

**Investigating the Effectiveness and Design of Mobile Apps for Reducing Non-Suicidal  
Self-Injury: A scoping review.**

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## Abstract

**Background:** In the past years a lot of different mobile applications have been developed for the treatment of different mental health issues, also including non-suicidal self-injury (NSSI). These interventions may be considered helpful tools and valuable options in the treatment of NSSI, but only if they are proven to be effective and if they are well understood. Therefore this scoping review provides a broader understanding of some of the currently available apps in the treatment of self-harm behaviours.

**Methods:** A search in the electronic databases Scopus, Web of Science, and PsychInfo was conducted. 226 titles were screened, resulting in 10 articles that met the inclusion criteria for this review. These 10 studies were analysed regarding the effectiveness of apps in the treatment, user experience and several other research characteristics. To provide a summary of the insights, the retrieved data were compiled and shown in tables.

**Results:** Various research designs were applied to study the effectiveness of apps in the treatment of self-harm behaviours in different populations. The majority of the studies focused on female adults above the age of 18 years. Moreover, most applications contained several features that users could choose from. Regarding the conceptualization of self-harm, most of the studies conceptualized it as an act of self-injury without suicidal intent, most often in the form of self-cutting. To assess the effectiveness of the apps in the treatment of self-harm, several outcome measures were used by the researchers, the most used measure was the SITBI. Lastly, the majority of apps were found to be effective in reducing the frequency of self-harm sessions and the urge to self-harm.

**Conclusions:** There are apps available that are promising and inviting for usage in NSSI treatment. Future research should examine how and why these applications are successful while taking a more diverse perspective regarding the population. Moreover, the long-term effects need to be investigated as most included studies from this review did not do that yet.

## **Investigating the Efficacy and Design of Mobile Apps for Reducing Non-Suicidal Self-Injury**

Self-harm is an increasing mental health concern because of this behaviour's worrisome repercussions, which include physical consequences like scarring, emotional consequences like feelings of guilt and shame and lastly social consequences like isolation. According to estimates on the prevalence of NSSI, about 17% of teenagers and young adults have participated in it at some time in their lives (Swannell et al., 2014), making this the group that's most affected. There are several methods to treat people with self-harm tendencies or associated illnesses using DBT or CBT-based psychotherapy tailored to their unique diagnosis and condition. These therapies frequently involve traditional face-to-face talk therapy, medication, or more contemporary types of therapy including art, sports, or music therapy.

However, as a result of technological advancements, new therapies for self-harming tendencies and associated disorders have emerged. Examples include mobile apps and online interventions, which are often referred to as e-health interventions (Torous et al., 2021). Currently, there are a large number of mental health apps on the market that offer a variety of tools and features like symptom tracking, guided meditations, mood tracking, and cognitive behavioural therapy. In addition, they can offer their users quick access to information and assistance, and they as well may be less expensive than traditional therapeutic options. Despite the possible advantages of mental health applications, there are also still a lot of unanswered questions, as previous research found that the knowledge about mental health applications is considerably low in the field (Becker, 2016). Most of these unanswered questions are regarding the effectiveness and acceptance of mental health apps specifically designed for individuals with self-injurious behaviours. Hence, it is not clear how well these apps work to reduce self-harm and there is no agreed-upon standard for the design of such

apps, therefore it is unclear which features are most often included in these apps, how well they work and what their target group of users is.

### **Non-suicidal self-injury (NSSI)**

NSSI involves deliberately harming oneself without the intent to die, often through cutting, burning, or hair-pulling (American Psychiatric Association, 2013). Whereas the most common forms are cutting, burning, or scratching of the skin and the most frequently harmed parts of the body are the wrists, legs, and arms. While NSSI is not a suicidal behaviour in itself, it often co-occurs with suicidal thoughts or attempts and it can therefore be seen as a warning sign of a serious underlying mental health issue which needs to be treated (Andover et al., 2012). Moreover, people suffering from mental health issues like borderline personality disorder, depression or anxiety, often also engage in NSSI as a way to cope with the overwhelming related emotions of these disorders, such as stress, anxiety, or depression (Suyemoto, 1998). Hence, those who engage in NSSI frequently, often experience feelings of isolation and social disapproval, which can even worsen their mental health problems (Klonsky et al., 2014). Hereby, by inflicting harm to the own body, the physical pain caused by this provides temporary relief from these encountered negative emotions, although the relief is often only short-lived and decreases over time (Hooley et al., 2020). As the feeling of temporary relief decreases relatively fast after an NSSI session, the affected person tends to increase the frequency of the injuries or the severeness, to perceive the relieving and satisfying feeling again. Therefore, NSSI can lead to a vicious cycle of negative emotions and behaviours, including guilt, shame, and self-isolation, which can in response increase the likelihood of engaging in the harming behaviour again (Klonsky et al., 2014).

### **Treatment**

To prevent self-harming behaviour from worsening, it is necessary to treat it and any underlying pathologies with the appropriate treatment. There are effective treatment options

available regarding psychotherapy. For example, cognitive-behavioural therapy and dialectical behaviour therapy are two of the most commonly used forms of therapy in the treatment of self-harm symptoms and also in the general treatment of other psychological disorders (Turner et al., 2014). Moreover, the current state of knowledge indicates that psychotherapy centred around cognitive behavioural therapy or dialectical behaviour therapy is the most favourable and established solution for addressing self-harm (Turner et al., 2014). In cognitive-behavioural therapy, the patient is assisted by the therapist to challenge and modify negative patterns, thereby teaching them more positive and adaptive ways of coping with distress (Washburn et al., 2012). In contrast, DBT-based therapy helps patients regulate their emotions and tolerate distress by teaching them specific skills such as mindfulness, distress tolerance, emotion regulation, and interpersonal effectiveness (May et al., 2016). Overall, treatment for self-harm seeks to facilitate the development of positive coping mechanisms amongst patients while bolstering their capacity for emotional regulation and ultimately reducing occurrences of self-injury.

Psychotherapy is an effective treatment for NSSI, but there are still gaps in its provision (Mohr et al., 2006). One barrier is the limited availability of qualified therapists, especially in countries lacking the necessary resources (Qin & Hsieh, 2020), this causes long waiting lists and limited session availability. Therefore, when the number of sessions is restricted, such as to one per week, it is impossible to guarantee that patients receive assistance whenever they require it, such as in routine situations. Moreover, Stigma and the belief that therapy is ineffective are other common barriers preventing individuals from seeking professional help (Bruffaerts et al., 2011). Stigma fosters a negative attitude towards mental illness so that it can lead those who don't believe in the effectiveness of psychotherapy to avoid therapy altogether, even when they need it (Bruffaerts et al., 2011). These barriers can result in a mismatch between patients' therapeutic needs and the type of

treatment they receive, undermining the effectiveness of therapy and increasing the risk of poorer mental health outcomes or treatment dropout. Moreover, these barriers elucidate that need-oriented therapy which aligns with individual patients' requirements and preferences along with appropriate evidence-centred approaches will not always be available (Lin & Baumeister, 2015). Therefore, if psychotherapy is not available or possible due to some of these reasons, technologies like mobile apps could also provide valuable help and support, as they could not only be used in conjunction with therapy but also like in this case as a standalone treatment.

### **Mobile applications for treating self-harm**

Given that more than 6 billion people own a smartphone in 2023 (Turner, 2023), mobile apps should be considered as a possible treatment option in the mental health care field. Nevertheless, it is currently impossible to pinpoint the exact number of available apps for NSSI treatment, as the number is continually fluctuating as new apps are released and older ones are updated or deleted. However, there are some mental-health apps available (approx. more than 20 for self-harm symptoms), some of them are intended as a stand-alone treatment, therefore they are intended to be used without concurrent psychotherapy, while others are intended as a blended care tool, that can be used supportive in conjunction beside psychotherapy. What is known so far about the apps in this field is that there are some advantages as well as disadvantages.

First, regarding the advantages, mobile apps offer a convenient and accessible way for individuals to receive treatment from the comfort of their home, at any time of day, helping to close the treatment gap or the gap in the number of available sessions. Moreover, apps can offer a range of different features such as tracking tools, coping strategies, and crisis intervention resources that can be beneficial in managing NSSI, as these can be tailored

specifically to the individual's needs and preferences. This in turn can then increase treatment engagement and adherence (Moock, 2014).

Considering the possible disadvantages of apps for self-injury and other mental health issues, it is known that there are still some concerns about the effectiveness and evidence (Moock, 2014). Here, some apps only have been tested shortly in a clinical setting or not at all at this point. Moreover, when assessing apps for self-harm treatment, the design of the technology itself is also crucial to consider, as poorly designed applications may be confusing to use and often lack key functionality or resources. Additionally, some applications might have bugs or technical problems that reduce both their effectiveness and usability.

Conclusively, it becomes clear that there are several self-harm app applications available, and some of them seem to offer great benefits like a range of tools or personalization of content. However, there are still many unanswered questions about how successful these apps are, who their primary user base is, and how the way they are designed is related to their effectiveness. Furthermore, although self-harm has a standardized definition, all researchers define it differently, which results in variations in how self-harm is measured or assessed across various studies. Therefore, the evaluation that follows offers an overview of the various mobile applications in relation to self-harm treatment by investigating the following objectives:

- 1) How effective are mobile applications in reducing self-injury and accompanying feelings in their users?
- 2) For which populations are apps mostly used to treat self-injury and are they more frequently used as a stand-alone treatment or blended care?
- 3) What are the perceptions and evaluations of users and clinicians regarding the usability of mobile apps for NSSI treatment?
- 4) Which features and tools are most often integrated into the apps?

- 5) How is self-harm conceptualized by the studies examining mobile applications for treatment?
- 6) Which research designs are applied to study the effectiveness of mobile interventions in treating self-harm?

## **Methods**

### **Research Design**

A scoping review was performed to address the research objectives of the chosen subject. This approach was selected because scoping reviews are studies that try to map out and synthesize the body of literature already written on a certain subject and identify the key themes pertinent to it, taking into consideration a variety of study types. As a result, a scoping review includes different articles with several study designs of varying quality (Peters et al., 2015). Lastly, scoping reviews arrange data into tables to produce a concise summary of the already existing research in the area of interest. This process aids in outlining the existing state of knowledge, highlighting gaps, and providing implications for further research (Peters et al., 2015).

### **Search Strategy**

Three electronic databases were searched (Scopus, PsycINFO, and Web of Science) with the following search string: ("self-harm" OR "self-mutilation" OR "self-injury") AND ("mobile app\*" OR "e-health" OR "mobile intervention\*" OR "mobile treatment\*" OR "mobile therapy"). The three databases were chosen because they focus on research studies of social, medical, and psychological character. Further to that, PsycInfo is primarily focused on psychological and mental health research, whereas Scopus, as well as Web of Science, are online databases that provide a broader variety of research areas and consequently also contain more literature records (van Lotringen et al., 2021). The search query was used to search for relevant records in the abstracts, author keywords, and titles of the



abovementioned databases. Additionally, the use of Boolean operators, truncation, and nesting to produce more specialized and targeted search queries helped to optimize this process by ensuring that there were adequate hits while searching the databases. Finally, the search was completed in March 2023, and Table 1 shows the corresponding search terms.

**Table 1**

Search queries and amount of hits per database

<b>Date</b>	<b>Database</b>	<b>Search String</b>	<b>Hits</b>
12.03.2023	Scopus	("self-harm" OR "self-mutilation" OR "self-injury") AND ("mobile app*" OR "e-health" OR "mobile intervention*" OR "mobile treatment*" OR "mobile therapy")	65
12.03.2023	PsycINFO	("self-harm" OR "self-mutilation" OR "self-injury") AND ("mobile app*" OR "e-health" OR "mobile intervention*" OR "mobile treatment*" OR "mobile therapy")	40
12.03.2023	Web of Science	("self-harm" OR "self-mutilation" OR "self-injury") AND ("mobile app*" OR "e-health" OR "mobile intervention*" OR "mobile treatment*" OR "mobile therapy")	57
<b>Total</b>			<b>162</b>

### **Inclusion and exclusion criteria**

To obtain eligible articles for the review, specific inclusion and exclusion criteria have been pre-defined. First, the included articles were limited to empirical studies and had to be written in English. Moreover, only original studies published in peer-reviewed journals were included to ensure the quality of the included articles. Regarding the exclusion criteria, studies from which the full text was not available or accessible were excluded. Additionally, all articles solely focusing on other mental disorders, without mentioning self-injury were as

well excluded. Otherwise, no restrictions were placed on diagnoses. Studies in which the investigated intervention was not a mobile- intervention were also excluded as this review primarily focuses on smartphone applications. Conclusively, included in this review were then studies with observational, qualitative, quantitative, or mixed methods that gathered data about the available types of mobile apps, their design features and their effectiveness in the treatment of self-harm.

### **Selection of Studies**

After searching the three different databases following the PRISMA ( Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Moher et al., 2010), the selected articles were imported to EndNote along with their titles, abstracts, authors' names, journal names and DOI. Duplicates and types of articles that did not meet the pre-defined inclusion criteria were deleted. This step was then followed by scanning the titles and abstracts of the remaining articles. After another quick scan of the literature, relevant studies were identified by carefully evaluating their abstracts. Doing this, valuable abstracts were saved for further full-text screening to assess their potential relevance for the review. To assess the quality, validity, and applicability of the study to the research questions, the full-text screening finally focused on the methods and results paragraph. This was done since the results part gives a comprehensive overview of the study's findings, while the methods section contains essential information regarding the study's design, data collecting, and analysis (Higgins et al., 2019). Consequently, the final quality of the review may thus be improved by giving these sections priority.

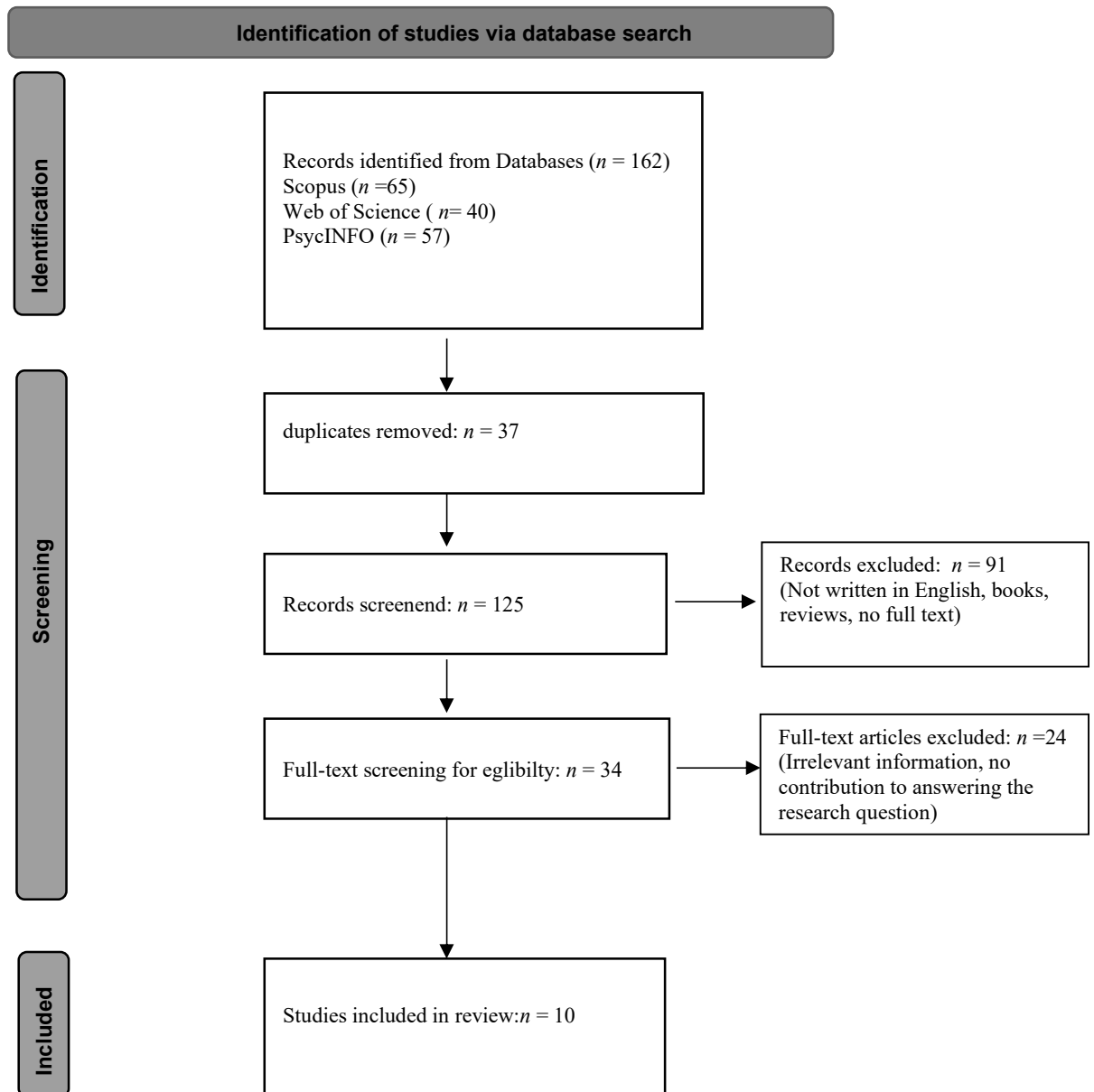
### **Summary of the included studies.**

The full text of the studies that were obtained in the search process and that met all pre-defined inclusion criteria were read and evaluated in relation to the goals of this scoping review. The first area of interest was the population which used the apps for self-injury and if

the apps are more frequently used in conjunction with blended care or as standalone therapies. Therefore, an overview of the demographics and characteristics of the populations can be found in Table 2. Moreover, Table 3 displays how the apps are used in a therapeutic context. Additionally, to provide a better understanding of the included studies of the review, information about the study design and therapy approach of the mobile applications was incorporated in Table 3 as well. When studies did not provide the above-mentioned information, this was indicated as "not available."

Another objective that was investigated was the user experience concerning usability and which features are most often integrated into the apps. Therefore, information regarding particular app features that users found useful or unpleasant as well as any recommendations they had for enhancing the general design and usability were retrieved and inserted in the Table. If the studies did not examine the relevant data, this was indicated as "not available."

Furthermore, it was investigated how effective the apps were in reducing self-injurious behaviours, feelings related to this and how the included studies conceptualized self-harm. Therefore, data about the outcome measures used to assess self-harm behaviours and related feelings were summarized in Table 4. Lastly, conceptualisations of self-injury were summarized in the table as well.

**Figure 1***Flow diagram on the study selection process*

## Results

This scoping review assessed, among others, the effectiveness and usability of several mobile applications in treating self-injurious behaviours and associated feelings based on 10 research studies. These 10 studies examined mobile interventions that aimed to have a beneficial impact on the treatment of self-harm behaviours and related constructs. Moreover, as some of the included studies also aimed to examine the technology design, the usage of these apps and their target group, this review also focused on these points.

### Participant Characteristics

The characteristics of the investigated populations are summarized in Table 2 below. The included studies' populations were only to some extent diverse. The population that was addressed the most with the mobile applications were adults older than 18 years ( $n = 6$ ), the remaining four studies focused on adolescents until the age of 18 ( $n = 1$ ) and adolescents and young adults ( $n = 3$ ). Eight out of the ten investigated populations actively engaged in self-harm behaviours or had a history of these in the past. The last population were U.S. service veterans in active treatment with suicidal ideation ( $n = 1$ ), see Table 2. Regarding the gender of the participants, in one study the targeted group were only females, while in the remaining 9 studies the majority ( $> 50\%$ ) were females as well. Besides, only three studies reported to have included small groups of non-binaries or others ( $< 14\%$ ). Lastly, the majority of the studies were conducted in countries with Western culture, therefore in the USA ( $n = 5$ ), Latin America ( $n = 1$ ) or Europe ( $n = 3$ ). Only one study was conducted in Oceania, namely in New Zealand. Looking at the sample sizes of the investigated studies, the majority of the studies used rather small samples ( $< 30$  participants) for the examination of their mobile application ( $n = 6$ ). Only three of the studies used bigger samples with more participants ( $> 100$ ).

**Table 2***Participant demographics*

	First Author	Sample, self-harm related behaviours or emotional states and sample size (N)	Gender	Age	Country
1	Bush, N., (2017)	U.S. service veterans in active treatment with suicidal ideation N = 118	Male (75%) Female (25%)	Older than 18 years Enhanced usual care: M = 48.67; SD = 14.31  VHB: M = 46.50; SD = 13.75	USA
2	Franklin, J. C., (2016)	Participants from online discussion boards on self-injury who had two or more incidents of self-cutting in the previous month N = 131	Female (74%) Male (26%)	Older than 18 years (M = 22.91; SD = 4.99)	USA

3	Kruzan, K. (2022)	Young individuals without current therapy who had experienced NSSI N = 20	Female (65%) Male (10%) Non-binary (5%)	18 – 24 years old (M = 20.7; SD = 2.2)	USA
4	Kruzan, K. (2021)	Individuals with current and chronic NSSI history N = 131	Female (67.9%) Male (18.3%) Non-binary/ other (13.8%)	16 – 25 years old (M = 20.32; SD = 2.52)	USA
5	Prada, P., (2017)	Participants who showed self-harm behaviours, selected from a specialist institution for BPD patients' care and treatment N = 16	Female (100%)	18 - 50 years old (M = 30.5; SD = 9.3)	CH
6	Rizvi, S. L., (2016)	Adults seeking comprehensive DBT at a DBT clinic based at a mid-Atlantic university, who fulfilled the	Female (75%) Male (25%)	19 – 49 years old (M = 27.50; SD = 7.71)	USA

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		criteria for BPD and had a recent history of recurrent non-suicidal self-injury N = 16			
7	Rodante, D. E., (2022)	Participants who attended a DBT Skills Training session run by the FORO Foundation for at least a month before the study's start, and had engaged in self-harming behaviour during the previous month N = 21	Female (64%) Male (36%) Female (100%)	18 – 65 years old DBT + CALMA: (M = 31.82; SD = 6.94) 18 – 65 years old DBT: (M = 27.70; SD = 6.60)	ARG
8	Stallard, P., (2018)	persons who were actively self-harming or had a history of self-harming between the ages of 12 and 17 N = 44	Female (90%) Male (10%)	12 – 17 years old (M = 16.0; SD = 1.4)	UK
9	Schiffler, T., (2022)	BDP-diagnosed former patients from a transitional mental facility who are experiencing NSSI N = 13	Female (99%) Male (1%)	15- 26 years old (M = 20.1; SD = 1.6)	AUT

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10	Thabrew, H., (2023)	“Young people experiencing low mood, thoughts related to self-harm, and suicidal ideation,, N = 26	Female (65%) Male (23%) Non-binary (12%)	16 - 25 years old (M = 17.7)	NZL
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### **Study characteristics**

The characteristics of the researched studies are compiled in Table 3 (see below). Most of the included studies applied a randomized controlled trial (RCT) (n = 4). Other studies applied a qualitative design (n = 1), a pilot study design (n = 2), a longitudinal design (n = 1), a mixed-methods design (n = 1) or a pre-post-test design (n = 1).

Regarding the design of the different applications, five apps contained a range of different features like mood trackers, diaries or mindfulness exercises. In two studies, the app was a support app, which was designed to provide mental health support if needed. Besides, one study was designed like a game, which provided the users with psychoeducation and other exercises. Moreover, another study did not exactly mention their included design features and the app of the remaining study was designed with a 10-point Likert scale that also provided no further described exercises to their users for distraction.

Examining the usability and user experience of the applications, one study was rated by clinicians as a helpful extra therapeutic tool. Moreover, five apps were rated as helpful and easy to use by their users. Contrary to this, one app was rated as being boring for users who are already familiar with DBT exercises and as being a tool rather for emergencies than for regular use. Besides that, some studies did not provide information about the user experience or usability (n = 3).

Information about the treatment setup was also summarized in Table 3. Here, the majority of the incorporated apps are intended to be used as a stand-alone treatment (n = 5). Three studies did not state how they intended the implementation of their applications and the remaining studies incorporated apps that should be used as a blended-care treatment (n = 2).

**Table 3***Study Characteristics and Usability/Feasibility of the included mobile apps*

	First Author	Research Design	Intervention	Conditions	Description	App features	Stand-alone treatment or blended care	Usability
1	Bush, N., (2017)	Parallel Group Randomized Controlled Trial	Control group; VHB Group		“Smartphone app to improve stress coping skills, suicidal ideation, and perceived reasons for living among patients at elevated risk of suicide and self-harm”	The hope box = a virtual box that contains things of happy memories like pictures of kind people, coping mechanisms, or reasons to live	n.a	The VHB was valued by clinicians as an extra therapeutic tool
2	Franklin, J. C., (2016)	Randomized Controlled Trials	TEC group; Control group		“Game-like app (Therapeutic Evaluative Conditioning (TEC)),	Game-like design, meant to be played multiple times,	Stand-alone treatment	n.a

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				designed to increase aversion to SITBs and decrease aversion to the self”	psychoeducation about self-injury, cognitive restructuring exercises, and evaluative conditioning tasks		
3	Kruzan, K. (2022)	Qualitative Research	One condition	„Understand self-management practices of young adults who engage in NSSI, explore how they currently use technologies for self-injury self-management and identify the ways they can envision an app-based technology supporting their self-management“	n.a	Stand-alone treatment	<p><b>Participants liked:</b></p> <p>Safe connection to social support;</p> <p>Tracking patterns for improved self-knowledge;</p> <p>Support for mental health and self-injury needs</p> <p><b>Dislike:</b></p> <p>preferences for in-person support;</p> <p>alerts without</p>

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							context or personalisation
4	Kruzan, K. (2022)	Small-scale Randomized Controlled Trial	Intervention group; control group	“Efficacy of the use of a peer support app, TalkLife, in reducing NSSI frequency and urges and increasing readiness to change”	TalkLife = provides young people with immediate and informal mental health support	Stand-alone treatment	n.a
5	Prada, P., (2017)	Pilot Study	One condition	“EMOTEO to help borderline personality disorder (BPD) patients to monitor and regulate their inner tension”	Contains an analogic visual scale, which selects an exercise for distracting the patient	Stand-alone treatment	After the app's initial trials, participants weren't bored or turned off from using it; Generally positive reviews for usage, acceptability, and satisfaction.
6	Rizvi, S. L., (2016)	Pilot Study	One condition	“App designed specifically to augment skills generalization	Mindfulness exercises, emotion regulation techniques, and	Blended care treatment	Participants found the app easy to understand and use;

				through interactive coaching in DBT skills”	distress tolerance skills; mood and behaviour trackers, goal setting, reminders to use the app regularly		Found it helpful and recommended it
7	Rodante, D. E., (2022)	Pilot Cluster Randomized Controlled Trial	DBT group (control group); DBT + CALMA group	“CALMA (DBT-based app) as an adjunct to therapy targeting non-suicidal and suicidal self-injury behaviour”	Mood tracker, daily diary, mindfulness exercises, breathing exercises, crisis support resources	Blended care treatment	n.a
8	Stallard, P., (2018)	Open Phase 1 Pre-Post Trial	One condition	“App (Blueice) designed to help young people manage distress and urge to self-harm, Blueice is a personalized toolbox of	Mood diary, a menu of personalized mood-lifting activities, automatic routing	Stand-alone treatment	<b>Post-use ratings:</b> high for ease of use (8.9, SD=1.2); Recommend BlueIce (8.6, SD=1.6);

				strategies based on CBT and DBT”			lower for helpfulness (6.6, SD=2.2); 29 of the 33 interviewed (88%) wanted to keep the app
9	Schiffler, T., (2022)	Longitudinal Qualitative Study	One condition	“Smartphone app (TalentLMS) for knowledge and learning management with content from DBT”	Mindfulness exercises, emotion regulation strategies, distress tolerance techniques, crisis support resources	n.a	<b>Participant report:</b> More suitable for inexperienced people (boring); More for emergencies than long term
10	Thabrew, H., (2023)	Mixed Methods Pilot Open Trial	One condition	"Communication app that helps young people experiencing low mood, self-harm, or suicidal ideation connect with a self-nominated support	Guide to creating messages, information about communication, common mental health issues	n.a	The majority of respondents believed it would enhance the likelihood of future help-seeking,

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network of peers or  
family members“

giving the app a  
mean rating of 3.8  
(range 2.7-4.6) out  
of 5 on a 5-point  
scale for app  
quality and an  
overall star rating  
of 3.4 out of 5 for  
subjective quality  
(3.9 out of 5)

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*Note.* dialectical behaviour therapy (DBT), Therapeutic Evaluative Conditioning (TEC), Virtual Hope Box (VHB)



### **Conceptualizations, Measurements, and Findings (Effectiveness)**

6 out of the 10 studies that employed a conceptualization of self-harm classified self-harm as an act of self-injury without suicidal intent ( $n = 6$ ). Moreover, the majority of these six studies referred to self-cutting as self-harm behaviour ( $n = 3$ ), while one of these studies also referred to other behaviours like head banging or burning ( $n = 1$ ) and another two included self-poisoning in their conceptualization ( $n = 2$ ). Of the remaining four studies, three studies did not mention how they conceptualise self-injury ( $n = 3$ ) and the last remaining study only referred to self-harm as distress management without explaining it more specifically ( $n = 1$ ). Table 4 provides a summary of the various conceptualizations that were provided (see below).

Regarding the outcome measures that were used to assess the effects of mobile applications on self-harm or self-harm-related constructs, several measurement instruments were found. One instrument that was used by more than one study, was the Self-Injurious Thoughts and Behaviour Interview (SITBI) ( $n = 3$ ). Moreover, three studies used interviews to assess the outcomes of the applications ( $n = 3$ ). Another study used the Alexian Brothers Urge to Self-Injure Scale (ABUSI) and the Non-Suicidal Self-Injury Assessment Tool (NSSI-AT) to assess self-harm urges and frequency ( $n = 1$ ). The remaining studies used instruments which measured constructs related to self-harm, for example, the Coping Self-Efficacy Scale (CSES) ( $n = 1$ ), the Difficulties in Emotion Regulation Scale (DERS) ( $n = 1$ ) or among others the Emotion Regulation Questionnaire (ERQ) ( $n = 1$ ). The whole variety of the used outcome measures in the different studies can be found in Table 4.

The following findings were made when looking at the efficacy of mobile apps in the treatment of self-harm behaviour and related constructs. Out of the seven studies that directly focused on treating self-harm behaviours, all studies found that mobile applications might be a good instrument to treat self-harm ( $n = 7$ ). Here, out of these seven studies, in six studies,

the frequency of self-harm behaviours decreased significantly, while in one of these studies, the urges to self-harm decreased. The remaining study did not directly measure the effectiveness of a mobile app but rather investigated how users envision an app supporting them (n = 1). This study found that the studied population already uses existing applications for self-management and information/support seeking. Regarding self-harm-related constructs, the other studies measured aversive tension (n = 1) and the ability to cope with unpleasant feelings (n = 1). These characteristics are associated with NSSI because those who feel high levels of aversive tension and have weak coping mechanisms may be more inclined to use NSSI to lessen their emotional suffering. Both studies discovered that mobile therapies may be a useful and efficient tool to lessen aversive stress and improve coping skills (n = 2).

Moreover, most of the included studies which used a control group, found that the control group showed less decrease in self-harm urges and frequency compared to the intervention group (n = 3) or showed less positive coping abilities (n = 1). Lastly, measures were taken at different points during the studies. Here, 9 out of the 10 studies started their research with a baseline measure and some of them ended with a last measure after 3 months (n = 5). Therefore, no study investigated the effects of their app after this period. Some of the remaining studies also measured the effects after 4 weeks into the intervention (n = 6). Table 4 shows all findings regarding the effectiveness of mobile applications in reducing self-harm or related constructs.

**Table 4***Conceptualizations, Measurements and Findings (Validity or Effectiveness)*

	Author	Conceptualizations of self-harm	Self-harm-related outcome measures	Moment of assessment	Findings (effectiveness)
1	Bush, N., (2017)	n.a	CSES	Baseline, three, six, and 12 weeks	Significantly greater ability to cope with unpleasant emotions and thoughts. This difference was evident at both three weeks ( $b=2.41$ , 95% CI=.29–4.55) and 12 weeks ( $b=2.99$ , 95% CI=.08–5.90) into the study
2	Franklin, J. C., (2016)	NSSI: cutting or burning without suicidal intent	SITBI ERS BSI IDB	Baseline, during the treatment weekly, after monthly	A significant decrease in self-cutting episodes ( $B = -.38$ , $SE = .07$ , $IRR = .68$ , $p < .001$ ) and self-cutting frequency, which decreased as the active TEC dosage increased; Significantly fewer overall NSSI behaviours ( $B = -.44$ , $SE = .06$ , $IRR = .64$ , $p < .001$ ), with a significant decrease as the active TEC dose increased

3	Kruzan, K. (2022)	self-harm is a way to manage distress and related emotional states	“Semi-structured interview with questions related to (1) managing mental health and self-injury, (2) technology use in mental health self-management, and (3) imaged use of an app,,	One assessment	“users have varied experiences with, and goals related to, NSSI; lack of effective strategies to reduce NSSI urges; A desire for an app-based technology to track patterns and deliver personalized suggestions for self-management; existing use of technologies as part of self-management, early information and support seeking for NSSI online,,
4	Kruzan, K. (2022)	Nonsuicidal self-injury (NSSI)—“the deliberate damage of body tissue without suicidal intent”	<b>NSSI Frequency:</b> NSSI-AT <b>NSSI Urges:</b> ABUSI	Baseline, 8-time points during the study, 1 and 2 months follow up	“Peer support app condition injured themselves less throughout the study (M = 1.30, SE = 0.18) than participants in the control condition (M =1.62, SE = 0.18; P =.02; H1i),,
5	Prada, P., (2017)	„nonsuicidal acts of self-injury (self-cutting, banging the head against the wall, burning oneself), which are deemed to be maladaptive behaviours	ALS DERS PANAS ERQ	Baseline, 6 and 12 weeks	A statistically significant decrease in aversive tension was found. The average aversive tension measured at starting the app was M = 5.95 (SD = 3.13), and the use of the app was

					aiming at rapidly reducing aversive states and the related negative emotions that accompany it“	associated with a decrease of $M = 2.83$ ( $SD = 2.36$ ) points (paired t-test = 3.18; $p < .05$ )
6	Rizvi, S. L., (2016)	n.a	SITBI Participant ratings	Pre-treatment, mid and posttreatment, and 3-month follow-up (SITBI)		Hierarchical Linear Modeling (HLM) analysis showed that the use of the app significantly reduced urges to self-harm. Before app usage, the average urge level was 1.75 ( $SD = 2.67$ ), after using the app, it was 1.13 ( $SD = 1.97$ ). The regression coefficient was -0.61 ( $SE = 0.15$ ), $t(721) = -4.10$ , $p < .001$ . In 30% of the sessions, urges to self-injure were reduced, in 67% of the sessions, the pre-and post-ratings remained the same.
7	Rodante, D. E., (2022)	n.a	SITBI	Baseline, after 4 weeks		DBT+CALMA group had a high probability of decreased suicidal ideation ( $p = 0.966$ ), plan ( $p = 0.849$ ), gesture ( $p = 0.760$ ), and non-suicidal

					self-injury ( $p = 0.826$ ) compared to the control group
8	Stallard, P., (2018)	“Self-harm: the intentional self-poisoning or self-injury, irrespective of the type of motive or the extent of suicidal intent,,	Self-report interview	Baseline, post familiarization (2 weeks), post use (12 weeks)	43 participants reported no self-harm in the 4 weeks before baseline assessment; 26 participants reported self-harm in the 4 weeks before the baseline assessment  Of these 26 participants, 4 completely stopped self-harming and 15 reported less frequent acts of self-harm at follow-up; 7 participants reported no reductions in their self-harming behaviour over the 12-week trial
9	Schiffler, T., (2022)	Self-destructive behaviour; “NSSI mostly takes the form of superficial cuts to the wrists and arms with non-suicidal intent,	Individual Semi-Structured Interviews Qualitative Text Analysis	Baseline, After 4 weeks	NSSI was slightly less frequent during the follow-up, when the second interview was conducted, most

		but is based on the emotion-regulatory problems of the affected person,,			respondents reported having reduced acute NSSI sessions
10	Thabrew, H., (2023)	“Self-harm is defined as intentional self-injury or self-poisoning, irrespective of the extent of suicidal intent,,	quantitative outcome measures (not specifically stated)	Baseline, 4 weeks, and 3 months	None of the study subjects who were interviewed at the end of the investigation mentioned any instances of self-harm or hospitalization while they were enrolled

*Note.* Self-Injurious Thoughts and Behaviour Interview (SITBI), Affective Lability Scale (ALS), Difficulties in Emotion Regulation Scale (DERS), Positive and Negative Affect Schedule (PANAS), Emotion Regulation Questionnaire (ERQ), Alexian Brothers Urge to Self-Injure Scale (ABUSI), The Non-Suicidal Self-Injury Assessment Tool (NSSI-AT), Emotion Reactivity Scale (ERS), Brief Symptom Inventory (BSI), Index of Dysregulated Behaviours (IDB), Coping Self-Efficacy Scale (CSES).

## Discussion

### Answers to Research Questions and Links to Previous Research

After the examination of the studies was finished, the following key findings can be presented. Firstly, the studies used several research designs for their investigation. This indicates that researchers from the field already investigated the topic in several ways to gain insights into various aspects for example how e-health applications in the field work and how they can be effectively used. Additionally, employing a variety of research designs can help to improve the validity and reliability of the results, which ultimately benefits the generalization of the results (Zohrabi, 2013). The majority of studies used a randomized controlled trial to evaluate the effectiveness of their mobile application for the treatment of self-harm. Here, the use of RCTs allows researchers to systematically compare treatment outcomes among both randomized intervention and control groups and thereby offers a standardized and comprehensive framework that reduces biases, controls for potential confounders, and ensures statistical power (Deaton & Cartwright, 2018). Therefore, this increases the validity of the research findings and promotes the use of evidence-based judgment in the field of self-harm interventions (Spieth et al., 2016). Furthermore, alongside the predominant use of randomized controlled trials, some researchers have also employed mixed-methods approaches and pilot studies to gain a comprehensive understanding of the effectiveness and feasibility of mobile applications for self-harm treatment.

Looking at the investigated populations, the review by Cliffe et al. (2020) found that most studies reported having included more female than male participants. This coincides with the findings of this current review, where also the majority of the investigated populations were females. This finding is a bit surprising, as other research in this field did not find significant gender differences regarding self-harm behaviours (Victor et al., 2018). Therefore, studies that examine the use of mobile applications for self-injury treatment



appear to have a disproportionately female participant population, which creates the impression that female populations have used these mobile applications more frequently than male populations. Another similarity between the current review and the one by Cliffe et al. (2020) is that neither review included any studies that focused specifically on children, instead both reviews mostly included studies that focused on young adults. This finding is not surprising, as the groups that are mostly affected by self-harm behaviours are adolescents and young adults, as it is estimated that approximately 17% of adolescents and young adults have engaged in NSSI at some point in their lives (Swannell et al., 2014). Lastly, it is noteworthy that the majority of the included studies in this review were conducted in Western cultures like the United States. This concentration of studies in one culture has implications for the diversity of the investigated populations, as the findings may not be representative of self-harm behaviours and the use of mobile applications for self-injury treatment in other cultural contexts or countries with different healthcare systems, social norms, and access to technology (Cooper et al., 2010).

Considering the usage of apps in the treatment of NSSI, this review found that the majority of the investigated apps are used as standalone treatments. This can be seen as a positive finding, as stand-alone applications can be used by those who might not have access to therapy and thus increase the provision of support to individuals who would otherwise face barriers to accessing traditional therapeutic resources. (Proudfoot, 2013). Furthermore, standalone apps provide a potentially accessible and cost-effective alternative compared to classical therapy, allowing users to engage in self-help interventions and receive support remotely, thus expanding the reach and availability of resources for those in need and therefore enhancing treatment outcomes (Torous et al., 2021). Lastly, stand-alone treatments can be employed at the user's speed and in their environment, which may increase usability and user satisfaction.

Regarding the design of the apps and their effect on the user experience, this review found that most of the users were satisfied with the usability of the apps and found them helpful, easy to use and would recommend them. Only one app from the study of Schiffler et al. (2022) reported that user satisfaction was a bit lower, as the user reported that the app might be boring for someone who is already familiar with DBT and related skills and that is more suitable for short-term emergencies than for long-term use. Furthermore, most of the apps included different modules with different features like mood diaries, emergency contacts and coping skills. Here, mood trackers and journals were the most frequently integrated tools. This finding is in line with what other researchers found, for example, Cliffe et al. (2020) also stated that most of the apps are designed with different features and that the majority of these were mood diaries, coping skills and support in emergencies. Overall, the design of the different apps already seemed to be good, as most of the studies described low dropout rates and high user satisfaction. As a result, apps should continue to emphasize offering a variety of features in the future because doing so increases the likelihood that a user will find a feature that works for his particular circumstance and therefore leads to improved engagement and effectiveness in addressing self-harm behaviours. Additionally, in terms of the user experience, it would appear crucial to give each user the option of customizing their care.

Fifth, most of the investigated studies conceptualized self-harm as an act of self-injury without suicidal intent and referred to self-cutting as the most often occurring form of self-harm. Moreover, some of the investigated studies pointed out that self-harm is a maladaptive coping mechanism to regulate difficult emotional states and arousal. This finding is in line with conducted research by Mikolajczak et al. (2009) and underlines the importance of treatment.

Lastly, this review sought to investigate the effectiveness of mobile apps in the treatment of self-harm behaviours and related states. Here, the findings suggest that all of the investigated apps had a positive influence on their users, as either the frequency or the urges to self-harm significantly decreased during the treatment and also in the follow-ups of most of the apps. Moreover, this suggests that, with further research and development, mobile apps indeed have the potential to become increasingly effective tools in addressing self-harm behaviours and related states, since they already appear to create significant benefits. However, although these results appear encouraging, it has been suggested that it is not wise to just depend on them because a decline in self-harm might also indicate that each episode has grown more severe or that a different form of self-harm behaviour has taken its place (Owens et al., 2020). Therefore, apps seem to be a valuable tool in the treatment which provides a lot of opportunities in the future, but one should not fully rely on their effectiveness. Also noteworthy is the fact that the effectiveness of most of the included applications was evaluated for the last time after a 12-week follow-up period or even before, so there is no clear information about the long-term effects. As a result, researchers should not rely on the body of current evidence to predict what these applications' long-term effects will be in the future. Therefore, the significance of taking into account any potential discrepancy between short-term and long-term outcomes is highlighted by this constraint.

### **Strengths and Limitations**

This scoping review was conducted following the PRISMA guidelines for reviews (Moher et al., 2009), which can be outlined as a strength. Another strength of this research is the conduction of the literature search in three different databases as this also ensured to get more hits and more appropriate studies for the final inclusion later on. Moreover, this scoping review has the strength of being useful as it helps to reveal gaps and inconsistencies in current research in the field of e-health applications in the treatment of self-harm behaviours.

These gaps can then guide the development of future studies and interventions, leading to a more comprehensive and robust evidence base.

Nevertheless, this review also encountered certain limitations, for example, excluding non-English articles might have limited its transparency by possibly overlooking crucial research that was written in another language. Moreover, as this thesis was conducted as a scoping review instead of a meta-analysis, its outcome has low statistical power. As a result of this, the generalization of the findings is not possible due to the lack of a quantitative synthesis of the results.

### **Implications for Future Research**

Mobile applications can be a valuable tool in the treatment of self-harm behaviours and related emotional states, as they can be an effective way to help reduce urges and frequencies of self-harm sessions. Nevertheless, there are several implications further research in this field should pay attention to. First, this review found that previous research often has been limited to females above the age of 18 years, highlighting the need to investigate understudied groups such as children and males. This is important as the gender gap in self-harm behaviours seems to be closing as the number of men who self-harm is increasing (Clements et al., 2019), stressing the need for effective treatment also for males. Regarding children, it would be important to investigate this group in this context as well, as children tend to have limited coping skills, difficulty expressing their emotions, and a limited understanding of alternative strategies for dealing with distress, because of their age (Compas et al., 2014). Here, researching effective treatment strategies designed especially for them can help to provide tailored interventions that suit their specific needs and encourage healthier coping techniques. Moreover, as a lot of the included studies predominantly focused on a specific country context (Western culture), the generalizability of the findings to global populations becomes limited. This is because self-harm behaviours and their treatment may

vary across cultures, influenced by factors such as cultural attitudes towards mental health, stigmatization, and available resources (Cooper et al., 2010). Therefore, future research should strive to include diverse populations from various geographical locations, especially non-Western countries, to gain a more comprehensive understanding of how self-harm manifests and how mobile applications can effectively support individuals in these regions.

Another implication is that the outcome measures of effectiveness were often restricted to a reduction in the frequency of sessions or the urges to self-harm. Even though this evaluation may be a useful tool for assessing the possible impact an app may have on its users, it may be wise to think about evaluating additional factors as well, such as other self-destructive behaviours that were not mentioned or the intensity of the self-harm sessions, as these factors may provide a more comprehensive understanding of the app's impact on users' overall mental well-being.

A further notable point is that the majority of studies used RCTs to evaluate the applications. Although RCTs have long been regarded as the most favourable research approach, the speed at which digital therapies are developed and evolved makes it possible for the obtained data to be out of date before the trial is even finished (Morrison, 2001). Because of this, future research should also take into account employing other study designs, such as qualitative studies, as they can give additional information about why particular apps are beneficial to use, rather than just giving information about their effectiveness, this implication is also in line with previous research from Cliffe et al. (2020).

The last implication for research in the future is, that it should also focus on how the available applications could be used and integrated into clinical care. Here, it should be explored how these apps can enhance treatment outcomes in already existing clinical services such as in-person therapy. Given that several applications have already been developed that are seen as complementary to treatment, it would be worthwhile to look into this.

Lastly, another rather future-oriented aspect is, that it is essential to promote the ongoing development and collaboration between app developers and mental health professionals in the field. Here, by embracing advancements in technology and fostering partnerships, the full potential of mobile apps in addressing self-harm behaviours can be harnessed (Čuš et al., 2021). This advice, therefore, highlights the significance of continuously improving and refining the available interventions to provide individuals with increasingly effective and tailored support, ultimately contributing to better mental health outcomes.

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