

SYSTEMATIC REVIEW

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Gatekeeper training for suicide prevention: a systematic review and meta-analysis of randomized controlled trials

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Abstract

Introduction Gatekeeper training (GKT) aims to enhance suicide gatekeepers' (GKs) abilities in assessing suicide risk, identify those at-risk and refer them. However, existing randomized controlled trials (RCTs) on GKT have not produced definitive results. This study reviewed RCTs on GKT to provide evidence for developing effective suicide prevention strategies.

Methods We conducted a systematic search of MEDLINE, PubMed, Web of Science, PsycINFO, CINAHL, Embase, Google Scholar, Medrxiv, and Ebsco for English-language RCTs published between January 1, 2000, and December 31, 2024. Two authors independently screened studies, extracted data, and assessed the risk of bias using the Cochrane risk-of-bias tool. Standardized mean differences (SMD) with 95% confidence intervals were calculated using a random-effect model. Heterogeneity was assessed by using I^2 statistic, and publication bias was evaluated through funnel plots and Egger's regression. We stratified participants into subgroups by characteristics and categorized interventions by delivery mode (online vs. offline). Post-test and follow-up data were integrated into a unified model, with follow-ups classified as short-term (1–5 months) or long-term (> 5 months). All analyses were performed using R version 3.4.0, following the PRISMA guidelines (registration number: CRD42024507513).

Results Sixteen studies were included. Compared to the control group, gatekeepers showed increased suicide knowledge (SMD=0.72, 95% CI: 0.32 – 1.13) and enhanced self-efficacy (SMD=0.73, 95% CI: 0.33 – 1.13) for suicide prevention. For knowledge, the improvements were sustained in the short-term (SMD=0.64, 95% CI: 0.22 – 1.06) but diminished in the long-term (SMD=0.25, 95% CI: 0.05 – 0.45). Online interventions showed a significant improvement in self-efficacy (SMD=1.02, 95% CI: 0.73 – 1.32), while offline interventions demonstrated a potential but non-significant improvement (SMD=0.53, 95% CI: -0.08 – 1.17). Preparedness also showed a significant improvement (SMD=0.69, 95% CI: 0.31 – 1.07).

Conclusion This meta-analysis demonstrated GKT's effectiveness in enhancing knowledge and self-efficacy (moderate effect) for suicide prevention. However, the positive effects tend to decrease over time. Online training offers significant benefits, making it a viable option for widespread implementation. Additionally, the selection of gatekeepers plays a crucial role in ensuring the effectiveness of online GKT programs.

Keywords Gatekeeper training, Suicide prevention, Systematic review, Randomized controlled trials, Meta-analysis

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Introduction

Suicide is a global public health concern, with over 800,000 people dying by suicide each year [1]. An even greater number of people have considered or attempted suicide [2]. Suicide poses a significant threat to life safety, resulting in substantial economic losses and profound impacts on families and society [3]. However, by enhancing the ability to identify specific risk groups and potential suicide attempts, and by developing effective responses, the risk of suicide can be significantly reduced. Preventing suicide has become an important goal and a valuable indicator of global progress in promoting mental health and preventing mental disorders. Many countries are developing suicide prevention strategies that require up-to-date, high-quality evidence [4]. Research has shown that the Gatekeeper Training (GKT) program is an effective suicide prevention intervention [5] and one of the most common interventions in suicide prevention [6–8].

Before attempting suicide, individuals often send distress signals, such as verbal language, written messages, and behaviors to those around them and need time to decide to proceed with the act. It is during this critical period that gatekeepers can detect suicidal intent through these signs and provide timely help and referrals, thereby reducing the risk of suicide [9]. A qualified gatekeeper (GK) can identify whether someone may have suicidal tendencies. Anyone can contribute to suicide prevention by recognizing early warning signs in others and offering assistance, such as teachers, friends, family members, co-workers, and community members [10]. In particular, teachers, health care workers, and family members are more likely to be in contact with people at high risk of suicide. GKT programs aim to develop participants' knowledge, attitudes, and skills for identifying individuals at risk, determining their level of risk, and then referring at-risk individuals for preventive treatment [1]. Training programs usually include the following components: raising awareness, increasing knowledge on suicidality, teaching intervention skills, and informing about local resources, and referral points [11]. GKT programs typically consist of brief training sessions focused on suicide prevention [12].

As early as Isaac's (2009) systematic review, it was found that GKT is associated with significant improvements in GKs' knowledge and attitudes towards suicide prevention [13]. Subsequent studies have also demonstrated that GKT can enhance GKs' understanding of suicide [14] and improve their suicide prevention skills [15, 16]. However, few studies have examined whether these effects can be sustained over time. Additionally, with the advancement of internet technology, online training methods are becoming increasingly prevalent.

However, its effectiveness compared to traditional methods remains unclear.

To our knowledge, no meta-analysis has specifically examined the long-term follow-up effectiveness of GKT using data from RCTs. While previous systematic reviews have included RCTs, they have not quantitatively analyzed the differences between post-test and follow-up outcomes [7, 12, 17–20]. This meta-analysis aims to address the existing research gap by systematically examining both the immediate and sustained effects of GKT, thereby offering insights into the durability of its outcomes. Furthermore, recent studies, particularly those on online training, have been included to evaluate its effectiveness in comparison to traditional offline methods. A recent review of systematic reviews on GKT proposed that the lack of RCTs is a major limitation in the assessment of GKT and that more RCT studies are needed to confirm these findings [8]. In addition, the heterogeneity of GKT training approaches (e.g., training modules, duration, and delivery methods) and outcome measures, as well as the absence of standardized evidence levels in the literature, limits conclusions about the current effectiveness of GKT [4]. In recent years, there has been an increase in investigational studies related to GKT. Therefore, this review aims to include these RCTs in a comprehensive quantitative analysis. It will focus on attitudinal and behavioral changes in suicide GKs, incorporating the most recent evidence to support the development of effective suicide prevention strategies.

Methods

Registration

This project was registered in PROSPERO (CRD42024507513) and followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guidelines [21].

Search strategy

A search for relevant RCT studies was conducted from January 1, 2000, to December 31, 2024, in MEDLINE, PubMed, Web of Science, PsycINFO, CINAHL, Embase, Google Scholar, Medrxiv, and Ebsco. Boolean logic searches were performed using the keywords (suicide prevention, prevention, suicide, suicide awareness, awareness, suicide) and (gatekeeper) and (randomized controlled trials). During the search process, I search terms were applied search terms primarily within the full text and filters were applied to limit the timeframe to between January 1, 2000 and July 1, 2024 (S1 Table in the Supplement).

Inclusion and exclusion criteria

This review focused on integrated interventions for GKT, defined as training programs that combine multiple components (e.g., psychoeducation, skill-building, and role-playing) to enhance gatekeepers' ability to identify and support individuals at risk of suicide. Typical GKT sessions cover how to identify at-risk individuals, discuss suicide, ask about suicidal thoughts, and encourage seeking appropriate mental health care or crisis services [12].

Only RCTs related to GKT were included, with no restrictions on participants or study populations. The control groups typically received either no intervention, waitlist conditions, or alternative interventions (e.g., general mental health education). Two reviewers independently conducted article selection and quality assessment using a standardized screening protocol and the Cochrane risk-of-bias tool [17]. Disagreements were resolved through discussion or consultation with a third reviewer. The reference lists of identified articles and previous relevant systematic reviews were also checked to ensure comprehensiveness.

Statistical analysis

The main outcomes included self-efficacy (confidence in identifying and supporting at-risk individuals), knowledge (understanding of suicide risk factors), attitudes (beliefs and perceptions toward suicide), behaviors (frequency of suicide prevention actions), preparedness (readiness to intervene), stigma (negative attitudes toward suicide), and skill (ability to conduct risk assessments). The outcome measures were continuous, and although the measurement tools varied across studies, we ensured all tools were aligned in the same direction before calculating standardized mean differences (SMD) with 95% confidence intervals (CI) to pool effect sizes. Higher scores on all scales indicated better outcomes, and we reversed scoring if necessary to maintain uniformity. The design effect ($DE = 1 + (m - 1) * ICC$) will be applied to adjust the sample size and variance estimates for cluster-randomized trials, ensuring comparability with traditional RCTs (where m represents the average cluster size and ICC (intra-cluster correlation coefficient) measures the similarity of outcomes within clusters). To ensure consistency in results, a random-effects model will be used to account for both within-study and between-study heterogeneity. For outcomes with fewer than 3 studies, meta-analysis will not be performed due to insufficient data.

We analyzed post-test data and stratified participants into subgroups based on their characteristics: specific populations (such as family members of individuals with mental illness, people dealing with youth issues, and

nurses), general populations (representing the broader society, encompassing individuals without specific vulnerabilities or roles related to suicide prevention), students, and school workers. Additionally, we compared interventions based on delivery mode (online vs. offline). To assess the sustainability and time-varying efficacy of the GKT effect, we integrated post-test and follow-up data into a unified model to validate the effectiveness over time. Follow-up periods were categorized as short-term (1–5 months) and long-term (>5 months).

Heterogeneity between studies was assessed using I^2 statistic, classified as low ($I^2 \leq 25\%$), moderate ($25\% < I^2 \leq 50\%$), or high ($I^2 > 50\%$) [18]. High heterogeneity necessitated sensitivity analyses, which involved excluding studies with a high risk of bias. The random-effects model, which accounts for errors at both the sampling and study levels, was deemed more suitable for this scenario [19]. Publication bias was evaluated using funnel plots or Egger's regression, with the Trim and Fill method used to adjust for potential bias [20, 22]. All data were analyzed using R version 3.4.0.

Results

Results of study search

A total of 7,766 articles were retrieved from the database. After excluding duplicates ($n = 22$), 7,744 publications were screened for inclusion. By reviewing the titles and abstracts, 7,710 studies were excluded. These studies were excluded based on the following criteria: studies that did not focus on suicide prevention; studies that were not randomized controlled trials (RCTs); studies that did not involve GKT interventions. Out of the 34 full-text articles assessed for eligibility, 16 studies provided sufficient data for meta-analysis. The search process and selection phases followed the PRISMA protocol flowchart, as shown in Fig. 1.

Characteristics of the included studies

The studies included in this review were published between 2000 and 2024 (Table 1). Six studies were from the USA [6, 22–26], two from Canada [27, 28], two from Korea [29, 30], two from Germany [31, 32], Australia [33], the Netherlands [34], Japan [35] and Taiwan [36] each contributed one study. Participants included school workers [6, 22], all students enrolled in schools, colleges and universities as well as graduate students [23, 24, 26, 32, 35], specific population (nurses in a general hospital [36], pastors, and Christian counselors [33], and veterans contacts [25], family members of patients with mental disorders [29], people dealing with youth issues [27, 34]), general population (recruited from the community) [28, 30, 31]. The duration of follow-up was mainly no

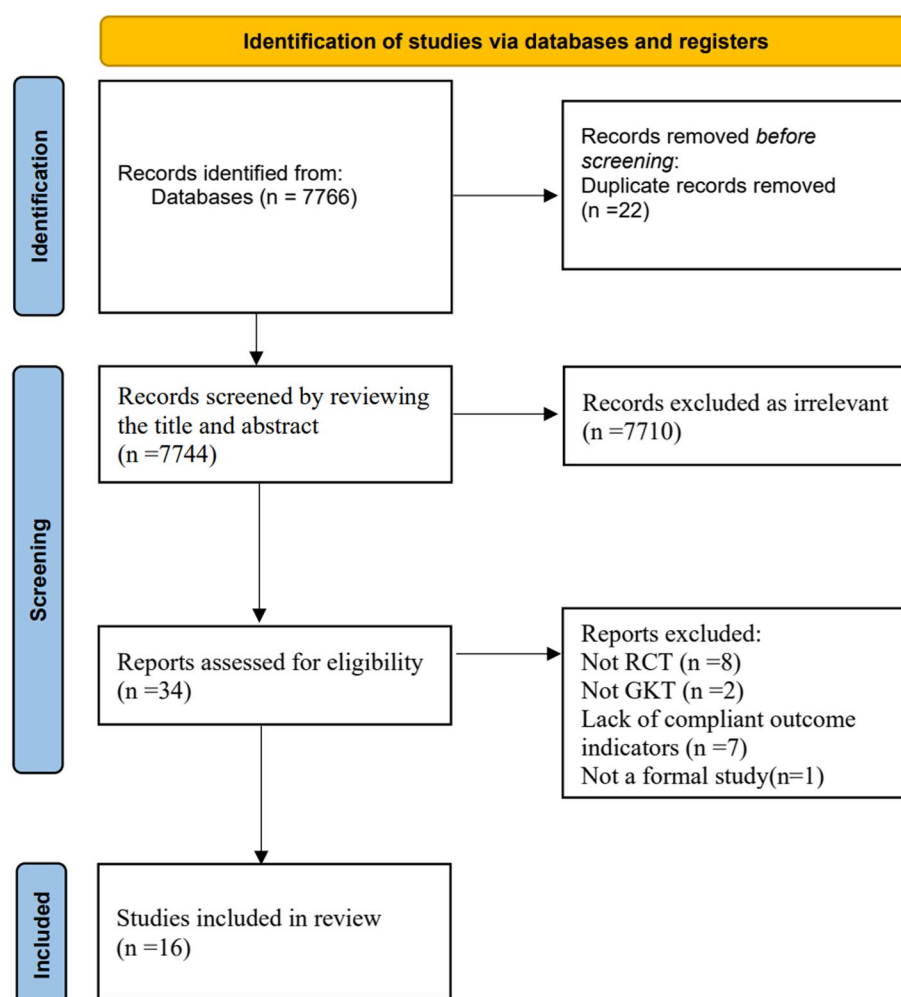


Fig. 1 Flow chart of literature search strategy

follow-up [24, 36], short-term follow-up [6, 23, 26, 29–31, 33–35] and long-term follow-up [22, 25, 27, 28, 32].

Methodological quality assessment of included studies

Most studies demonstrated a low risk of bias in random sequence generation and allocation concealment. However, there were some concerns regarding the blinding of participants and personnel, as well as incomplete outcome data. Specifically, the inability to blind participants and personnel in GKT studies was a common limitation due to the nature of the intervention. (S3 Table and S4 Figure in the Supplement).

The effect of GKT on trainees' knowledge for suicide prevention

The pooled SMD for knowledge about suicide prevention in post-test data was 0.72 (95% CI: 0.32 – 1.13). However, significant heterogeneity was observed ($I^2=90\%$, $p<0.01$). Sensitivity analysis revealed that

excluding Hill' study [24] increased the SMD to 0.73 (95% CI: 0.59 – 0.87). For follow-up data, the improvement in knowledge was sustained in the short-term (SMD=0.64, 95% CI: 0.22 – 1.06), but diminished in the long-term (SMD=0.25, 95% CI: 0.05 – 0.45). Offline interventions showed a moderate effect size (SMD=0.68, 95% CI: 0.17 – 1.19). The specific population showed a large improvement (SMD=1.10, 95% CI: 0.58 – 1.63). (Fig. 2, Tables 2 and 3, S5 Figure. a in the Supplement).

Egger's regression test indicated no significant publication bias for post-test data (Bias estimate=5.34, SE=2.76, $p=0.09$). Visual inspection of the funnel plot suggested potential asymmetry. The Trim and Fill method yielded an adjusted SMD of 0.13 (95% CI: -0.40 – 0.66; $p=0.63$). Although the adjusted effect size was not statistically significant ($p=0.63$), the confidence interval included the original pooled effect size (SMD=0.72). (S7 Table, S8 Figure. cd and S9 Table in the Supplement).

Table 1 Characteristics of the articles included

Author/year	Country	Study participants	Intervention	Comparison	Outcomes	Study design	Scales	More detailed information(age, gender, level of education and so on)
Chagnon F, et al. 2007 [27]	Canada	The participants were helpers from tablishments and community or institutional organization's serving the youth clientele.	A program over 3 days (1 day a week for 3 consecutive weeks) by senior staff from the suicide prevention center.	The experimental group consisted of 43 participants developed by the Montreal Suicide Prevention Center (Montreal Suicide Action), and the control group had 28 participants. No training measures have been taken for the EG.	①③⑥	RCT (pre-, post- and 6-months)	Attitudes, The Suicide Intervention Questionnaire (SIO); The Knowledge and Skills Questionnaire is self-administered	The final sample consisted of 71 participants, including 46 females (65%) and 25 males (35%). Overall, participants in both groups had years of experience working in youth interventions (M= 7.43 years). The majority of participants (746%; 53/71) were college educated (EG 76.7% vs. CG 71.4%); of these, 85% had an undergraduate degree (EG 87.8% vs. CG 80.6%), and 1.4% had a graduate degree (EG 21.2% vs. CG 20%).
Peter A. Wyman, et al. 2008 [22]	USA	Secondary school staff from 10 middle and 6 high schools.	QPR program(Question, Persuade, Refer)	There were 166 participants (of whom 122 were analyzed) in the experimental group, 176 staff (127 analyzed)in the control group. No training measures have been taken for the EG.	①②④⑤	Cluster RCT (pre-, post- 1-year)	The scale was self-developed with reference to previous articles, and the specific scale can be found in the article.[22] https://doi.org/10.1037/0022-006X.76.1.104	81.9% were female, mean age was 44.5 years (range 22 – 75 years)
Tsai, WP, et al. 2011 [36]	China	A total of 195 nurses took part in this study.	Regular monthly continuing education class and a 90-min Gatekeeper Suicide-Aware ness Program	98 participants were in the experimental group, and 97 were in the control group. No training measures have been taken for the EG.	①	RCT (pre-, post-training)	Modified Scale, a modification from Wang's (1997) [37] Sensitivity of Suicide Warning Signs Questionnaire	The EG consisted of 4 males and 94 females, and all 97 in the control group were females. More than half of the participants were between 20 and 30 years old. Sixty-three percent had been working in nursing for longer than 5 years. One hundred and forty-four participants (74%) were registered nurses.

Table 1 (continued)

Author/year	Country	Study participants	Intervention	Comparison	Outcomes	Study design	Scales	More detailed information (age, gender, level of education and so on)
Wendi F. Cross 2011 [6]	USA	The participants were school personnel (including mental health professionals, teachers and bus drivers), mental health professionals and parents.	Brief gatekeeper training (QPR) with training; the 1-h program consisted of a lecture, a 10-min introductory video, distribution of booklets and referral cards, and a question-and-answer discussion period	72 participants were in the experimental group, and 75 were in the control group. No training measures have been taken for the EG.	①②④⑥	RCT (pre-, post-, 3 months)	Scale modified from previous article. Declarative Knowledge: a 14-item assessment of declarative knowledge about suicide-related facts (Cross et al. 2007 [38]; Wyman et al. 2008 [22]). The knowledge score is the percentage of correct responses; Self-perceived knowledge about suicide (Cross et al. 2007 [38], 2010 [39]; Matthieu et al. 2008 [40]). Self-efficacy for intervening: A 5-item measure of efficacy for intervening with a suicidal individual used previously (Cross et al. 2010 [39]; Matthieu et al. 2008 [40]) was slightly modified for the current study; Observational Rating Scale of Gatekeeper Skills (ORS-GS) Minor contextual revisions were made to the ORSGS scoring system (Cross et al. 2010 [39]) based on the youth and school-based scenarios used in the present study	Of 170 participants in the study, 114 were school personnel (79 teachers/aides/administrators, 22 mental health professionals, and 13 bus drivers), and 56 were parents. The sample was primarily Caucasian (93%) and female (87%), with an average age of 42 years (SD = 9).

Table 1 (continued)

Author/year	Country	Study participants	Intervention	Comparison	Outcomes	Study design	Scales	More detailed information (age, gender, level of education and so on)
Jacobson, JM, et al. 2012 [23]	USA	Seventy senior social Work MA students were randomly assigned to the training and control groups.	QPR program	35 participants were in the experimental group, and 38 were in the control group. No training measures have been taken for the EG	①②③④⑤	RCT (pre-, post-, 4 months)	A standardized 14-item self-report measure developed by Wyman et al. (2008) [22] the Self Evaluation of Suicide Prevention Knowledge; The researchers used the Attitudes to suicide prevention (ASP) scale (Herron et al., 2001 [41]) to assess stigma regarding suicide and suicide prevention; Asking Clients about Suicide in Response to Warning Signs; Use of Gatekeeper Behaviors with Suicidal Clients scale; Asking Depressed Clients About Suicide scale; the Appropriate Referral of a Suicidal Client scale	Students in the control and intervention groups were primarily female (97.4% and 90.9%, respectively) and Caucasian (68.4% and 63.6%). Both groups had similar compositions in terms of age, M ¼ 31.4; for the control group vs. M ¼ 29.4 for the intervention group.
Sareen J, et al. 2013 [28]	Canada	All members of the Swampy Cree tribal communities who were currently residing on the reserves were eligible to participate in the study. Exclusion criteria for the study included being less than 16 years of age, prior training in SafeTALK (a brief intervention of suicide awareness training) or ASIST, being an elected official in a First Nations community, living off reserve, and an inability to read or write English.	2 days of ASSIST program, ASIST is a 2-day intensive, interactive and practice-dominated workshop aimed at enabling people to recognize risk and learn how to intervene immediately to prevent suicide.	31 participants in the ASIST training group and 24 participants in the control group consisting of a Resilience Retreat (RR)/created a 2-day (RR) with a focus on increasing youth resilience, the 2-day RR was divided into cultural teachings and activities, sharing circles, small group discussions, and story telling.)	①②⑤⑥	RCT (pre-, post-, and 6 months)	The Suicide Intervention Response Inventory-2 (SIRI-2); The Kessler 6-item distress measure (K-6)	In the Resilience Retreat group there were 9 aged 16–21, 10 aged 22–44, 12 males, 14 unmarried and 7 married. In the ASIST group there were 15 aged 16–22, 8 aged 45+, 10 males, 12 unmarried and 11 married.

Table 1 (continued)

Author/year	Country	Study participants	Intervention	Comparison	Outcomes	Study design	Scales	More detailed information (age, gender, level of education and so on)
Ghoncheh R, et al. 2016 [34]	Netherlands	The participants of this study were Dutch-speaking gatekeepers who worked with adolescents. The inclusion criteria were the following: (1) gatekeepers 18 years of age and older, (2) who worked frequently with adolescents from 12 to 20 years of age, (3) whose profession involved responsibilities with regard to the (mental) health care of adolescents, and (4) who had access to the Internet. Although every individual who met the inclusion criteria was eligible to participate in this study, three main target groups were identified for recruitment: members of mental health care teams of schools, youth health care nurses, and (mental) health care employees.	Mental Health Organization (MHO) Program, 8 e-learning modules alongside additional information regarding adolescent suicide prevention; The intervention in this study consisted of 8 e-learning modules alongside additional information regarding adolescent suicide prevention. The base of the modules was a PowerPoint presentation containing features such as voice-over, case descriptions, and quizzes.	The experimental group received the intervention during the study, and the waitlist control group received the intervention after completion of the study. The enrolled participants were randomized to either the experimental group ($n=94$) or the waitlist control group ($n=96$).	①②	RCT (pre-, 4 weeks; 12 weeks)	The Actual Knowledge Questionnaire consisted of 6 cases each providing several characteristics (name, age, and education) of a fictional adolescent displayed in a photograph. Each case was followed by 2 general questions (yes/no answer), and 8 specific questions (multiple choice, 1 correct answer) each pertaining to the content of one of the e-learning modules of the MHO program; The Perceived Knowledge Questionnaire consisted of 9 statements to be rated on a 3-point Likert scale (0 = disagree, 1 = partially agree, 2 = agree); A 16-item questionnaire was developed, which consisted of statements regarding the necessary skills and attitudes when dealing with adolescent suicide prevention. The statements were rated on a 3-point Likert scale (0 = disagree, 1 = partially agree, 2 = agree) and were related to the 8 e-learning modules.	Gatekeepers in this study were 21 to 62 years of age (mean 43.55, SD 10.96), the majority were female (81.6%, 155/190) and had a higher vocational (55.8%, 106/190) or university (38.4%, 73/190) degree. The majority (67.9%, 129/190) of the gatekeepers worked within a school setting (such as mentors, counselors, teachers, and social workers) while the rest worked in a (mental) health care related setting or institute (such as psychologists, behavioral scientists, youth health care nurses, and psychiatrists). The participants of this study had 0 to 30 years of experience in their current job (mean 8.28, SD 7.16).
Coleman et al. 2019 [26]	USA	Undergraduates typically taken by freshmen and sophomores.	Kognito; interactive online suicide prevention trainings	Participants were randomized to the Kognito condition ($n=58$) or a no-intervention control group ($n=59$). No training measures have been taken for the EG.	②⑤	RCT (pre-, post-, 2 months)	Scales from studies of QPR typified by Wyman et al. (2008) [22]	There were 18 males (26%) and 51 females (74%). The average age was 20.5 years ($SD=7.3$). Approximately one-third of the sample identified as White, 27% as Asian, and 22% as Latino, with small numbers of other ethnic identifications. One third of the participants were in their freshman year and 47% were sophomores.

Table 1 (continued)

Author/year	Country	Study participants	Intervention	Comparison	Outcomes	Study design	Scales	More detailed information (age, gender, level of education and so on)
Renée Bazley, et al. 2019 [33]	Australia	The participants were chaplains and Christian counsellors.	HOLLY Program (this one-day 6-h program comprises two modules: Module 1 focuses on delivering suicide knowledge and skills for responding to suicide in both crisis and low-risk formats; Module 2 teaches participants how to flexibly engage with their cognitions and emotions in the context of suicide via ACT processes and with deliberate linkage to suicide prevention behaviors.)	41 participants were in the experimental group, and 31 were in the control group. No training measures have been taken for the EG.	②④⑦	RCT, (pre-, 1 month)	Suicide Knowledge was measured using a 12-item purpose-built scale; the authors followed the trend of previous GKT evaluations (Jacobson et al., 2012 [23]; Wyman et al., 2008 [22]); SRI-1; Suicide Stigma was measured using The Stigma of Suicide Scale – Short Form (SOSS-SF); Self-efficacy to respond to suicide risk was assessed using a 5-item purpose-built scale; Suicide Prevention Behaviors were measured using a purpose-built scale; Suicide Prevention Action Goal was measured using a 14-item purpose-built scale assessing engagement; the 7-item Acceptance and Action Questionnaire – II (AAQ-II); Defusion was measured using the 10-item Drexel Defusion Scale (DDS); Mindfulness was measured using the 24-item Five Facet Mindfulness Questionnaire – Short Form (FFMQ-SF); Engagement with Values was measured using the 16-item Engaged Living Scale (ELS).	The sample was primarily female (70%), with an average age of 53 years (SD = 14.97; range = 18–77 years). Whilst 25% had a university level education, 24% of the sample was retired. Twenty-two percent of participants indicated that they worked in the field of mental health (including doctors and church leaders), and 29% of participants had previously received a form of training for helping persons at risk of suicide.

Table 1 (continued)

Author/year	Country	Study participants	Intervention	Comparison	Outcomes	Study design	Scales	More detailed information(age, gender, level of education and so on)
Daisuke Kawashima, 2023 [35]	Japan	Ninety-two Japanese university students living in the Tokai region were invited to participate in the study.	a web-based questionnaire using Qualtrics.com; QPR program	25 participants were in the experimental group, and 24 were in the control group. No training measures have been taken for the EG.	①②③④⑥	RCT, (pre-, post-, 2 weeks)	Kessler Psychological Distress Scale; The knowledge scale used in this study was edumetric rather than psychometric; The original version of the Suicide Intervention Response Inventory (SIRI), the SIRI-JS is a short version of the Japanese SIRI-2; Confidence in Suicide Prevention Scale developed by themselves; self-harm or suicide, and mental health status (The K6 scale); Self-Evaluation Knowledge (SEK) developed by Wyman et al.2008 [22]; Attitude Toward Suicide-20 (ATTS-20); Preparedness to Help Scale (PHS); Suicide Prevention Behavior (SPB); family problem-solving communication using a modified instrument.	72% of the EG were female, with an average age of 21.32 years. 71% of the CG were female, with an average age of 21.33 years.
Deuk-kweon You, et al. 2023 [29]	Korea	Fifty-nine family members of people with mental disorders were recruited from eight community psychiatric rehabilitation centers.	SPEM-F	experimental group (n = 30) and the control group (n = 29). No training measures have been taken for the EG.	①②③④⑤	RCT, (pre-, post-, 1 month)		The EG had 6 male participants, with 1 person aged 20–29, 5 people aged 40–49, 8 people aged 50–59, and 12 people aged 60–69; the CG had 4 male participants, with 6 people aged 50–59, 19 people aged 60–69, and 4 people over the age of 70.
Ryan M. Hill, 2023 [24]	USA	Participants were US college students.	AS + K2 Suicide Gatekeeper Training Program	142 participants were in the experimental group, and 164 were in the control group. This information-only comparison condition included statistics about suicide, an overview of suicide risk and protective factors, discussion of prevention interventions, an introduction to theories of suicidal behavior, and crisis resources.	①⑤	RCT, (pre-, post-)	The Literacy of Suicide Scale (LOSS); The Gatekeeper Behavior Scale; The Attitudes Toward Suicide Prevention Scale (ATSPS)	The mean age of the participants was 19.01 years (SD= 2.03). Participants self-identified their gender as women (69.3%), men (26.0%), nonbinary (1.3%), transgender men (0.5%), agender (0.5%), and other (0.3), and 2.1% did not provide their gender. The ethnoracial distribution of the sample was Hispanic (52.1%), non-Hispanic White (22.4%), non-Hispanic Asian American (10.6%), non-Hispanic African American or Black (8.5%), non-Hispanic Native Hawaiian or Pacific Islander (0.8%), and multiracial (3.6%), and 2.1% did not provide their race/ethnicity.

Table 1 (continued)

Author/year	Country	Study participants	Intervention	Comparison	Outcomes	Study design	Scales	More detailed information (age, gender, level of education and so on)
Teo et al., 2023 [25]	USA	participants had to have social contact with a veteran at least once a week.	VA S.A.V.E.	102 participants were in the experimental group, and 112 were in the control group. The control arm training video was designed to serve as an attention control. It was similar to the intervention in length (24:04 min duration) and style (also created by PsychAirmor); however, content was unrelated to suicide and instead showed information on helping veterans prepare their finances, network, search for a job, and use educational benefits	①②④⑦	RCT (pre-, post-, 6 months)	The Literacy of Suicide Scale (LOSS-SF) (Calear et al., 2014 [42]); The Stigma of Suicide Scale (SOSS) (Batterham et al., 2013 [43]); self-efficacy scale (Litteken & Sale, 2018 [44]); a 4-item measure of intention to use gatekeeper behaviors (Teo et al., 2016 [45]); the items based on measures contained in prior trials of gatekeeper training (Wyman et al., 2008 [22], 2010 [46])	Across both study arms, participants represented 44 states, 88% (n = 189) were women, 61% (n = 130) were the spouse or romantic partner of a veteran, 48% (n = 103) had a bachelor's degree or higher education, and 77% (n = 163) knew at least one person who had died by suicide.
Hofmann L et al., 2024 [31]	Germany	Participants were mainly recruited via social media, online advertisements, and cooperation partners (eg, clinics, crisis services). Recruitment took place between January 2023 and October 2023 in Germany. The end of recruitment was based on the duration of the project and that the necessary sample size was reached. Eligible participants had to meet the following inclusion criteria: (1) aged 18 years or older, (2), access to the internet, (3) being in contact with a man with suicidal ideation, (4) sufficient knowledge of German, and (5) signed informed consent.	Online program: the program consisted of a total of four modules: (1) Suicidal ideation and behavior in men, (2) communicating and referring to help, (3) support services, and (4) support for relatives. The individual modules comprised four films, each lasting 15–20 min, and contained psychoeducational information and videos with experts and affected men as well as audio plays with fictional dialogues between men and their relatives.	Randomly divide 123 people into two groups: 63 in the treatment group and 60 on the waitlist. Participants in the waiting group had to wait 6 weeks after randomization, then received a questionnaire after the waiting period and were then given access to the online program. After a further 6 weeks, they also received a post questionnaire.	①②⑤	RCT (pre-, post-, 3 months)	Gatekeeper outcomes: Scales from studies of QPR typified by (Wyman et al. 2008) [22]; Knowledge: fourteen questions on suicidal ideation and behavior in men, as well as suicide prevention, were developed by the authors specifically for this study to assess actual participant knowledge	Of the 84 participants, 90.5% were female and participants were on average 38.79 (SD = 12.72) years old. Over a third (34.5%) were receiving professional support at the time of participation.

Table 1 (continued)

Author/year	Country	Study participants	Intervention	Comparison	Outcomes	Study design	Scales	More detailed information (age, gender, level of education and so on)
Grosselli L et al., 2024 [32]	Germany	54 classes from 19 schools participated in the study	HEYLIFE is a school-based suicide prevention intervention for students aged > 12 years with a duration of 180 min deliverable in one or two sessions.	n = 353 intervention group, n = 392 control group. No training measures have been taken for the EG.	①③	RCT (pre-, post-, 6 months)	Signs-of-Suicide-knowledge-questionnaire (SOS-k); The Emotional Reactions towards the Mentally Ill Scale; The General Help-Seeking Questionnaire (GHSQ); Risk Factor Scale	Gender proportions were almost balanced at baseline, with n = 308 (41.3%) males. Mean age was 15.5 years (SD = 2.3 years; min = 12, max = 42 years; n = 21 > 25 years old; Table 1). The EG and the CG had no significant difference regarding age, gender, migration background and mental health status.
Seol J et al., 2024 [30]	Korea	These participants were adults aged 20 to 65 residing in Seoul/Gyeonggi areas. They recruited 110 participants by posting promotional information on the website of the Korea Association for Suicide Prevention.	Suicide CARE version 2.0	The EG completed a 2-h training session on July 13, 2022 and completed a survey before and after the training. No training measures have been taken for the EG. The CG underwent a pre-inspection by phone within a 14-day period from July 13, 2022. After 3 months, both the EG and CG underwent a follow-up test, which was conducted online between September 28th and October 12th.	①②③⑤	RCT (pre-, post-, 3 months)	1) perceived suicide prevention knowledge scale (perceived knowledge); 2) self-efficacy to intervene scale (gatekeeper efficacy); 3) suicide prevention related behaviors scale (perceived preparedness); 4) the attitude towards suicide (ATTS)	The EG had 83.7% females, with an average age of 34.9 years. Among them, 49% had completed high school education, 38.8% had completed undergraduate studies, and 42.9% were unemployed. The CG had 77.4% females, with an average age of 31.8 years. Within the CG, 49% had completed high school, 41.5% had completed undergraduate studies, and 47.2% were unemployed.

Note: Outcomes: ①knowledge; ②self-efficacy; ③attitude; ④behavior; ⑤preparedness; ⑥skill; ⑦stigma. EG: the experimental group; CG: the control group; SPEM-F is a single-session (90 min), face-to-face offline group program, and the target audience includes families of PMDs. The aim of SPEM-F is to improve family members' suicide knowledge, attitudes, self-efficacy, preventive behavioral intentions, and family communication skills. Accordingly, the program addresses understanding depressive symptoms, psychiatric disorders and suicide, suicide warning signs, family communication to prevent suicide, and evaluation and response to suicide risk AS + K7 Suicide Gatekeeper Training Program: AS + K7 provides participants with basic suicide statistics and teaches how to identify warning signs for suicide, how to ask about suicidal thoughts, and how to respond appropriately, including seeking emergency services. VA S.A.V.E.: The brief video version of VA S.A.V.E. (24:43 min duration) included myths and facts about suicide, components of the S.A.V.E. model, and suicide prevention and mental health resources. The S.A.V.E. model emphasizes four suicide prevention skills: learning Signs of suicide, Asking about suicidal thoughts, Validating feelings, and Encouraging help and Expediting treatment (S.A.V.E., n.d.). The video concludes with three scripted video vignettes. An abridged version of the training (without the vignettes) is available online <https://learn.psycharmor.org/courses/va-save>

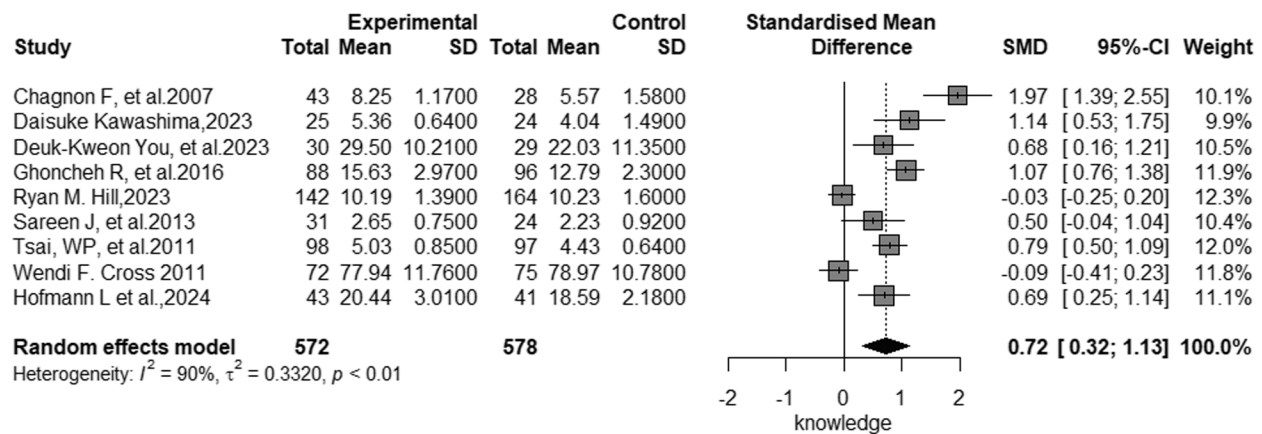


Fig. 2 GKT Forest plot of the effect on knowledge

Table 2 Meta-analysis results stratified by follow-up periods

Variable	Subgroup analysis	Heterogeneity test results		Meta-analysis results	
		I ² value	P value	SMD effect size	(95% CI)
Knowledge		86%	<0.01	0.60	(0.36,0.83)
	post-trained	90%	<0.01	0.72	(0.32,1.13)
	short-term follow-up	81%	<0.01	0.64	(0.22,1.06)
	long-term follow-up	37%	0.18	0.25	(0.05,0.45)
Self-efficacy		85%	<0.01	0.77	(0.54,1.00)
	post-trained	89%	<0.01	0.73	(0.33,1.13)
	short-term follow-up	78%	<0.01	0.86	(0.51,1.20)
	long-term follow-up	85%	<0.01	0.69	(0.04,1.34)
Attitude		96%	<0.01	0.34	(-1.68,1.00)
	post-trained	-	-	-	-
	short-term follow-up	-	-	-	-
	long-term follow-up	-	-	-	-
Behavior		57%	0.03	0.16	(-0.06,0.37)
	post-trained	-	-	-	-
	short-term follow-up	48%	0.14	0.07	(-0.27,0.40)
	long-term follow-up	0%	0.44	0.15	(-0.03,0.30)
Skill		93%	<0.01	0.40	(-0.22,1.02)
	post-trained	96%	<0.01	0.62	(-0.47,1.70)
	short-term follow-up	-	-	-	-
	long-term follow-up	-	-	-	-
Preparedness		83%	<0.01	0.64	(0.32,0.95)
	post-trained	77%	<0.01	0.69	(0.31,1.04)
	short-term follow-up	75%	0.02	0.97	(0.42,1.53)
	long-term follow-up	-	-	-	-
Stigma		0%	<0.01	-0.23	(-0.40,-0.06)
	post-trained	-	-	-	-
	short-term follow-up	-	-	-	-
	long-term follow-up	-	-	-	-

Table 3 Meta-analysis results stratified by participant subgroups, and intervention modality

Variable	Subgroup analysis	Heterogeneity test results		Meta-analysis results	
		I ² value	P value	SMD effect size	(95% CI)
Knowledge		90%	< 0.01	0.72	(0.32,1.13)
	offline	92%	< 0.01	0.68	(0.17,1.19)
	online	-	-	-	-
	specific population	79%	< 0.01	1.10	(0.58,1.63)
	student	-	-	-	-
	school worker	-	-	-	-
	general population	-	-	-	-
Self-efficacy		89%	< 0.01	0.73	(0.33,1.13)
	offline	93%	< 0.01	0.53	(-0.08,1.17)
	online	0%	0.83	1.02	(0.73,1.32)
	specific population	-	-	-	-
	student	83%	< 0.01	0.66	(0.11,1.20)
	school worker	-	-	-	-
	general population	-	-	-	-
Skill		96%	< 0.01	0.62	(-0.47,1.70)
	offline	97%	< 0.01	0.92	(-0.34,2.19)
	online	-	-	-	-
	specific population	-	-	-	-
	student	-	-	-	-
	school worker	-	-	-	-
	general population	-	-	-	-
Preparedness		77%	< 0.01	0.69	(0.31,1.07)
	offline	0%	0.50	0.38	(0.18,0.57)
	online	-	-	-	-
	specific population	-	-	-	-
	student	38%	0.20	0.50	(0.20,0.80)
	school worker	-	-	-	-
	general population	-	-	-	-

The effect of GKT on trainees' self-efficacy for suicide prevention

The pooled SMD for self-efficacy was 0.73 (95% CI: 0.33 – 1.13). However, significant heterogeneity was observed ($I^2=89\%$; $p<0.01$). Sensitivity analysis revealed that excluding individual studies did not substantially alter the overall effect size. (Fig. 3, S5 Figure. b in the Supplement). For follow-up data, the improvement in self-efficacy was sustained in the short-term (SMD=0.86, 95% CI: 0.51–1.20), but diminished in the long-term (SMD=0.69, 95% CI: 0.04–1.34). Online interventions showed a large effect size (SMD=1.02, 95% CI: 0.73 –1.32). A moderate but significant improvement in self-efficacy among students (SMD=0.66, 95% CI: 0.11–1.20). (Tables 2 and Tables 3).

Egger's regression test indicated no significant publication bias for post-test data (Bias estimate=3.43, SE=3.48, $p=0.37$). Visual inspection of the funnel

plot suggested potential asymmetry. The Trim and Fill method yielded an adjusted SMD of 0.44 (95% CI: -0.05 – 0.92; $p=0.08$). Although the adjusted effect size was not statistically significant ($p=0.08$), the confidence interval included the original pooled effect size (SMD=0.73). (S7 Table, S8 Figure. cd and S9 Table in the Supplement).

The effect of GKT on trainees' skills for suicide prevention

The pooled SMD for skills using the random-effects model was 0.62 (95% CI: -0.47–1.70), there was no statistically significant improvement in skills among gatekeepers following GKT. Significant heterogeneity was observed ($I^2=93\%$, $p<0.01$). In the short-term follow-up, the effect size was small and not statistically significant. (Fig. 4, Tables 2 and 3).

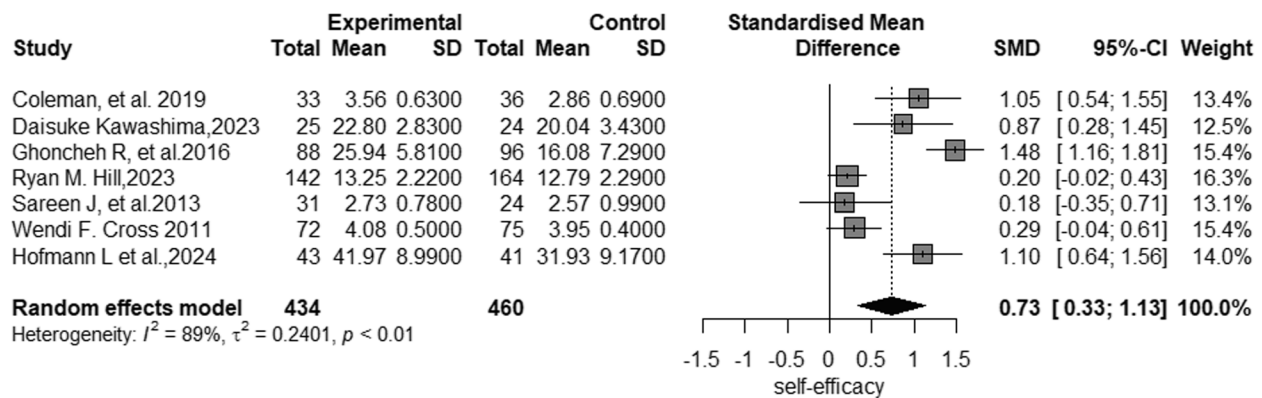


Fig. 3 GKT Forest plot of the effect on self-efficacy

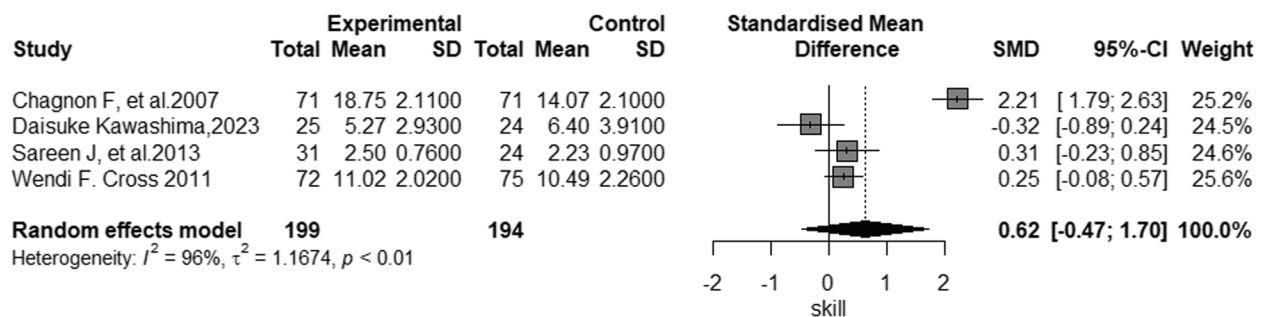


Fig. 4 GKT Forest plot of the effect on skill

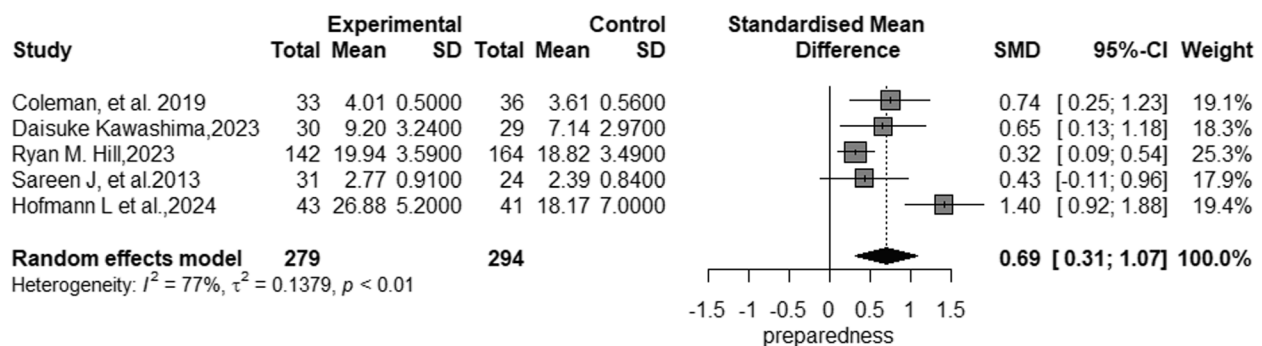


Fig. 5 GKT Forest plot of the effect on preparedness

The effect of GKT on trainees' preparedness for suicide prevention

The pooled SMD for preparedness using the random-effects model was 0.69 (95% CI: 0.31 – 1.07) with significant heterogeneity ($I^2 = 77\%$, $p < 0.01$). In the short-term follow-up, the effect size was large and statistically significant (SMD = 0.97, 95% CI: 0.42 – 1.53). For students, the SMD ranged from 0.20 to 0.80, while offline interventions demonstrated a small improvement with an SMD

of 0.38 (95% CI: 0.18 – 0.57) and very low heterogeneity ($I^2 = 0\%$, $p = 0.50$). (Fig. 5, Tables 2 and 3).

Egger's regression test indicated no significant publication bias for preparedness (Bias estimate = 3.26, SE = 2.19, $p = 0.23$). Visual inspection of the funnel plot suggested potential asymmetry. The Trim and Fill method yielded an adjusted SMD of 0.41 (95% CI: -0.05 – 0.88; $p = 0.09$). Although the adjusted effect size was not statistically significant ($p = 0.09$), the confidence interval included the

original pooled effect size ($SMD=0.69$). (S7 Table, S8 Figure, and S9 Table in the Supplement).

Discussion

To our knowledge, this is the first and most comprehensive pooled analysis of RCTs related to GKT, encompassing a diverse and broad population without restriction to specific population. Preliminary data suggested that GKT can enhance participants' knowledge of suicide prevention, improve self-efficacy and preparedness, and reduce stigma toward suicide. However, definitive evidence on its effects on attitudinal and behavioral outcomes remains lacking [7, 13, 47, 48]. Because acquiring knowledge is relatively straightforward, changing attitudes is more challenging. Attitudes reflect deeper values and may require extended durations to achieve significant change. Short training sessions (e.g., 1–2 h) may be insufficient to induce meaningful attitudinal shifts [29]. Insufficient attitudinal changes can undermine the sustainability of GKT outcomes, as improved knowledge and skills in suicide prevention do not always translate into behavioral change. The short follow-up periods of most studies may not be long enough to capture significant behavioral changes among participants [49]. To ensure a lasting impact on suicide prevention behaviors, future GKT programs should focus more on altering attitudes, as this is a crucial factor in achieving sustained behavioral change [47].

Our study confirms that GKT is effective in enhancing both knowledge and self-efficacy, consistent with previous research [7]. However, we observed a significant decline in suicide knowledge scores from post-test to follow-up, indicating that knowledge gained may diminish over time. This novel finding suggests that acquired knowledge tends to decline over time if not regularly applied [50]. Although the effectiveness of GKT decreases over time, its importance is not diminished. Similar to other forms of skills training, GKT should be periodically refreshed to maintain its impact [50, 51]. Strategies such as spaced learning, which involves distributing training over time rather than concentrating it in a single phase, and practice-based interventions, have been identified as effective methods to enhance training outcomes [52].

The results indicated that both online and offline delivery methods have an impact on GKT. Specifically, online methods appear to be more effective in improving self-efficacy among trainees. Innovative training modalities are essential as advancements in science and technology increasingly influence GKT. Recent years have seen a growing reliance on online technologies for GKT [26, 53–55]. Online training offers several benefits: it overcomes time and space constraints, providing accessibility

and flexibility that benefit gatekeepers with limited resources [34]. Online training utilizes flexible, user-friendly and relatively inexpensive internet technologies [24, 34, 56]. The online training can accommodate for its flexibility and scalability. This format has proven effective in reducing training costs, as demonstrated during the COVID-19 pandemic when remote meetings enabled interaction with national suicide prevention experts without incurring high travel costs [25]; Additionally, online training can enhance privacy and engagement by addressing concerns associated with sharing sensitive content in traditional settings. Some participants may be reluctant to participate in this program due to privacy concerns. Online GKT courses may help overcome these obstacles to promote more people's participation [53]; Studies have shown that online training can be as effective as face-to-face training, sometimes even reducing trainee reluctance to intervene more effectively [57]. It also increases learner control over the training process and extends accessibility to individuals who previously had limited opportunities for suicide prevention training [7, 58]. However, online training does have limitations: participants may lack foundational knowledge, be less adequately prepared, and show lower efficiency or exhibit reluctance to assume the role of gatekeepers. There is also a shortage of comprehensive videos offering detailed implementation guidance or targeted content for specific demographics [59]. Therefore, combining online and offline training modalities can significantly enhance the overall effectiveness of GKT.

The results indicated that the effectiveness of GKT varies depending on the participants, highlighting the need for careful consideration in selecting individuals for the program. Preliminary analysis suggested that targeted training for specific professional groups, such as healthcare workers, teachers, and first responders, may yield higher benefits as gatekeepers. This is likely due to their frequent interactions with high-risk individuals and their ability to apply GKT skills in their daily roles. In contrast, the general population may derive less immediate benefit. Therefore, given the challenging nature of the gatekeeper role, individuals must be selected thoughtfully, choosing more suitable trainees for the program. GKs should possess the capacity to effectively support suicide prevention efforts for at-risk populations. They need to have the skills and sense of responsibility required to intervene and take action to prevent suicide [60]. Previous studies have often overlooked the importance of participant selection. Future research should address aspects such as the suitability of trainers, the selection criteria for trainees, and the content of the training. Additionally, it is crucial to evaluate training tailored to specific backgrounds or populations [4]. Equally important is the

consideration of health support for GKs. Establishing a robust support system, such as a buddy system for GKs to train together and regular meetings to share experiences and technical resources, is essential [6].

Some limitations of this study should be noted. Significant heterogeneity was observed among the included studies, indicating substantial variability in results. The limited number of studies for certain outcomes, particularly in subgroup analyses, may restrict the reliability and generalizability of the findings. Future research should include more high-quality studies to validate these findings and enhance the robustness of the analysis. Methodological challenges were also identified, particularly the difficulty in achieving blinding of participants and personnel. Given that GKT involves active participation and skill-building, blinding is often impractical, potentially introducing performance bias. Despite this limitation, the consistency of results across studies with varying levels of blinding suggests that the impact of performance bias may be mitigated. Researchers should explore innovative approaches, such as using objective outcome measures or independent assessors, to address these challenges. Addressing these limitations, particularly those related to blinding and incomplete data, will be crucial for advancing our understanding of GKT's effectiveness and its long-term impact on suicide prevention behaviors, ultimately informing the development of more effective strategies.

Conclusions

Based on the meta-analysis of RCTs, this review provides robust evidence reaffirming the effectiveness of GKT programs in enhancing knowledge, self-efficacy, and preparedness. However, the positive effects on knowledge and self-efficacy tend to diminish over time. Online training has gained popularity as a delivery method for GKT, and our analysis compared its effectiveness with traditional in-person approaches. The selection of training participants is critical, given that the effectiveness of GKT varies across different populations. To maximize outcomes, we recommend that future GKT programs incorporate regular sessions, extended durations, innovative modalities, and more targeted participant selection, thereby fostering lasting attitude changes and promoting sustained intervention behaviors.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-21736-1>.

Supplementary Material 1.

Acknowledgements

Not applicable.

Authors' contributions

W G: Writing – review & editing, Supervision, Resources, Project administration, Investigation, Funding acquisition, Conceptualization. H L: Writing – original draft, Validation, Project administration, Methodology, Formal analysis, Data curation. C Z: Writing – review & editing. Y C: Writing – review & editing. F Z: Methodology, Formal analysis. H C: Methodology, Formal analysis.

Funding

This project was supported by Senior Talent Startup Fund of Nanchang University [grant number 28170120/9167] and Postgraduate Innovation Special Fund of Jiangxi Province [grant number YC2023–S181].

Data availability

All data generated or analyzed in this study are included in this manuscript. This means that a list of all studies included in this review is provided as supplementary material.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 15 August 2024 Accepted: 31 January 2025

Published online: 31 March 2025

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