suggests the use of a random-effects model, which takes heterogeneity into account, was justified. In light of the high level of inconsistency we recommend that readers focus not on the prevalence point estimates but instead the range provide by the 95% confidence intervals. Forest plots associated with each analysis are reported in Appendix III.

Intrapersonal functions, where the aim of NSSI was to manage or change one's internal state (e.g. emotions, thoughts, or physical sensations), were notably more prevalent (66–81% of individuals) than interpersonal functions where NSSI was used to communicate distress or influence one's external environment (e.g. to increase social support or influence the behaviour of others; 32–56% of individuals). Within

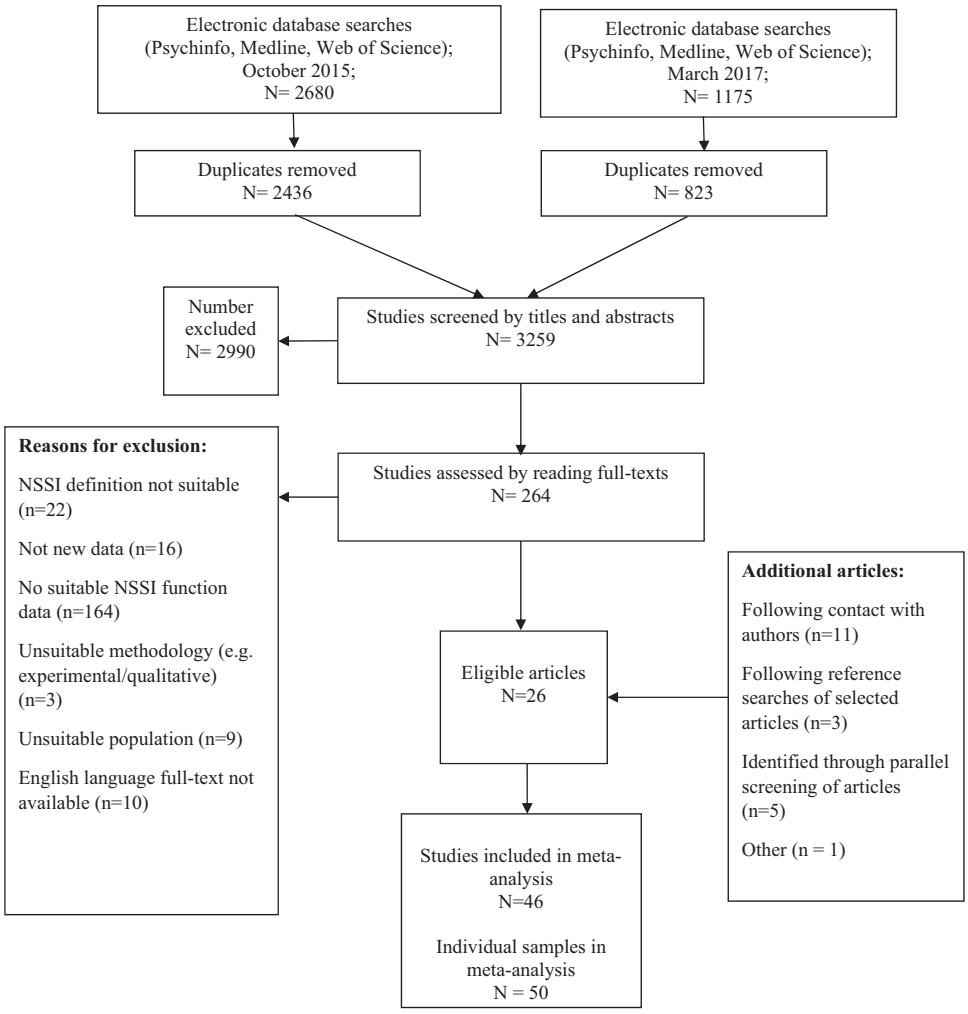

Fig. 2. Flow chart detailing search strategy.

the category of intrapersonal functions, avoidance or escape from an unwanted internal state (e.g. “to stop bad feelings”; “to escape negative thoughts”) was the most highly endorsed function. Inducing a positive state (e.g., excitement, relaxation) and self-punishment were less common but were still endorsed by approximately half of participants (42–57% and 41–62%, respectively). Amongst the interpersonal functions the use of NSSI as a means of communicating distress (e.g. “to show others how I desperate I am”; “to show others how hurt I am”) was the most commonly endorsed, whilst endorsement rates were lowest for NSSI serving as a means of hurting or punishing others (e.g. “to hurt someone else”; “to make others angry”).

Sensitivity analyses, excluding those studies using Likert scales where the rules for determining what counted as endorsement of a function was not clear, suggested this made little difference to results with prevalence point estimates and confidence intervals changing by ≤ 7%. Additional meta-analyses were conducted just on the three outlying studies that included children/ young adolescence (see Appendix II). Whilst rates are much lower than the main meta-analyses, the same pattern emerges, with intrapersonal functions being more common that interpersonal, and punishing or hurting others being the least endorsed. Caution is needed in interpreting these results due to the small number of studies included.

3.4. Moderators of prevalence estimates

It is important to consider study characteristics that might account for the high degree of inconsistency across studies. The results of the meta-regression analyses are reported in Table 4. These should be interpreted with caution since they were planned post-hoc and meta-regression is prone to Type I error (Higgins and Thompson, 2004). Nonetheless, across both interpersonal and intrapersonal functions, the choice of measure used stands out as a major moderator of function endorsement rates. The adjusted R^2 can be taken here as an estimate of the degree of moderation, estimating the proportion of between-study variance explained by moderators. Specifically, the ISAS is typically associated with greater endorsement, whilst the FASM is associated with lower endorsement. This difference can also be seen in Table 1, where meta-analysis results are reported separately for studies using the ISAS or FASM. The use of university student samples was also a notable moderator, with endorsement of functions being lower in these samples versus others.

The three significant moderators (ISAS, FASM, and university student sample) were included together as joint covariates in a further meta-regression model (see Table 5). For both intrapersonal and interpersonal functions this explained a substantial proportion of between-study variance, leaving only moderate inconsistency for intrapersonal functions (41%), and slightly higher residual inconsistency for interpersonal functions (68%).

4. Discussion

This paper reviewed forty-six studies with the aim of investigating commonly endorsed functions of NSSI and the prevalence of these different functions. It was hoped that findings would give a clearer indication of the dominant subgroups amongst those with NSSI in terms of function, contrast the relative endorsement of different functions,

Table 1
Characteristics of included studies (n = 41).

Author(s), Year, Country	Design	Sample Source	NSSI Sample Characteristics	NSSI Functions Measure
Baetens et al. (2011); Belgium	Cross-sectional	Youth websites	N = 183 (155 female). Demographics not reported for NSSI sample; for full sample (N = 1,417), 1,153 females, Mean age = 15.13 years (SD = 1.76)	Non-validated measure of reasons for NSSI
Bentley et al. (2015); USA	Cross-sectional	University	N = 150 (105 female) Mean age = 18.77 years (SD = 0.97)	Inventory of Statements of Self-Injury (ISAS; Klonsky and Glenn, 2009)
Bentley (unpublished); USA	Cross-sectional	Community	N = 90 (32 female) Mean age = 29.2 years (SD = 6.29)	Inventory of Statements of Self-Injury (ISAS; Klonsky and Glenn, 2009)
Brown et al. (2002); USA	Cross-sectional	Psychiatry departments for treatment of BPD	N = 46. Demographics not reported for NSSI sample; for full sample (N = 75), 75 females, Mean age = 30.0 years (SD = 7.3)	Non-validated measure of reasons for NSSI
Claes et al. (2010); Belgium	Cross-sectional	Inpatient eatingdisorder unit	N = 49. Demographics not reported for NSSI sample; for full sample (N = 177), 177 females, Mean age = 15.32 years (SD = 1.97)	Self-Injury Questionnaire- Treatment Related (SIQ-TR; Claes and Vandereycken, 2007)
Dandy (2017; unpublished) UK	Cross-sectional	Community	N = 92 (83 female) Mean age = 25.8 years (SD = 8.72)	Inventory of Statements of Self-Injury (ISAS; Klonsky and Glenn, 2009)
Groschwitz et al. (2016) Germany	Cross-sectional	Adolescent psychiatric units	N = 14 (11 female) Mean age = 15.4 years (SD = 1.9)	Self-Injurious Thoughts and Behaviour Interview- (SITBI; Nock et al., 2007) German translation
Groschwitz et al. (2015); Germany	Cross-sectional	Adolescent inpatient units	N = 60. Demographics not reported for NSSI sample; for full sample (N = 111), 73 females, Mean age = 15.3 years (SD = 1.7)	Self-Injurious Thoughts and Behaviour Interview- (SITBI; Nock et al., 2007) German translation
Heath et al. (2009); Canada	Cross-sectional	University	N = 23 (21 females) Mean age = 20.2 years (SD = 1.76)	Non-validated measure of reasons for NSSI
Hilt et al. (2015); US	Cross-sectional	University	N = 50 (38 females) Mean age = 19.95 (SD = 1.20)	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
Hilt and Pollak; (2012) US	Cross-sectional	Community	N = 44. Demographics not reported for NSSI sample; for full sample (N = 102), 65 females, Mean age = 11.51 years (SD = 1.47)	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
Hilt et al. (2008); US	Cross-sectional	Community	N = 53. Demographics not reported for NSSI sample; for full sample (N = 94), 94 females, Mean age = 12.7 years	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
Houben (unpublished); Belgium	Cross-sectional	Inpatients	N = 11. Demographics not reported for NSSI sample; for full sample (N = 30), 26 females, Mean age = 29.0 years (SD = NR)	Non-validated measure of reasons for NSSI
Hughes (unpublished); UK	Cross-sectional	Community	N = 100 (84 female) Mean age = 20.6 years (SD = 2.8)	Inventory of Statements of Self-Injury (ISAS; Klonsky and Glenn, 2009)
Kaess et al. (2013); Germany	Cross-sectional	Psychiatric inpatient units	N = 75 (43 female) Mean age = 16.5 years (SD = 2.6)	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
Kharsati and Bhola (2015); India	Cross-sectional	English- medium colleges	N = 143. Demographics not reported for NSSI sample; for full sample (N = 470), 329 females, Mean age = 20.3 years (SD = 1.7)	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
King (unpublished) and 2015 USA	Cross-sectional	University	N = 28 (23 females) Mean age = 20.5 years (SD = 3.3).	Inventory of Statements of Self-Injury (ISAS; Klonsky and Glenn, 2009)
Kleindienst et al. (2008); Germany	Cross-sectional	Psychiatry departments for treatment of BPD	N = 95 (95 females) Mean age = 30.4 years (SD = 8.1)	Non-validated questionnaire assessing motives for NSSI
Klonsky (2009); USA	Cross-sectional	University	N = 39 (30 females) Mean age = 19.4 years (SD = 2.4)	Non-validated questionnaire assessing functions of NSSI
Klonsky (2011); USA	Cross-sectional	Community	N = 26 (16 females) Mean age = 55.5 years (SD = 16.6)	Non-validated questionnaire assessing functions of NSSI
Klonsky and Olino (2008); USA	Cross-sectional	University	N = 205 (117 females) Mean age = 18.5 years (SD = 1.2)	Inventory of Statements of Self-Injury (ISAS; Klonsky and Glenn, 2009)
Laye-Gindhu and Schonert-Reichl (2005); Canada	Cross-sectional	Public school	N = 56 (43 females). Demographics not reported for NSSI sample; for full sample (N = 424), 236 females, Mean age = 15.3 years (SD = 1.10)	Non-validated questionnaire assessing motives for NSSI
Leong et al. (2014); China	Cross- sectional	High school	N = 345 (189 females) Mean age = 11.41 years (SD = 2.63)	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
Lindholm et al. (2011); Sweden	Cross-sectional	Female psychiatric units	N = 26 (26 females) Mean age = 20 years (SD = 3.1)	Inventory of Statements of Self-Injury (ISAS; Klonsky and Glenn, 2009) Swedish translation (non-validated)
Lloyd-Richardson et al. (2007); USA	Cross-sectional	High school	N = 293 (N = 119 minor NSSI; N = 174 moderate/severe NSSI). Demographics not reported for NSSI sample; for full sample (N = 633), 360 females, Mean age = 15.5 years (SD = 1.18)	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
Martin et al. (2010); Australia	Cross-sectional	Community	N = 133 (72 females). Demographics not reported for NSSI sample; for full sample (N = 12,006), 6063 females, aged 10–100 years	Non-validated measure of motivations for NSSI
Muehlenkamp et al. (2013); USA	Cross-sectional	University	N = 183. Demographics not reported for NSSI sample; for full sample (N = 1243), Mean age = 21.5 years (SD = 4.15)	Non-Suicidal Self-Injury Assessment Tool (NSSI-AT; Whitlock et al., 2014)

(*continued on next page*)

Table 1 (*continued*)

Author(s), Year, Country	Design	Sample Source	NSSI Sample Characteristics	NSSI Functions Measure
Nixon et al. (2015); Canada	Cross-sectional	Adolescent psychiatric inpatient unit	N = 94. Demographics not reported for NSSI sample; for full sample (N = 1243), 76 females, Mean age = 15.7 years (SD = 1.5)	The Ottawa Self-Injury Questionnaire (Cloutier and Nixon, 2003)
Nixon et al. (2002); Canada	Cross-sectional	Adolescent psychiatric inpatient unit	N = 42 (36 females) Mean age = 15.70 years (SD = 1.70)	Non-validated measure of reasons for NSSI
Nock and Prinstein (2004); USA	Cross-sectional	Adolescent psychiatric inpatient unit	N = 89 (66 females). Demographics not reported for NSSI sample; for full sample (N = 108), 76 females, Mean age = 14.8 years (SD = 1.4)	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
Paul et al. (2015); USA	Cross-sectional	University	Demographics not reported for NSSI sample; for full sample (N = 13,396), 76 females, aged 19–29 years.	Non-validated measure of reasons for NSSI
Plener et al. (2016); Germany	Cross-sectional	Community	N = 78. Demographics not reported for NSSI sample; for full sample (N = 2,509), 1391 females, Mean age = 48.8 years (SD = 18.1)	Self-Injurious Thoughts and Behaviour Interview- (SITBI; Nock et al., 2007) German translation
Rodav et al. (2014); Israel	Cross-sectional	High school	N = 57. Demographics not reported for NSSI sample; for full sample (N = 275), 137 females, Mean age = 14.8 years (SD = 1.36)	The Ottawa Self-Injury Questionnaire (Cloutier and Nixon, 2003)
Roley-Roberts et al. (2016); USA	Cross-sectional	University	N = 72. Demographics not reported for NSSI sample; for full sample (N = 121), Mean age = 18.7 years	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
Sadeh et al. (2014); USA	Cross-sectional	Adolescent psychotherapy clinic	N = 36 (32 females) Mean age = 16.70 years (SD = 2.30)	The Inventory of Statements about Self Injury (ISAS; Klonsky and Glenn, 2009)
Saraff and Pepper (2014); USA	Cross-sectional	University	N = 52 (44 females) Mean age = 19.81 years (SD = 1.92)	The Inventory of Statements About Self-Injury (ISAS; Klonsky and Glenn, 2009)
Swannell et al. (2008); Australia	Cross-sectional	Adolescent psychiatric inpatient unit	N = 38 (28 females) Mean age females = 15.70 years (SD = 1.00); Mean age males = 16.10 years (SD = 0.90)	Non-validated measure to assess motives for NSSI- Adapted the SIMS (Osuch et al., 1999)
Turner et al. (2012); Canada	Cross-sectional	Social networkwebsites	N = 162 (162 females) Mean age = 22.47 years (SD = 7.14)	Non-validated measure of NSSI functions
Vashling et al. (2015); US	Cross-sectional	Community	N = 53. Demographics not reported for NSSI sample; for full sample (N = 160), 77 females, Mean age = 12 years 7 month SD = 1 year 1 month	The Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
Washburn (a unpublished) USA	Cross-sectional	Acute care patients	N = 1065(943 female) Mean age = 18.98 years (SD = 7.86); Inpatients: 594	The Inventory of Statements About Self-Injury (ISAS; Klonsky and Glenn, 2009)
Washburn (b unpublished) USA	Cross-sectional	Acute care patients	N = 2384 (2087 female) Mean age = 16.53; Inpatients = 1087	The Inventory of Statements About Self-Injury Short form (ISAS; Klonsky and Glenn, 2009)
Wilcox et al. (2012); USA	Cross-sectional	University	N = 75 (55 females). Demographics not reported for NSSI or full sample	Non-validated measure for reasons for NSSI
Yen et al. (2016); USA	Cross-sectional	Psychiatric inpatients	N = 71. Demographics not reported for NSSI sample; for full sample (N = 92), 59 females, Mean age = 15.3 years (SD = 1.38)	Functional Assessment of Self-Mutilation (FASM; Lloyd et al., 1997)
You et al. (2015)[2] China	Cross sectional	High school	N = 42 (32 females) Mean age = 15.64 years (SD = 1.14); Divided into cutting, hitting and scratching groups.	Non-validated measure of NSSI functions
Zanarini et al. (2013); USA	Longitudinal study	Psychiatric inpatient unit	More extensive NSSI group: N = 133 (102 females) Mean age = 27.60 years (SD = 5.90) Less extensive NSSI group: N = 129 (107 females) Mean age = 26.30 (SD = 5.40)	Lifetime Self-Destructiveness Scale (LDLS; Zanarini et al., 2006)
Zetterqvist et al. (2013); Sweden	Cross-sectional	High school	N = 836. Demographics not reported for NSSI sample; for full sample (N = 3,060), 1531 females, aged 15–17 years	Functional Assessment of Self-Mutilation (FASM; Lloyd, Kelly, and Hope, 1997)-Swedish translation (validated)

and further identify the needs of the population of those who use NSSI. The resulting meta-analyses provide a valuable indication of the likely relative prevalence of nine pre-specified categories of NSSI function. The high level of inconsistency merits caution in interpreting results, and we would advise that confidence intervals are used to suggest a likely range of prevalence, rather than point estimates. Notably, choice of measure emerged as a major moderator of prevalence estimate. The ISAS produced higher estimates whilst the FASM gave lower estimates. This could relate to item wording and content but also the rating scale used. The FASM allows a "rarely" category whilst the ISAS jumps straight from "not relevant" to "somewhat relevant". As we did not count the FASM "rarely" category as endorsement this means that the FASM ultimately provided a more conservative indicator of endorsement, and the ISAS a more liberal one. Accounting for the moderating effects of measure and sample (university students) lead to a substantial reduction in inconsistency.

A number of important conclusions can be derived from the results. These data support the conclusion that regulation of distressing emotional states underlies NSSI in many individuals and interventions that aim to improve regulation or tolerance of emotions, such as DBT or ERGT, may therefore be well suited to this population. This finding lends support to the dominant focus on affect-regulation based models of NSSI (Chapman et al., 2006; Hasking et al., 2016; Nock, 2009). Moreover, there is some indication that the avoidance or escape from negative internal states is a more common function than inducing a desired state, consistent with experiential avoidance models of NSSI (Chapman et al., 2006; Hasking et al., 2016), although this finding was more dependent upon the measure used. However, the data also indicates that emotion-regulation functions do not hold for everyone, and other functions are also highly endorsed (communicating distress, self-punishment). Therefore, given the findings, clinical services require alternative treatment pathways for individuals whose NSSI is not primarily about emotion regulation. Compassion-Focussed Therapy, for example, may be better suited to individuals where self-punishment is a primary motive (Van Vilet and Kalnins, 2011). Interpersonal functions are still widely endorsed and models that make sense of these functions of NSSI (e.g. Nock, 2008) therefore require further research attention. Lower prevalence estimates were evident for NSSI functions related to

Table 2
Risk of bias assessment.

	Unbiased Selection of Cohort	Adequate Description of the Cohort	Validated Measure for Determining NSSI	Validated Methods for Ascertaining Functions of NSSI	Adequate Handling of Missing Data
Baetens et al. (2011)	Partial	Partial	Partial	Partial	Yes
Bentley et al. (2015)	Partial	Yes	Yes	Yes	Yes
Bentley (unpub.)	Partial	Yes	Yes	Yes	Yes
Brown et al. (2002)	Cannot tell	Yes	Yes	No	Cannot tell
Claes et al. (2010)	Partial	Partial	Yes	Yes	Cannot tell
Dandy (unpub.)	Partial	Yes	Partial	Yes	Yes
Groschwitz et al. (2015)	Cannot tell	Partial	Yes	Yes	Yes
Groschwitz et al. (2016)	Cannot tell	Partial	Yes	Yes	Yes
Heath et al. (2009)	Partial	Partial	Yes	No	Cannot tell
Hilt et al. (2015)	Cannot tell	Partial	Yes	Yes	Cannot tell
Hilt and Pollak (2012)	Partial	Partial	Yes	Yes	Yes
Hilt et al. (2008)	Partial	Yes	Yes	Yes	Yes
Houben (unpub.)	Cannot tell	No	Yes	Yes	Cannot tell
Hughes (unpub.)	Partial	Yes	Yes	Yes	Yes
Kaess et al. (2013)	Yes	Partial	Yes	Yes	Cannot tell
Kharsati and Bhola (2015)	Cannot tell	Yes	Yes	Yes	Cannot tell
Kleindienst et al. (2008)	Yes	Yes	No	No	Cannot tell
King (2015)	Partial	Yes	Yes	Yes	Yes
Klonsky (2009)	Yes	Yes	No	No	Cannot tell
Klonsky (2011)	Yes	Yes	Partial	Partial	Cannot tell
Klonsky and Olino (2008)	Partial	Yes	Yes	Yes	Yes
Laye-Gindhu and Schonert-Reichl (2005)	Partial	Partial	No	No	Cannot tell
Leong et al. (2014)	Partial	Yes	Yes	Yes	Cannot tell
Lindholm et al. (2011)	No	Partial	Yes	Partial	Yes
Lloyd-Richardson et al. (2007)	Yes	Yes	Yes	Yes	Yes
Martin et al. (2010)	Yes	Yes	No	No	Partial
Muehlenkamp et al. (2013)	Yes	Partial	Yes	Yes	Yes
Nixon et al. (2002)	Partial	Yes	Partial	Partial	Cannot tell
Nixon et al. (2015)	Yes	Yes	Yes	Yes	Yes
Nock and Prinstein (2004)	Yes	Yes	Yes	Yes	Yes
Paul et al. (2015)	Yes	Yes	Yes	Partial	yes
Plener et al. (2016)	Yes	Yes	Yes	Yes	Yes
Rodav et al. (2014)	Partial	Partial	Partial	Partial	Cannot tell
Roley-Roberts et al. (2016)	Cannot tell	Yes	Yes	Yes	Yes
Sadeh et al. (2014)	Yes	Yes	Yes	Yes	Yes
Saraff and Pepper (2014)	Partial	Yes	Yes	Yes	Cannot tell
Swannell et al. (2008)	Partial	Partial	Partial	Partial	Cannot tell
Turner et al. (2012)	Partial	Partial	Partial	Partial	Yes
Vashling et al. (2015)	Cannot tell	Partial	Yes	Yes	Yes
Washburn (unpub. A)[a]	Cannot tell	Partial	Yes	Yes	Cannot tell
Washburn (unpub. B)[a]	Cannot tell	Partial	Yes	Yes	Cannot tell
Wilcox et al. (2012)	Cannot tell	Yes	No	No	Yes
You et al. (2013)	Yes	Partial	Partial	Partial	Cannot tell
Yen et al. (2016)	Yes	Yes	Yes	Yes	Yes
Zanarini et al. (2013)	Partial	Yes	Yes	Yes	Cannot tell
Zetterqvist et al. (2013)	Yes	Partial	Yes	Yes	Cannot tell

[a] These samples relate to a large unpublished dataset which has contributed to multiple published studies.

Table 3
Result of meta-analyses for all studies and just for studies using the ISAS or FASM.

All studies				FASM only			ISAS only		
Functions of NSSI	Number of studies/ participants(K/N)	Pooled Prevalence % % CI]	I^2	Number of studies/ participants(K/N)	Pooled Prevalence % [95% CI]	I^2	Number of studies/ participants(K/N)	Pooled Prevalence % [95% CI]	I^2
Intrapersonal	47/10013	74 (66, 81)	98	11/1968	42 (35, 49)	87	11/4198	91 (84, 96)	96
Emotional Regulation	47/10020	71 (63, 78)	98	11/1968	41 (35, 48)	87	11/4205	89 (82, 94)	95
Escape a Negative/ Unwanted State	46/9887	70 (62, 78)	98	11/1968	38 (29, 47)	93	11/4205	89 (82, 94)	95
Induce a Positive/ Wanted State	44/9721	50 (42, 57)	98	11/1968	38 (32, 45)	85	11/4194	65 (55, 76)	97
Self-Punishment	43/9784	51 (41, 62)	99	11/1968	31 (22, 40)	94	11/4195	78 (69, 86)	96
Interpersonal	43/9784	44 (33, 56)	99	10/1893	22 (17, 27)	83	11/4087	81 (72, 89)	97
Communicate Level of Distress	32/7180	42 (30, 55)	99	10/1893	13 (10, 17)	67	11/4094	72 (63, 80)	95
Interpersonal Influence	42/9773	28 (23, 33)	96	10/1893	21 (16, 27)	82	11/4102	43 (36, 50)	91
Punish Others	22/6520	18 (13, 23)	95	8/1599	5 (3, 8)	73	10/4076	27 (21, 34)	93

ISAS = Inventory of Statement about Self-Injury; FASM = Functional Assessment of Self-Mutilation.

Table 4
Tests of potential moderators of prevalence estimates via meta-regression.

	Intrapersonal functions			Intrapersonal functions		
	***B* (95% CI)**	**Adjusted R^2**	**Residual I^2**	***B* (95% CI)**	**Adjusted R^2**	**Residual I^2**
ISAS	.24 (.10, .38)	27%	78%	.46 (.30, .61)	54%	83%
FASM	−.35 (−.48, −.23)	52%	85%	−.29 (−.49, −.08)	17%	95%
Adolescent Sample[a]	−.08 (−.23, .06)	2.40%	90%	−.10 (−.30, .10)	1%	95%
University sample	−.15 (−.29,−.01)	11%	87%	−.14 (−.33, .06)	3%	94%
Inpatient sample[b]	.08 (−.08, .24)	0%	91%	−.01 (−.22, .21)	0%	96%

ISAS = Inventory of Statement about Self-Injury; FASM = Functional Assessment of Self-Mutilation; [a] These meta-analyses were conducted excluding the three studies with particularly young adolescent samples. Including these three studies leads to a stronger moderating effect of adolescent sample, for intrapersonal, $B = -.15$ (−.30, −.01) functions, but still no significant moderating effect for interpersonal functions, $B = -.15$ (−.33, .04). [b] In instances where predictors explain very minimal between-study variance it is possible to receive a negative adjusted R^2 value. In this table values have been lower-capped at zero to aid interpretation.

influencing others and punishing others. As such these results conflict with the common myth that NSSI is largely about seeking attention or manipulating others (Caicedo and Whitlock, 2009).

All prevalence estimates calculated had high I^2 values. This statistic can be taken as an indication of inconsistency in prevalence estimates (not the overall amount of heterogeneity; Higgins and Thompson, 2002) across studies, implying that differences between the studies may account for variability in the pooled prevalence estimates (Higgins, 2008). Clearly, individual estimates vary greatly from study to study and so the confidence intervals for the pooled estimates of prevalence provided in this review may better capture the true prevalence a particular function whilst encompassing the imprecision in this estimate. Notably, high heterogeneity is rarely a reason to favour narrative synthesis over meta-analysis (Loannidis et al., 2008), and is not uncommon within meta-analyses of prevalence data (Fayaz et al., 2015; Mansfield et al., 2016). Proportions may be particularly sensitive to the idiosyncrasies of study design and sample. Nonetheless, these meta-analyses results reveal informative patterns in the endorsement of different NSSI functions and give a useful approximate range of likely prevalence that is more precise than relying on simple ranges from across studies.

Methodological issues may partly account for the observed inconsistency. Self-selection bias may have created issues around representativeness of samples and increase the risk of statistical idiosyncrasy (especially in smaller samples) influencing results. The use of non-validated measures (or adaptions of measures) also raises uncertainty around the suitability and validity of these measures. Inconsistency may also be explained by conceptual issues surrounding functions of NSSI. Research has long established the complex nature of NSSI including the significant variability in its functions (Andover, 2012). Indeed, there is evidence that many people endorse multiple functions of NSSI which are often overlapping or inter-related (Lloyd-Richardson et al., 2007). In the current review we therefore did not treat functions as mutually exclusive categories. However, the data presented in the reviewed studies did not consider whether certain functions are more dominant or important for a particular individual. Focussing on the function deemed most important by an individual may have produced different results.

While this review contributed novel and important information about the study of NSSI functions, it should be considered in light of some limitations. Meta-regression was not originally considered in the registered protocol, but were planned after the level of inconsistency became apparent, and so are post-hoc in nature, increasing the risk of Type I error for these analyses (Higgins and Thompson, 2004). Additionally, this review only included studies published in English and therefore may have excluded relevant research in other languages. However, the review did include studies from range of countries including non-English speaking populations. The majority of studies included in this review had predominately female samples. However, differences between studies related to the proportion of females in the sample do not necessarily translate to associations between sex and NSSI function at the participant level (Robinson, 1950). Cultural differences in samples may have also contributed to inconsistency (Gholamrezaei et al., 2015). This review was limited to community and clinical samples, but notably a great deal of research has been undertaken with other groups, including forensic populations. It may be that the prevalence of particular functions differs for these other populations.

Studies that provided no data for a particular function could not be included in the meta-analysis for this function. However, it is possible that some studies did not report prevalence rates for certain functions because these were not endorsed by any participants. This may mean that for functions with very low rates of endorsement (where zero rates of endorsement are probable), the meta-analytic prevalence estimates are an over-estimation. We would encourage researchers to report endorsement rates for key NSSI functions even where zero. This review focused on self-reported functions, but it is worth considering that implicit or inferred motivations for NSSI can also be identified that may sometimes differ to those explicitly mentioned (Snir et al., 2015).

Clinically the function that NSSI serves appears to be an important factor in making sense of and considering treatment options for that individual. Different functions potentially entail different clinical needs in terms of therapeutic support and intervention and in turn may entail different training demands for services (e.g., staff training in DBT versus CFT). The current review suggests that a small number of key functions likely apply to the majority of those who engage in NSSI, with emotion-regulation being an important function for many individuals. These data support the current emphasis on emotion-regulation orientated

Table 5
Tests of multiple moderators of prevalence estimates via meta-regression.

	Intrapersonal functions			Intrapersonal functions		
	***B* (95% CI)**	**Adjusted R^2**	**Residual I^2**	***B* (95% CI)**	**Adjusted R^2**	**Residual I^2**
ISAS	.18 (.08, .28)	83%	41%	.45 (.31, .60)	68%	75%
FASM	−.28 (−.37, −.18)			−.11 (−.26, −.04)		
University sample	−.18 (−.27,−.10)			−.19 (−.32, −.06)		

ISAS = Inventory of Statement about Self-Injury; FASM = Functional Assessment of Self-Mutilation.

interventions for NSSI (e.g. DBT). Nonetheless, it is important not to assume this function applies to every individual who engages in NSSI and it should be remembered that even with the highest estimates of interpersonal function endorsement (based on ISAS) 5–21% of individuals do not endorse this function. Comprehensive idiographic assessment of function is clearly crucial in ensuring that interventions offered match the underlying functions of an individual's NSSI. Further research investigating whether the function of NSSI acts as a moderator of treatment-effect would be valuable. From a public health perspective the data in this review may also inform awareness and prevention campaigns, supporting claims about common reasons for NSSI but also countering prevailing myths (e.g. that NSSI is just a way of getting attention, this only applies to a minority of individuals).

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Appendix A. Supporting information

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