

Article

Digital Therapeutic Interventions for Suicide Prevention: A Systematic Review and Meta-Analysis of Their Effectiveness in Reducing Suicidal Ideation and Suicide Attempts

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ARTICLE INFO

Received: 21/02/2026

Accepted: 23/03/2026

Keywords:

Suicide
Digital intervention
Meta-analysis
Prevention
Mental health

ABSTRACT

Background: Although digital interventions show potential for reducing suicidal ideation and behavior, the evidence base is mixed and characterized by methodological variability. This study synthesizes randomized clinical trials that have evaluated their effectiveness. **Method:** We conducted a systematic review and meta-analysis in accordance with PRISMA guidelines. Seventeen studies ($N = 5,089$) met the inclusion criteria. Effect sizes were estimated using random-effects models, and we conducted analyses for type of control group (traditional vs. active), moderators (age, delivery setting, and intervention format), and follow-up. Heterogeneity and publication bias were also examined. **Results:** Digital interventions significantly reduced suicidal ideation ($g = -0.61$), with effects maintained at follow up ($g = -0.77$). Significant effects were observed with respect to both traditional and active controls. There was a moderate reduction in relative risk of suicide attempts, although it was not statistically significant. Moderator analysis indicated a greater effect for clinical populations, self-guided interventions, and younger participants. There was no robust evidence of publication bias. **Conclusions:** Digital interventions may represent a promising complementary approach for reducing suicidal ideation and potentially lowering suicide risk. However, the findings should be interpreted cautiously given the heterogeneity of the studies and the limited evidence regarding suicide attempts.

Intervenciones Terapéuticas Digitales para la Prevención del Suicidio: una Revisión Sistemática y Metaanálisis de su Eficacia en la Reducción de la Ideación Suicida y los Intentos de Suicidio

RESUMEN

Antecedentes: Las intervenciones digitales han mostrado potencial para reducir la ideación y la conducta suicida, pero la evidencia disponible es heterogénea. Este estudio sintetiza los hallazgos de ensayos clínicos aleatorizados que han evaluado su eficacia. **Método:** Se realizó una revisión sistemática y metaanálisis siguiendo las directrices PRISMA. Se incluyeron 17 estudios ($N = 5,089$). Los tamaños del efecto se estimaron mediante modelos de efectos aleatorios y se realizaron análisis por tipo de grupo control, moderadores (edad, contexto y modalidad), seguimiento, heterogeneidad y sesgo de publicación. **Resultados:** Las intervenciones digitales redujeron significativamente la ideación suicida ($g = -0.61$), manteniéndose los efectos en el seguimiento ($g = -0.77$). Se observaron efectos significativos frente a controles tradicionales y activos. En los intentos de suicidio se observó una reducción del riesgo de magnitud moderada, aunque sin significación estadística. Los efectos fueron mayores en muestras clínicas, intervenciones autoguiadas y participantes jóvenes. No se detectó sesgo de publicación robusto. **Conclusiones:** Las intervenciones digitales pueden constituir una estrategia complementaria prometedora para reducir la ideación suicida y potencialmente disminuir el riesgo suicida. No obstante, los resultados deben interpretarse con cautela debido a la heterogeneidad de los estudios y a la limitada evidencia disponible sobre los intentos de suicidio.

Palabras clave:

Suicidio
Intervenciones digitales
Metaanálisis
Prevención
Salud mental

Suicide is a major public health problem worldwide. The World Health Organization (2021) estimates that more than 700,000 people die by suicide each year, making it one of the leading causes of death. Suicidal behavior is currently understood as a complex and multifactorial phenomenon that must be interpreted within individuals' biographical, social, and cultural contexts, as well as broader social determinants shaping trajectories of suicide risk across the life course (Al-Halabi & Fonseca-Pedrero, 2024; Hawton & Pirkis, 2024). From a psychological perspective, this view is broadly consistent with the Fluid Vulnerability Theory of suicide, which proposes that suicide risk emerges from the interaction between relatively stable vulnerabilities and dynamic suicidal states that fluctuate over time (Rudd, 2006). In this regard, it is important to distinguish between suicidal ideation, which refers to thoughts about death or killing oneself, and suicidal behavior, which includes suicide attempts. Although these phenomena are closely related, they are not interchangeable and may involve partly distinct mechanisms and intervention targets (Al-Halabi & Fonseca-Pedrero, 2024).

Despite advances in identifying risk and protective factors and in developing effective psychological interventions (Fox et al., 2020; Mann et al., 2021), important barriers to accessing care remain (Bryan et al., 2025). Many individuals experiencing suicidal ideation or behaviors do not seek or receive timely help due to factors such as self-reliance, low perceived need for treatment, and stigma toward mental health and help-seeking (Han et al., 2017). These barriers highlight the need for innovative approaches that complement traditional services and reach individuals who are reluctant or unable to engage in face-to-face care.

In this context, digital interventions have emerged as a promising alternative (Yosep et al., 2024). Mobile applications, online programs, self-guided platforms, telehealth, and blended models of care offer several advantages, including immediate access, the possibility of anonymity, scalability, and potentially reduced costs (Bryan et al., 2025).

Evidence from recent systematic reviews and meta-analyses shows mixed findings regarding the impact of digital interventions on suicidal ideation, with generally small but significant effects and persistent limitations related to adherence and maintenance over time (Burr et al., 2025; Büscher et al., 2020, 2022; Josifovski et al., 2025; Torok et al., 2020). In one of the earliest meta-analyses, Torok et al. (2020) reported small but significant reductions in suicidal ideation, particularly for interventions directly targeting suicidality. However, subsequent reviews have highlighted that effects vary depending on factors such as comparison group and participant age, with weaker or null findings in adolescents and when compared with active controls (Burr et al., 2025).

From a related perspective, some studies have examined telehealth interventions that include synchronous human contact. A meta-analysis of telephone- or video-based follow-up interventions found reductions in suicide rates and re-attempts, along with high acceptability, particularly among patients with depressive symptoms (Shoib et al., 2024). However, the substantial heterogeneity and the specific focus on telehealth limit the generalizability of these findings to other types of digital interventions.

A recent systematic review and meta-analysis of digital interventions targeting suicidality (Josifovski et al., 2025) concluded that these approaches produce small but significant reductions in suicidal ideation in clinical and community settings, but not consistently in educational contexts. Evidence for effects on suicidal

behaviors remained inconclusive. The authors also reported minimal differences between direct and indirect interventions and slightly stronger effects for self-guided formats in community samples, highlighting the influence of delivery setting and format on outcomes.

Complementing this literature, reviews focusing on specific therapeutic approaches have reported consistent positive effects on suicidal ideation, although evidence for reductions in suicide attempts remains inconclusive (Büscher et al., 2020, 2022). Similarly, a recent meta-analysis of digital psychotherapy based mainly on CBT and DBT identified moderate effects on suicidal ideation and depressive symptoms, albeit with considerable heterogeneity and a limited number of studies (Oh et al., 2024).

Overall, prior research suggests that digital interventions have meaningful potential to reduce suicidal ideation, although effect sizes are typically small to moderate. Outcomes appear to vary according to participant characteristics and delivery context, with less consistent findings in adolescents and educational settings. The literature is also marked by substantial methodological heterogeneity and limited evidence regarding suicide attempts. In addition, persistent concerns remain about participant retention, maintenance of effects, and the influence of comparison group type on observed outcomes.

In light of these limitations, the present study aimed to update and extend current knowledge regarding the effectiveness of digital interventions in reducing suicidal ideation and suicide attempts. We conducted a systematic review and meta-analysis of randomized clinical trials published between 2014 and 2025, covering recent technological developments and the post-pandemic period. Specifically, we examined (a) overall intervention effectiveness; (b) differences according to type of comparison group (traditional vs. active); (c) maintenance of effects over time; and (d) the moderating role of participant age, delivery setting, and intervention format. Between-study heterogeneity and potential publication bias were systematically assessed.

Method

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). The study protocol was registered in PROSPERO (International Prospective Register of Systematic Reviews; registration number: CRD420251266844).

Search Strategy and Inclusion Criteria

A systematic search was carried out in four electronic databases: Web of Science, PubMed, PsycINFO, and Scopus. The search strategy used different combinations of the following MeSh terms: "suicide prevention", "suicidal attempts", "suicidal behaviors", "suicidal ideation", "suicidality", "self-harm", "non-suicidal self-injuries", "hopelessness", "thwarted belongingness", "perceived burdensomeness" AND/OR "telemedicine", "telepsychiatry", "telehealth", "digital interventions", "combined treatment", "internet-based interventions (IBIs)", "ICBT", "IDBT", AND/OR "systematic review", "meta-analysis".

The inclusion criteria were: (a) randomized clinical trials evaluating digital interventions aimed specifically at reducing suicidal ideation or suicide attempts; (b) reports published in English or Spanish; and (c) publication between January 2014 and September 2025.

The following exclusion criteria were applied: (a) studies with non-experimental, observational or qualitative designs; (b) studies that did not report results related to suicidal ideation or suicide attempts; and (c) protocols, narrative reviews or any other type of study reporting non-empirical data.

Extraction and Coding of Data

Data were extracted using a standardized matrix comprising: (a) bibliographic and contextual information—authors, year of publication, and country where the research was conducted; (b) characteristics of the digital intervention—format (web, mobile app, hybrid program), duration, therapeutic content, and type of comparison group; (c) outcome variables and instruments used to evaluate them; (d) sample characteristics—size, delivery setting, age, gender, and details of follow-up assessments; and (e) main results reported.

For this meta-analysis we distinguished between two types of comparison group: (a) traditional (i.e., no treatment or waitlist controls); and (b) active comparators, where participants received an alternative intervention that had been previously evaluated and considered to be effective.

Data Analysis

Effect sizes were calculated based on the available data reported in each study (pre–post means and standard deviations, differences in means, comparative statistics, and—when possible—pre–post correlations). Suicidal ideation effect sizes were based on pre–post changes within each arm, whereas suicide attempts were analyzed using ratio-based comparisons between intervention and control groups. For suicidal ideation, we calculated standardized mean differences using Hedges' g so as to correct for small sample bias. For suicide attempts, we used ratio-based effect sizes (odds ratios or incidence rate ratios), transformed onto a logarithmic scale for the purposes of analysis.

Meta-analyses were estimated with random-effects models and the restricted maximum likelihood (REML) estimator, using the Comprehensive Meta-Analysis software (version 4; Borenstein et al., 2022) and the metafor package (Viechtbauer, 2010) in R (version 4.5.2). For each outcome we calculated the overall effect size with 95% confidence intervals, as well as Cochran's Q , P , and τ^2 to estimate heterogeneity. Heterogeneity was interpreted in accordance with the criteria of Higgins et al. (2003), such that values of P close to 25%, 50%, and 75% were considered to indicate low, moderate, and high heterogeneity, respectively.

For studies which did not report pre–post correlations, we imputed a value of 0.50, based on evidence suggesting high temporal stability in psychological scales used in clinical interventions (Balk et al., 2012; Cuijpers et al., 2017). This imputation, consistent with the recommended range in previous meta-analyses (0.50–0.70), accounts for the dependence between repeated measures when estimating the standard error (Hesser et al., 2011; Hofmann et al., 2012). To examine the robustness of this assumption, sensitivity analyses were conducted using an alternative correlation value ($r = 0.70$), yielding comparable results.

Possible publication bias was assessed visually using funnel plots and statistically with Egger's regression test (Egger et al., 1997),

with an intercept significantly different from zero being considered indicative of asymmetry.

For suicide attempts, we only included those studies that reported dichotomous measures or rates (e.g., total number of attempts, proportion of participants with at least one attempt or rates of attempts) and which provided sufficient information to estimate odds ratios with their standard errors. Following logarithmic transformation of effect sizes, we applied random-effects models, weighting each study by the inverse variance. Given the small number of studies and the limited variability across samples, we did not perform sub-group analyses for this outcome.

Methodological Quality of Included Studies

The methodological quality and risk of individual bias in the studies reviewed were assessed using Version 2 of the Cochrane Risk-of-Bias Tool for Randomized Trials (RoB 2; Sterne et al., 2019). This tool comprises five domains: (1) bias arising from the randomization process; (2) bias due to deviation from intended interventions; (3) bias due to missing outcome data; (4) bias in measurement of the outcome; and (5) bias in selection of the reported result. For each domain there are a series of signaling questions, the answers to which allow a judgment to be made as to the corresponding risk of bias for the domain in question, classified as low, some concerns or high risk. The overall risk of bias for a study is determined based on the judgments made across the five domains.

Results

Study Selection

Figure 1 shows the PRISMA flow diagram for study selection. A total of 370 records were identified through database searches and 7 through other sources. After removing duplicates, 255 records were screened and 96 full texts assessed for eligibility. When necessary, authors were contacted for missing data. Finally, 17 randomized clinical trials published between 2014 and 2025 were included in the review and meta-analysis.

Descriptive Characteristics of the Studies

Table 1 summarizes the main characteristics of the included studies.

Evaluation of the Risk of Bias

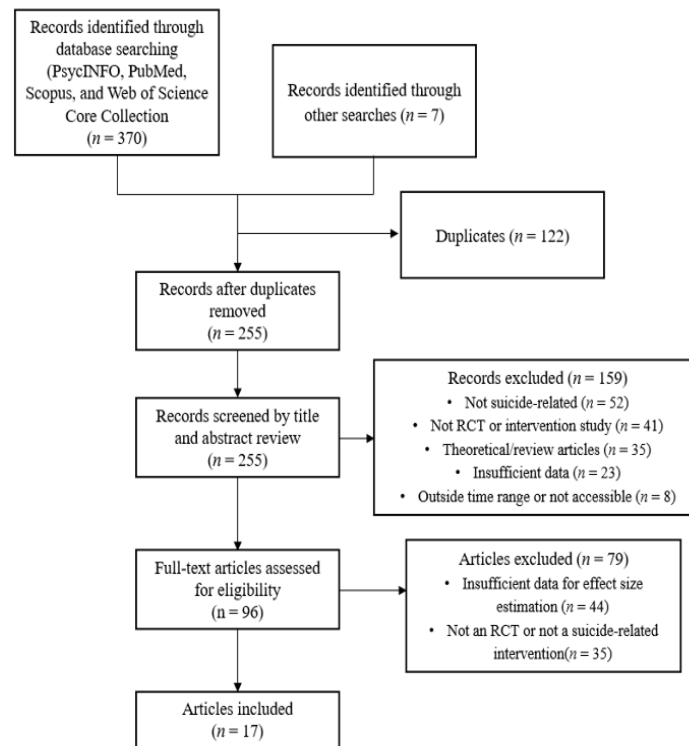
Based on the RoB 2 assessment (Sterne et al., 2019), most studies showed moderate or high risk of bias, with only a few trials judged to have low risk across all domains. Although randomization procedures were generally adequate, limitations included lack of masking, follow-up difficulties, high attrition rates, and reliance on self-reported outcomes. Overall, the findings should therefore be interpreted with caution.

Effect of Digital Interventions on Suicidal Ideation

The meta-analysis indicated a significant effect of digital interventions on suicidal ideation ($g = -0.61$, 95% CI $[-0.81, -0.40]$).

Figure 1

Flow Diagram of the Search and Selection Process

**Table 1**

Main Characteristics of Included Studies

Study	Country	n	Population	Age group	Format	Guidance	Comparison	Outcomes
Baker et al. (2024)	USA	96	Clinical	Adults	Web	Guided	Active	SI, SA
Batterham et al. (2018)	Australia	418	Community	Adults	Web	Self	Active/Traditional	SI
Batterham et al. (2021)	Australia	1986	Community	Adults	Web	Self	Active	SI
Bryan et al. (2025)	USA	339	Clinical	Adults	App	Self	Active	SI, SA
Burback et al. (2024)	Canada	42	Clinical	Adults	Web	Guided	Active	SI, SA
Bush et al. (2016)	USA	118	Clinical	Adults	App	Guided	Active	SI
De Jaegere et al. (2019)	Belgium	724	Clinical	Adults	Web	Self	Traditional	SI, SA
Eylem et al. (2021)	Netherlands	18	Clinical	Adults	Web	Guided	Traditional	SI, SA
Hetrick et al. (2017)	Australia	50	School	Adolescents	Web	Self	Active	SI, SA
Hill & Pettit (2019)	USA	80	Clinical	Adolescents	Web	Guided	Active	SI, SA
Kaskow et al. (2015)	USA	25	Clinical	Adults	Web	Guided	Active	SI
Li et al. (2019)	China	300	Clinical	Adults	Web	Self	Active	SI/SA
Lohani et al. (2024)	USA	82	Community	Adults	Web	Guided	Active	SI
Tighe et al. (2017)	Australia	61	Clinical	Adults	App	Guided	Traditional	SI
Torok et al. (2022)	Australia	455	Community	Young adults	App	Self	Active	SI, SA
van Spijker et al. (2014)	Netherlands	236	Community	Adults	Web	Self	Traditional	SI, SA
Wilks et al. (2018)	USA	59	Clinical	Adults	Web	Self	Traditional	SI

Notes. SI = suicidal ideation; SA = suicide attempts; Self = self-guided; Guided = intervention with human support; Traditional = waitlist/no treatment; Active = active comparator.

This effect size, of moderate magnitude, was the largest observed among the different clinical domains analyzed. Figure 2 displays the corresponding forest plot, showing the individual effect sizes, along with the 95% confidence intervals. Baker et al. (2024) and Li et al. (2019) assessed suicidal ideation but did not report sufficient data to calculate an independent effect size for this outcome and were therefore excluded from the quantitative synthesis.

Meta-analyses were estimated using a random-effects model, which is appropriate when true effects are expected to vary across studies. The analysis showed substantial heterogeneity ($Q(15) = 173.14, p < .001; I^2 = 91.35\%$). Despite this heterogeneity, the analysis of publication bias, using Egger's regression test, did not indicate significant asymmetry ($t(14) = 0.59, p = .56$), which suggests a low probability of bias in the distribution of effect sizes (Figure 3).

When studies were stratified by type of control condition, the magnitude of the pre-post improvement observed in the intervention groups remained significant both in studies including active comparators ($g = -0.44$; 95% CI $[-0.66, -0.22]$) and in those using traditional control conditions ($g = -0.34$; 95% CI $[-0.49, -0.18]$). Heterogeneity across studies was high in both cases (active controls: $Q(11) = 102.09, p < .01, I^2 = 83.85\%$; traditional controls: $Q(5) = 13.19, p = .02, I^2 = 62.10\%$), justifying the use of a random-effects model. Egger's regression test indicated no significant evidence of publication bias (active comparators: $t(10) = 1.74, p = .11$; traditional controls: $t(4) = 0.90, p = .41$), suggesting an absence of systematic asymmetry in estimates.

Follow-up analyses showed that improvements in suicidal ideation were maintained in the medium term in experimental

Figure 2

Forest Plot of Suicidal Ideation in The Experimental Group: Pretest-Posttest

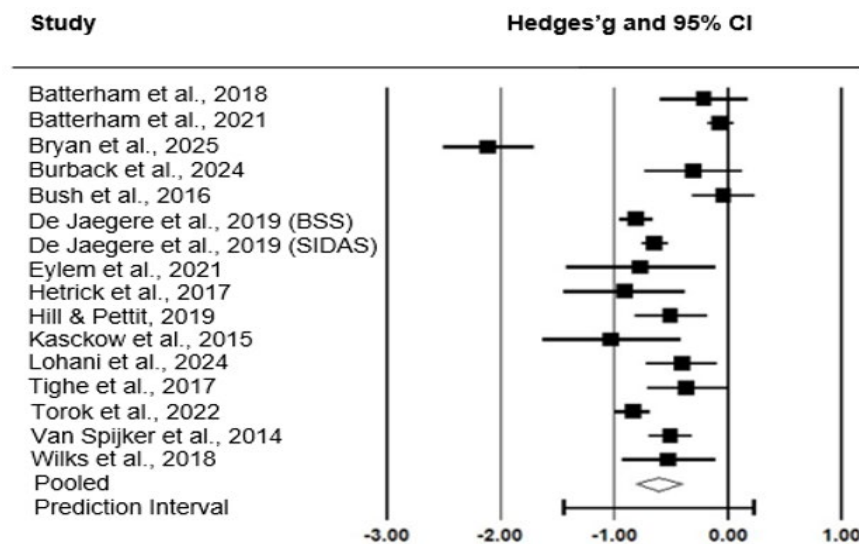
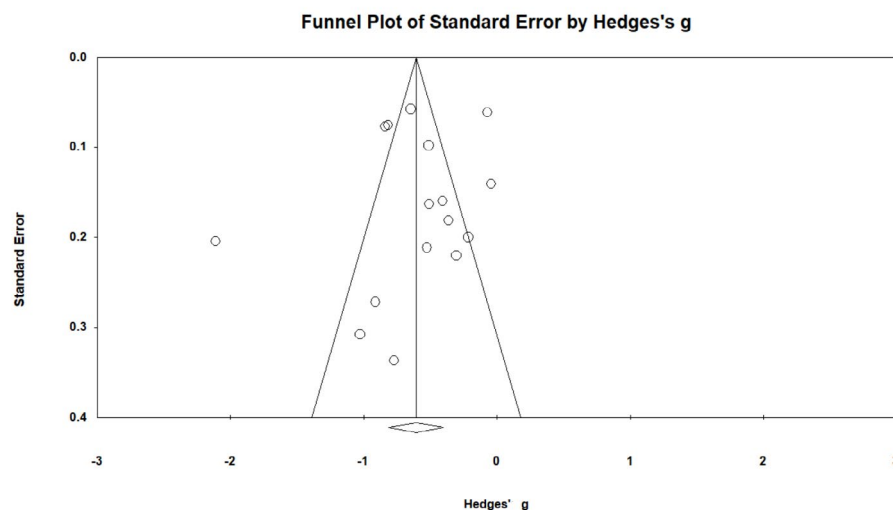


Figure 3

Funnel Plot of Suicidal Ideation in The Experimental Group: Pretest-Posttest



groups ($g = -0.75$; 95% CI $[-0.95, -0.55]$), and also in both traditional controls ($g = -0.57$, 95% CI $[-0.81, -0.34]$) and active comparators ($g = -0.49$, 95% CI $[-0.68, -0.29]$). Heterogeneity across studies was significant in all three contrasts (experimental group: $Q(9) = 54.00$, $p < .01$, $I^2 = 83.33\%$; traditional controls: $Q(3) = 17.24$, $p < .01$, $I^2 = 82.0\%$; active comparators: $Q(6) = 13.47$, $p = .01$, $I^2 = 55.45\%$), indicating moderate to high between-study variability, possibly associated with differences between interventions or in sample characteristics. Egger's regression test showed no evidence of publication bias in any of the analyses (experimental group: $t(8) = 0.61$, $p = .56$; traditional controls: $t(2) = 0.60$, $p = .60$; active comparators: $t(5) = 0.39$, $p = .71$).

Suicidal Ideation: Analysis of Moderator Variables

Digital interventions had an effect of moderate magnitude on suicidal ideation in samples comprising both adolescents/youth ($g = -0.65$, 95% CI $[-0.91, -0.39]$) and adults ($g = -0.59$, 95% CI $[-0.85, -0.34]$). There was significant heterogeneity across studies involving adolescents and youth ($Q(3) = 8.42$, $p = .04$; $I^2 = 64.36\%$), indicating moderate between-study variability. Heterogeneity was also high for studies in adult populations ($Q(11) = 153.26$, $p < .01$; $I^2 = 92.82\%$), suggesting substantial variability that was possibly related to differences in the type of intervention, clinical severity or the duration of follow up. Egger's regression test indicated no evidence of publication bias in either of the two contrasts (adolescents/youth: $t(2) = 0.96$, $p = .43$; adults: $t(10) = 0.66$, $p = .51$).

Effects were also greater in clinical samples ($g = -0.71$, 95% CI $[-1.01, -0.42]$) than in the general population ($g = -0.43$, 95% CI $[-0.73, -0.12]$). Heterogeneity was significant in both cases (clinical samples: $Q(8) = 81.22$, $p < .01$; $I^2 = 90.15\%$; general population: $Q(5) = 64.46$, $p < .01$; $I^2 = 92.24\%$), which suggests that the magnitude of effects may be influenced by differences in clinical severity and the content and/or format of interventions. There was no evidence of publication bias (clinical samples: $t(7) = 0.17$, $p = .87$; general population: $t(4) = 0.38$, $p = .72$).

Finally, fully self-guided interventions showed a greater effect ($g = -0.71$, 95% CI $[-0.99, -0.43]$) than did mixed interventions that included human support ($g = -0.41$, 95% CI $[-0.62, -0.20]$). Heterogeneity was high for studies involving self-guided interventions ($Q(8) = 153.83$, $p < .01$; $I^2 = 94.80\%$), and moderate for those describing mixed interventions ($Q(6) = 12.29$, $p = .05$; $I^2 = 51.19\%$). Egger's regression test indicated no evidence of publication bias in studies reporting self-guided interventions ($t(7) = 0.95$, $p = .37$), but there was possible asymmetry in the case of mixed

interventions ($t(5) = 2.57$, $p = .05$), suggesting marginal bias and the need to interpret the results with caution.

Effect of Digital Interventions on Suicide Attempts

The meta-analysis included five studies that assessed the effectiveness of digital interventions in preventing suicide attempts (Table 2). Sample sizes ranged between 42 and 724 participants, and interventions involved both self-guided applications and structured CBT programs in digital format.

The random-effects model, with the restricted maximum likelihood estimator, showed a pooled effect in the expected direction, indicating a reduction in the risk of suicide attempts in groups that received the digital intervention, in comparison with controls (Figure 4). The pooled estimate suggested a reduction in the risk of suicide attempts (ratio = 0.65; 95% CI $[0.40, 1.04]$; $p = .07$), corresponding to an approximate 35% lower likelihood among intervention participants, although the result did not reach statistical significance. Heterogeneity was moderate ($I^2 = 35\%$) and the test of heterogeneity was not significant ($Q(4) = 6.06$, $p = .19$), indicating acceptable between-study variability.

In contrast to the results obtained for suicidal ideation, it was not possible to conduct a stratified analysis for suicide attempts. This limitation is due primarily to the small number of studies that assessed this outcome (only five studies provided sufficient data), reducing substantially the statistical power for sub-group comparisons. In addition, all but one of these studies were focused exclusively on a clinical population, preventing us from examining possible differences between clinical and non-clinical contexts. Furthermore, as four of the five studies (the exception being the study by De Jaegere et al., 2019) used an active comparator, we could not compare effectiveness with respect to traditional (no treatment or waitlist) controls. Neither was it possible to explore differences by age group, as none of the five studies focused specifically on adolescents or youth. Finally, the intervention formats were not sufficiently diverse or balanced to allow for a reliable comparison between self-guided and mixed (self-guided with human support) interventions.

Discussion

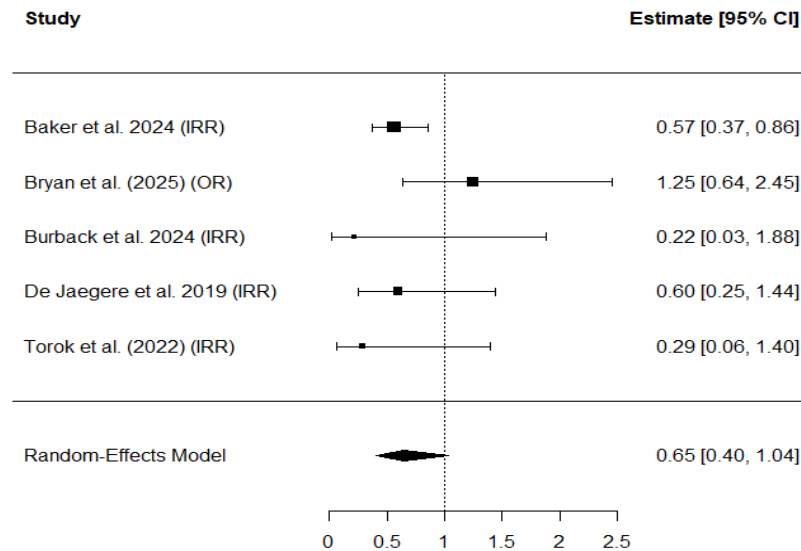
Overall, results of this meta-analysis suggest that digital interventions may be effective in reducing suicidal ideation and may, to a lesser extent, help to reduce the risk of suicide attempts. Accordingly, digital technologies may be promising tools within the spectrum of suicide prevention strategies, especially in a global context characterized by persistent barriers to accessing mental health services (Bryan et al.,

Table 2
Characteristics and Effect Sizes of Included Studies Examining the Effect of Digital Interventions On Suicide Attempts

Study	Experimental <i>n</i>	Control <i>n</i>	Metric	Effect size (IRR/OR)	95% CI	Weight (%)
Baker et al. (2024)	51	45	IRR	0.57	0.37 – 0.86	41
Bryan et al. (2025)	127	139	OR	1.25	0.64 – 2.45	27
Burback et al. (2024)	20	22	IRR	0.22	0.03 – 1.88	4
De Jaegere et al. (2019)	365	359	IRR	0.60	0.25 – 1.44	19
Torok et al. (2022)	228	232	IRR	0.29	0.06 – 1.40	8

Pooled effect: 0.65 $[0.40 - 1.04]$; $p = .07$; $I^2 = 35\%$.

Notes. IRR = Incidence Rate Ratio; OR = Odds Ratio; CI = Confidence Interval; I^2 = percentage of between-study heterogeneity.

Figure 4*Forest Plot of the Random-Effects Meta-Analysis Examining the Effect of Digital Interventions On Suicide Attempts*

Notes. Each square represents the study-specific effect size (rate ratio or odds ratio) and its 95% confidence interval. The diamond at the bottom represents the pooled estimate under a random-effects model (REML). Values below 1 indicate a lower odds/rate of suicide attempts in the digital intervention group.

2025) and the urgent need to develop scalable, accessible, and evidence-based therapeutic modalities (Büscher et al., 2022).

The most consistent finding relates to a reduction in suicidal ideation, with moderate pooled effect sizes being observed in studies that compare digital interventions with baseline. Effectiveness was maintained in both the overall analysis and when conducting subgroup analyses by participants' age, the delivery setting, and the intervention format. However, these moderator analyses should be considered exploratory given the small number of studies in some subgroups, and the larger effects observed in self-guided interventions should therefore be interpreted cautiously. Variability in the level of therapeutic guidance may also be relevant, as alliance-related processes have been shown to influence outcomes in both traditional and digital psychotherapy (Berger, 2017; Flückiger et al., 2018). This finding is in line with previous reviews that identified significant—albeit modest—effects on suicidal ideation (Burr et al., 2025; Büscher et al., 2020; Oh et al., 2024; Sutori et al., 2024; Torok et al., 2020), although it brings clarity to the conditions under which digital interventions appear to be most effective. Although the effect size observed in the present review appears somewhat larger than those reported previously, this comparison should be interpreted cautiously given methodological differences across studies and the substantial heterogeneity observed. From a clinical perspective, even moderate reductions in suicidal ideation may be meaningful, as ideation is a proximal risk factor for suicide attempts (Jobes et al., 2024). In addition to symptom reduction, some digital interventions may also strengthen protective processes such as reasons for living, hope, or sources of meaning and connectedness (Bryan & Bozzay, 2026; Rain et al., 2024). Particularly noteworthy is the temporal stability of the observed effects on suicidal ideation. The analyses of follow-up data showed that post-intervention reductions in suicidal ideation were not only maintained over time but tended, in the experimental group, to increase in the medium term. This

pattern suggests that digital interventions may help to promote processes of sustained change, beyond any immediate effect in terms of symptom relief. From a clinical and preventive perspective, the persistence of effects is especially relevant insofar as suicidal ideation is a dynamic and fluctuating risk factor (Jobes et al., 2024), and its sustained reduction may help to decrease the likelihood of a transition to more serious suicidal behaviors. This interpretation is consistent with the Fluid Vulnerability Theory of suicide (Rudd, 2006), which conceptualizes suicide risk as the interaction between relatively stable vulnerabilities and fluctuating suicidal states that may be modified through targeted interventions.

An important contribution of the present review relates to the comparison of results according to the type of control group used in the pre-test vs. post-test analyses. Although both active comparators and traditional control groups showed an improvement in suicidal ideation, the magnitude of change followed a descending pattern, with the largest effect sizes being observed in experimental groups ($g = -0.61$), followed by active comparators ($g = -0.44$) and traditional controls ($g = -0.34$). This pattern is consistent with the literature on clinical trials in mental health, which show that treatment effects tend to be smaller when interventions are compared with active comparators, as the latter can also lead to important clinical improvements (Cuijpers et al., 2024; Patterson et al., 2016). Although active comparators varied in their specific content and intensity, they were grouped together because all represented interventions intended to provide some form of therapeutic input beyond no-treatment or waitlist conditions. From a clinical perspective, these results suggest that the therapeutic potential of digital interventions extends beyond their consideration as low-threshold-resources.

The analysis by sub-groups adds further nuance to our findings. Digital interventions appeared to be more effective in adolescents and youth than in adults, although both groups showed significant benefits.

This finding is relevant given that suicidal ideation is one of the main risk factors for suicide behavior during adolescence (Tabares et al., 2025). It should be noted that adolescents and youth are generally adept in using digital technologies and may therefore experience fewer barriers to engaging with interventions that use this medium (Forte et al., 2021). From the public health perspective, the possibility of implementing scalable digital programs aimed specifically at young people represents a strategic opportunity for early and universal prevention (Potts et al., 2025; Wanniarachchi et al., 2025).

Our analysis also identified differences depending on the delivery setting, with larger effect sizes being observed in clinical samples ($g = -0.71$) than in the general population ($g = -0.43$). This pattern is in line with the meta-analysis conducted by Josifovski et al. (2025), although the respective effect sizes they found were more modest. The present review therefore extends the previous literature by reporting larger effect sizes, especially in clinical samples, which may reflect both a greater activation of mechanisms of change in populations with clinical symptoms and the application of more specific digital interventions in recent studies.

Another important finding of the present review relates to the intervention format. Self-guided interventions were associated with larger pretest–post-test effect sizes than were mixed interventions that included human support, which raises questions as to the mechanisms of change involved. One possible explanation is that the self-guided format offers greater anonymity, flexibility, and autonomy, which may foster therapeutic engagement, whereas mixed interventions may be characterized by greater variability in their implementation. However, this finding should be interpreted with caution given the marginal evidence of publication bias in studies involving mixed interventions. Furthermore, and in line with a point made by Sutori et al. (2024), these results do not mean that self-guided interventions are sufficient as a sole treatment for people with suicidal ideation; rather they should be considered as useful components within a broader framework of care.

In contrast to the robust results obtained for suicidal ideation, the evidence relating to suicide attempts remains limited. Although the five studies reviewed consistently pointed towards a protective effect of digital interventions, this did not reach statistical significance, a finding in line with previous broad scope reviews (Büscher et al., 2020, 2022; Josifovski et al., 2025; Sutori et al., 2024; Witt et al., 2017). Given the small number of studies and the low base rate of suicide attempts in clinical trials, the statistical power of this analysis is limited and the results should therefore be interpreted cautiously. These findings suggest that the current evidence is inconclusive rather than indicative of the absence of an effect, and highlights the need for larger trials specifically designed to examine suicide attempts as an outcome. This pattern is consistent with the greater methodological and clinical complexity associated with an infrequent outcome, one characterized by a low base rate and strong contextual influences. In this respect, while the available evidence suggests that digital interventions (especially when self-guided) may be capable of reducing suicidal ideation, the prevention of suicide attempts likely requires more intense interventions that include more specific face-to-face input from one or more professionals.

A relevant benchmark for interpreting our findings is the large meta-analysis by van Ballegooijen et al. (2025), which synthesized the effects of direct and indirect psychotherapies on suicidal ideation and suicide attempts, and reported treatment effects by specific therapeutic

protocols. In their overall estimates, direct psychotherapy showed a pooled effect of $g = -0.39$ for suicidal ideation and $RR = 0.72$ for suicide attempts, while indirect psychotherapy showed $g = -0.30$ for suicidal ideation and $RR = 0.68$ for suicide attempts.

Against this backdrop, the effect of digital interventions observed in our meta-analysis appears clinically meaningful. Specifically, we found a moderate reduction in suicidal ideation ($g = -0.61$), which is comparable to—or slightly larger than—the overall effects reported for direct psychotherapy in face-to-face settings. Moreover, subgroup estimates from van Ballegooijen et al. (2025) indicate that several evidence-based protocols can achieve similar magnitudes of change in ideation, including CBT ($g = -0.51$) and CAMS ($g = -0.46$), while DBT showed a more uncertain estimate for ideation outcomes.

Regarding suicide attempts, van Ballegooijen et al. (2025) reported a pooled RR of 0.65 for CBT and $RR = 0.49$ for DBT, with direct psychotherapy overall showing $RR = 0.72$. In our meta-analysis, the pooled effect for suicide attempts ($RR = 0.65$) was highly similar in magnitude to CBT in traditional psychotherapy, but did not reach statistical significance, likely reflecting the smaller number of included trials, limited statistical power, and the low base rate of suicide attempts in most samples. Taken together, these comparisons suggest that digital interventions may provide effects on suicidal ideation that are broadly comparable to established face-to-face modalities, while evidence for effects on attempts remains promising but less precise and warrants further high-powered trials with longer follow-up and sufficient event rates. Digital interventions should therefore not be interpreted as substitutes for established psychotherapeutic approaches, but rather as accessible and scalable tools that can complement evidence-based treatments within stepped-care or blended models of suicide prevention.

This review has several limitations. First, between-study heterogeneity was high in several analyses, reflecting the considerable diversity in intervention formats, measurement instruments, therapeutic doses, and sample characteristics. Although moderator analyses were conducted (age group, delivery setting, and intervention format), the relatively small number of studies limited the possibility of more detailed analyses such as meta-regression. Reporting of intervention fidelity and participant adherence was inconsistent, and suicidal ideation was assessed predominantly through self-report measures, which may be influenced by factors such as social desirability or stigma. In addition, several trials showed moderate or high risk of bias according to the RoB 2 assessment, particularly due to attrition and the difficulty of blinding participants in digital interventions. Some analyses relied on pre–post within-group comparisons, which may produce larger effect size estimates than between-group comparisons and should therefore be interpreted cautiously (Cuijpers et al., 2017). Second, the limited available data relating to suicide attempts prevented us from conducting more detailed sub-group analyses, reducing the accuracy of estimates for this outcome. This limitation is compounded by 1) the fact that many digital interventions are not conceived as independent treatments but rather as a complement to treatment as usual, and 2) the frequent exclusion of individuals who are considered high risk for suicide, a decision taken on safety grounds. These aspects reduce the ecological validity of studies and make it difficult to isolate the specific effect of digital interventions (Sutori et al., 2024). Finally, most studies were conducted in high-income Western countries, limiting the generalizability of the findings.

In light of these limitations, future studies should prioritize trials examining the effects of digital interventions on suicide attempts, including designs that allow the safe participation of individuals at elevated risk. Research should also explore mechanisms of change using proximal variables such as hopelessness, perceived burdensomeness, thwarted belongingness, suicide-related beliefs, or mental pain, and evaluate the implementation of digital interventions in educational and community settings.

In conclusion, the findings of this systematic review and meta-analysis suggest that digital interventions may represent a promising complementary approach for reducing suicidal ideation and potentially reducing suicide risk. However, these results should be interpreted cautiously given the heterogeneity of the studies and the limited evidence regarding suicide attempts.

Author Contributions

Ainize Sarrionandia: Methodology, Supervision. **Maria Ruiz-Iriondo:** Data curation, Visualization. **Irene Izquierdo-Sanchez:** Data curation, Formal Analysis. **Andrea Gabilondo:** Funding acquisition, Writing—Review and Editing. **Craig J. Bryan:** Writing—Review and Editing. **Jon García-Ormaza:** Funding acquisition, Writing—Review and Editing. **Alexander Muela:** Conceptualization, Writing—Review and Editing.

Funding

This research was funded by a grant from the Eusko Jaurlaritza (2025333029). This funding source had no role in the design of this study, data collection, management, analysis, and interpretation of data, writing of the manuscript, and the decision to submit the manuscript for publication.

Declaration of Interests

The authors declare that there is no conflict of interest.

Data Availability Statement

The data described in the manuscript and the analytical code will be available upon request to the corresponding author.

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