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SYSTEMATIC REVIEW / SİSTEMATİK DERLEME

A Systematic Analysis on the Effectiveness of Mobile Applications for Suicide Prevention

İntiharı Önlemeye Yönelik Geliştirilen Mobil Uygulamaların Etkinliği Üzerine Sistematik Bir Analiz

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Abstract

Objective: This descriptive systematic review was evaluated the effectiveness of mobile applications designed to aimed to prevent suicide.

Material and Method: Within the scope of the study, open access Turkish and English articles published in online databases (Web of Science, PubMed, WİLEY, Taylor & Francis Online, Science Direct) between 2019 and August 2024 were reviewed. Randomized controlled trials on mobile applications whose role in preventing suicide was clearly stated in the articles were included in the study.

Results: As a result of the screening, seven studies that met the inclusion criteria were included in this study. In four of the included studies, a routine intervention (awareness training, psychotherapy or medical treatment) was compared with an additional mobile application; in three studies, a routine intervention was compared with a mobile application. As a result of the evaluation, different results were obtained in terms of the effectiveness, acceptability and usability of mobile applications. It was concluded that mobile applications with psychotherapy content, especially applied together with face-to-face interventions, provided more positive results in reducing the risk of suicide. However, the level of effectiveness may vary depending on the content of the application, the characteristics of the sample, and whether it is a treatment support. All that, it has been determined that mobile applications are usable but that there is strictly limited data on their acceptability.

Conclusion: Mobile applications aimed at preventing suicide are potential tools that can be used in preventing suicide. However, there is no definitive result regarding their alone effectiveness. It is important to increase randomized controlled studies with a large sample, long follow-up period, and high level of evidence.

Keywords: Suicide, mobile applications, mental health.

Öz

Amaç: Bu tanımlayıcı sistematik derleme, intiharı önlemeye yönelik tasarlanan mobil uygulamaların etkinliğini değerlendirmek amacıyla yapılmıştır.

Gereç ve Yöntem: Çalışma kapsamında 2019 - Ağustos 2024 tarihleri arasında çevrimiçi veri tabanlarında (Web of Science, PubMed (MEDLINE), WİLEY, Taylor & Francis Online, Science Direct) sağlık alanındaki dergilerde yayınlanmış, açık erişimi olan, Türkçe ve İngilizce makaleler ele alınmıştır. Makalelerde intiharı önlemedeki rolü açıkça belirtilen mobil uygulamalarla ilgili randomize kontrollü deneysel araştırmalar çalışmaya dahil edilmiştir.

Bulgular: Yapılan tarama sonucunda dahil etme kriterlerine uygun yedi araştırma bu çalışmaya dahil edilmiştir. Dahil edilen dört araştırmada rutin bir uygulama (farkındalık eğitimi, psikoterapi veya tıbbi tedavi) ile ek olarak bir mobil uygulama; üç araştırma da ise rutin bir uygulama ile mobil uygulama karşılaştırılmıştır. Değerlendirme sonucunda mobil uygulamaların etkinliği, kabul edilebilirliği ve kullanılabilirliği açısından farklı sonuçlar elde edilmiştir. Özellikle yüz yüze müdahaleler ile birlikte uygulanan psikoterapi içerikli mobil uygulamaların intihar riskini azaltmaya yönelik daha olumlu sonuç verdiği sonucuna ulaşılmıştır. Ancak etkinlik düzeyinin uygulamanın içeriğine, örneklemin özelliğine, bir tedavi desteği olup olmamasına göre değişebilmektedir. Aynı zamanda mobil uygulamaların kullanılabilir olduğu ancak kabul edilebilirliği ile ilgili kesin verilerin sınırlı olduğu belirlenmiştir.

Sonuç: İntiharı önlemeye yönelik mobil uygulamalar potansiyel araç olarak kullanılabilir. Ancak tek başına etkinliği ile ilgili kesin bir sonuç yoktur. Geniş örneklemde, takip süresinin uzun sürdüğü, kanıt düzeyi yüksek olan randomize kontollü çalışmaların artırılması önemlidir.

Anahtar Kelimeler: İntihar, mobil uygulamalar, ruh sağlığı.

1. Introduction

Suicide, which is a multifaceted phenomenon that includes biological, social, spiritual, economic and cultural aspects in terms of community mental health, is defined as the intentional ending of one's own life (1). Suicide is among the leading causes of death in many countries and is a serious global public health problem (1, 2). Therefore, suicide prevention efforts should be carried out in a multidisciplinary manner with state coordination; in a planned manner at the level of family, school, workplace and relevant organizations (3). In addition, psychosocial interventions conducted individually or in groups have an important place in suicide prevention efforts (4, 5). In the literature, studies on psychosocial interventions with high evidence level for suicide prevention have determined that interventions such as Cognitive Behavioral Therapy (CBT) (5, 6), Dialectical Behavioral Therapy (DBT) (7), and Collaborative Suicide Assessment and Management (8) are effective. These interventions require trained and experienced therapists, are costly, and may cause difficulties with appointments due to being mostly face-to-face (individual therapy, group therapy), and people in rural areas may have limited access. Such situations can make it difficult to access psychosocial interventions (9, 10). In some countries, the small number of mental health workers and therapists compared to the population size; and the inadequacy of mental health services in rural areas further increase the risk of suicide (9). While traditional suicide prevention strategies are generally based on face-to-face interventions, mobile applications have added a new dimension to suicide prevention efforts with the development of technology. Mobile applications have provided an easily accessible platform for users to encourage help-seeking behaviors, provide emotional support, cope with suicidal thoughts, and provide psychotherapy support (11, 12). In addition, due to their ease of access, they have advantages such as being easily accessible during crisis periods, providing accurate reporting on sensitive issues, and reducing stigma compared to face-to-face interventions (2, 10, 13). There are many studies in the literature that evaluate the effectiveness of mobile applications developed for suicide prevention (such as reducing suicidal ideation, crisis intervention) (11, 14, 15). These studies emphasize that these applications are limited, especially because the subject of suicide is a sensitive and risky issue (2, 10, 11), and that studies with a high level of evidence should be increased (10). In the literature, there are randomized controlled trials with a high level of evidence aimed at determining the effectiveness of many mobile applications designed to prevent suicide (12, 16, 14). This systematic analysis aims to evaluate the effectiveness of mobile applications designed to prevent suicide by examining randomized controlled trials. It is thought that the study will contribute to interventions aimed at preventing suicide and guide users in using mobile applications correctly and more consciously when necessary. The research questions regarding the purpose of the study are as follows:

1. Are mobile applications effective in preventing suicide?
2. Are mobile applications acceptable and usable in preventing suicide?
3. What application features and content were used?

2. Material and Method

The descriptive study is a systematic review of randomized controlled experimental trials conducted to determine the effectiveness of mobile applications used to prevent suicide. For this purpose, PICOS steps (17) were taken into account to create the framework of the research questions. Accordingly, Population (P): The studies that investigate the individuals with suicidal ideation or risk targeted to evaluate the effect of the mobile application. Intervention (I): The studies that use of a mobile application that has direct results for preventing suicide. Comparators (C): Comparison of individuals who use and do not use the mobile application. Outcome (O): Effects of the mobile application on preventing suicide, reducing suicidal behavior and thoughts. Study design (S): Randomized controlled experimental studies. The Preferred Reporting Items For Systematic Reviews and Meta-Analyses (PRISMA) protocol was followed in the conduct of this study (18) and it is registered on PROSPERO (ID: CRD42024582557).

2.1 Search Strategy

The literature search was conducted between July and August 2024 within the scope of the study. The searches were conducted in Web of Science, PubMed (MEDLINE), WILEY, Taylor & Francis Online, and ScienceDirect databases. In order to access national and international publications, the keywords 'suicide' AND 'mobile app', 'suicide' AND 'mobile application', 'suicide' AND 'smartphone', 'suicide' AND 'app' were used. In the first stage of the searches, articles published between 2019 and August 2024, open access, and published in English and Turkish were examined.

2.2 Selection of Studies

In the study, first, two researchers searched the literature using the defined keywords in a joint session and examined five randomly selected sample articles. At this stage, a pilot application was conducted by evaluating the selection of articles, defining the quality of the article, and determining the criteria. Then, the researchers worked independently to reduce bias. Finally, the researchers came together again in a joint session, discussed the articles they had identified, and a consensus was reached.

When evaluating the articles, the inclusion criteria such as being related to a mobile application for preventing suicide, being a randomized controlled trial only to reach a high level of evidence, and clearly defining the role of the application in preventing suicide (suicide prevention, suicide management, reduction of suicidal ideation) were taken into consideration. In addition, randomized controlled trials related to web-based computer-based applications, whose results were unclear, whose full text could not be accessed, which non-randomized controlled trial (study protocol, systematic review - meta-analysis, clinical research, etc.), and which were only related to self-harming behaviors without a suicide risk were not included in this systematic review.

In this process, the researchers worked independently to reduce bias, then discussed the articles they identified in a joint session and reached a consensus. In the first step, the abstracts of all articles were examined, and the full texts of the studies that met or were thought to meet the criteria were read. As a result of the evaluation, the eligibility of seven studies was decided. Later, the "RAYYAN" application (19) was used to evaluate the accuracy of the data, and a similar result was obtained. The PRISMA diagram regarding the selection process of the articles examined in the systematic review is given in Figure 1.

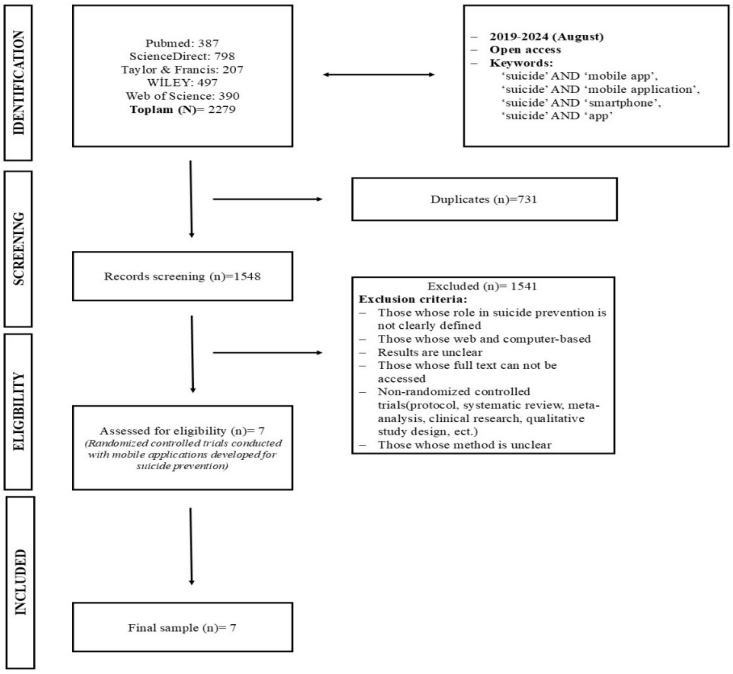

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses Flowchart

2.3 Data Extraction

The data extraction process was carried out independently by two researchers and then checked in a joint session and converted into a single text. In order to determine the appropriate studies within the scope of the inclusion and exclusion criteria, a data extraction tool was developed by the researchers using the EXCEL program. In this data extraction tool; data regarding the author and publication year of the studies, method, sample characteristics, country of conduct, purpose, mobile application name, measurement tools in evaluation, intervention method and outcome were defined. Data regarding the studies included in the systematic review are shown in Table.

2.4 Assessment of the Quality of Studies

The quality of the articles that evaluated the effectiveness of mobile applications, determined within the scope of the study, was assessed by taking into account the criteria adapted from the Study Quality Assessment Tools prepared by the National Institute of Health (NIH) (13,20). The assessment criteria are as follows; 1) clear statement of the research question or purpose, 2) clear definition of the study population, 3) representativeness of the sample (0.5 points) and presence of clearly stated inclusion and exclusion criteria (0.5 points), 4) justification of the sample size or presence of a power analysis, 5) presence of a sufficient time frame to justify the association between mobile app use and outcome, 6) presence of multiple assessment points (i.e., baseline and follow-up or pre- and post-test), (7) presence of evidence-based measures to assess outcome (0.5 points for self-report; 1 point for clinician-report, as clinician-reported measures are generally considered more reliable) (i.e., 0.5 for the Beck Suicidal Ideation Inventory; 1 point for the Columbia Suicide Severity Rating Scale), 8) presence of raters unaware of participants' status, 9) less than 20% of participants were lost to follow-up, 10) presence of covariates whose effects on outcome were statistically adjusted. In the assessment; each criterion is given a score between 0 and 1, and the total quality score varies between 0 and 10. 0-3 points = low quality study, 4-6 points = moderate quality study, 7-10 points = good quality study (13). In order to prevent bias in the study, the researchers first scored the articles individually, then discussed them in a joint session and finalized the scoring.

2.5 Statistical Analysis

Since the research data examined within the scope of the study were heterogeneous, meta-analysis could not be performed. The data obtained as a result of the systematic analysis are presented in the form of a table.

3. Results

In this systematic review conducted to evaluate the effectiveness of mobile applications used to prevent suicide, 1580 articles published between 2019 and August 2024 were reached as a result of the database scan, and when examined according to the exclusion criteria; a total of seven randomized controlled trials were analyzed.

3.1 Characteristics of the Studies

The studies included in the evaluation were conducted in Australia (11, 15, 16), Denmark (21), Argentina (12), Iran and Azerbaijan (22), the United States (14), and the United Kingdom (23), with a total sample size of 2710. The sample group of the studies consisted of adolescents (14) and adults (11, 12, 15, 16, 21, 22). The studies evaluated the mobile applications MATESmobile, LifeApp, CALMA, LifeBuoy, BrighterSide, YARA, and BRITE (Table 1).

In the studies involving experimental and control groups, randomized controlled trial methods such as parallel group design (single-blind and double-blind), factorial design and multicenter design were applied. In four studies, educational intervention (11), psychotherapy (12, 21) and routine treatment (14) interventions were used in the control group; mobile applications were used in addition to these in the experimental group. In three studies, a mobile application providing non-therapeutic information (16) and routine care and treatment (15, 22) were used in the experimental group; only the mobile application was used in the control group and the groups were compared.

The effectiveness of mobile applications on suicide (thoughts, behaviors) was evaluated using different criteria. The General Help-seeking Questionnaire (GHSQ) (11), Suicide Status Form II–R (SSF) (21), Self-Injurious Thoughts and Behaviors Interview (SITBI) (12), Columbia-Suicide Severity Rating Scale (C-SSRS) (14), Suicidal Ideation Attributes Scale (SIDAS) (15, 16), Beck Scale for Suicidal Ideation (BSSI) (22) scales were used in the evaluation (Table 1). The quality assessment scores of the articles examined within the scope of the study varied between 6.5 and 9.5; when evaluated in general, it was determined that they were "good quality studies". The quality scores of the studies are shown in Table 1.

Table 1. Efficacy and Features of Mobile Applications For Suicide Prevention

Study	App	Aim	Sample	Interventions	Suicidal Outcome Measures	Main Findings	Quality Score
King et al. (2023)	MATESmobile	Evaluation of the MATESmobile application Evaluation of the effectiveness of the MATESmobile application in completing face-to-face education	1084 construction workers aged 18 and over working in **Australia**	At the beginning and at the 3rd month; Control group: General Awareness Training Experimental group: General Awareness Training and MATESmobile	Modified version of the face-to-face training suicide awareness questionnaire Suicide prevention literacy scal General Help-seeking Questionnaire (GHSQ)	According to the results of the research, MATESmobile application increased the help-seeking behaviors of individuals working in the construction sector for their emotional problems, MATESmobile users had a weak effect on seeking help for suicidal thoughts; it did not have any effect on seeking help from different sources, The mobile application supported MATES face-to-face general awareness training.	8
O'Toole MS, Arendt MB, Pedersen CM. (2019)	LifeApp	Evaluation of the effect of mobile application (Lifeapp) on suicide prevention treatment	129 patients aged 18-65 receiving treatment for suicide risk in **Denmark**	During the four-month follow-up period; Control group: Psychotherapy Experimental group: Psychotherapy + LifeApp	Suicide Status Form II–R (SSF) Major Depression Inventory	According to the results of the study, It was determined that the group combined with psychotherapy had a decrease in the suicide risk they reported after the treatment, but there was no difference between the groups regarding depression symptoms.	8,25
Rodante DE et al. (2022)	CALMA	Evaluating the acceptability and preliminary efficacy of CALMA as an adjunct to Dialectical Behavior Therapy (DBT) for non-suicidal and suicidal self-harming behaviors.	18 patients aged 18-65 who attended one of the DBT Skills Training groups in **Argentina** and had a history of suicide within one month	During the four-month follow-up period; • Control group: Psychotherapy (DBT) • Experimental group: Psychotherapy (DBT) + CALMA	• Self-Injurious Thoughts and Behaviors Interview (SITBI) • User Experience Questionnaire short version (UEQ-s)	• According to the results of the study, • CALMA showed good acceptability for use as an adjunct to DBT to reduce suicide and non-suicide self-harming behavior, • In the context of preliminary efficacy, it was determined that CALMA application was useful in reducing suicidal behavior.	6,5
Torok M et al. (2022)	LifeBuoy	To investigate the effectiveness of a therapeutic smartphone application (LifeBuoy) in reducing the severity of suicidal thoughts by comparing it with an attention management application (LifeBuoy-C) and to examine the effects of this effectiveness on mental states such as depression, anxiety, stress and general well-being.	455 young people aged 18-25 in **Australia** who had suicidal thoughts in the last 12 months	With follow-ups at the beginning, after the intervention and at 3th month; • Control group: LifeBuoy-C (Non-therapeutic) Experimental group: LifeBuoy (DBT)	• Suicidal Ideation Attributes Scale (SIDAS) • Patient Health Questionnaire-9 (PHQ-9) • Generalized Anxiety Disorder-7 (GAD-7) • Distress Questionnaire-5 (DQ5) • Short Warwick–Edinburgh Mental Well-Being Scale, (SWEMWBS)	According to the results of the study, • LifeBuoy was associated with significant improvements in the severity of suicidal ideation when compared to the control application LifeBuoy-C, It was not associated with mental conditions.	9

Table 1. (continued) Efficacy and Features of Mobile Applications For Suicide Prevention

Study	App	Aim	Sample	Interventions	Suicidal Outcome Measures	Main Findings	Quality Score
Goldstein TR et al. (2024)	BRITE	Evaluation of the effectiveness of ASAP (psychoeducation), BRITE and its combinations on suicide attempts/ ideation, non-suicidal self-harm and repeated hospitalizations	240 adolescent patients aged 12-18 years who were hospitalized in psychiatric clinics in the **United States** due to suicide attempt/ ideation	To be evaluated at weeks 4, 12 and 24; • Control group: Treatment as usual (TAU) • Experimental group: ASAP + BRITE + TAU • Experimental group: ASAP + TAU • Experimental group: BRITE + TAU	• Columbia–Suicide Severity Rating Scale (C-SSRS) • Child and Adolescent Services Assessment (CASA)	According to the results of the study, • ASAP or BRITE had no significant effect on the rate of actual attempts, time to attempt, and non-suicidal self-harm behavior • The rate of hospitalization for suicide attempts decreased (76.5% with BRITE vs. 86.4% without BRITE) and the interval between attempts was extended • The combination of ASAP, BRITE, TAU was similarly effective in reducing the risk of suicide 6 months after hospital discharge in high-risk participants • ASAP intervention (with or without BRITE) had a lower risk of rehospitalization over 6 months • Although not statistically significant, ASAP+BRITE was most consistently associated with a 60% reduction in suicide attempts.	9,5
Josifovski N. Et al. (2024)	BrighterSide	Evaluation of the effectiveness of the BrighterSide application in reducing the severity of suicidal ideation	A total of 550 adults aged 18 to 65 in **Australia** who had suicidal thoughts in the past two weeks	To be evaluated at baseline, 6th week and 12th week; • Control group: TAU • Experimental group: BrighterSide	• Self-report questionnaires • Suicidal Ideation Attributes Scale (SIDAS) • Coping Orientation to Problems Experienced Inventory (Brief-COPE) • Functioning and Recovery Scale (FRS) • Distress Questionnaire-5 (DQ5) • Actual Health-Seeking Questionnaire (ASHQ) • WHO Disability Assessment Schedule (WHODAS–1 item) • Implementation Appropriateness Measure (IAM) • Digital Working Alliance Inventory (DWAI)	According to the results of the study, • It was determined that the BrighterSide application did not lead to a significant improvement in suicidal ideation compared to the control group.	9,5
Soltani Z et al. (2024)	YARA	Determining the effects of YARA mobile application on major depression, anxiety, sleep quality and suicidal thoughts	64 patients aged 15-60 hospitalized in psychiatric clinics in **Iran and Azerbaijan**	During the three-month follow-up period; • Control group: TAU Experimental group: YARA	• Spielberger State-Trait Anxiety Inventory (STAI), • Pittsburgh Sleep Quality Index (PSQI) • Beck Scale for Suicidal Ideation (BSSI)	According to the results of the study, • YARA application was found to be a suitable solution for improving major depression, anxiety and sleep quality, YARA application was found to be ineffective in reducing suicidal thoughts.	7,5

It has been stated that some of the studies examined within the scope of the study experienced sample loss due to being conducted during the COVID period, and this situation reduced the power to detect the effect of the mobile application (11,22). In addition, it has been stated that reasons such as the small sample size (11, 12, 21), the sample consisting of people with similar characteristics (12, 14, 22), the low response rate of users in the follow-up (11), and the low number of people downloading the application (11, 22) negatively affect the generalizability of the research results.

3.2 Features of Mobile Applications

3.2.1 Content of mobile applications

The content of mobile applications evaluated in the studies is seen to have different characteristics. When the applications are examined; MATESmobile is an education-supported application developed to strengthen the general awareness training on suicide given to construction workers and to provide psychological support when necessary (11).

LifeApp application consists of sections such as psychoeducation on suicide, self-assessment, daily sleep, appetite and stress levels, safety plan, a digital hope kit, asking for help, and self-help exercises. Techniques such as problem solving, distraction, awareness, acceptance and commitment therapy (ACT), planning enjoyable activities, reducing social isolation, etc. are used (21).

CALMA application includes dialectical behavior therapy-supported interventions aimed at preventing suicide in times of crisis (12).

LifeBuoy application includes interventions related to value identification, goal setting, psychoeducation, emotion regulation and distress tolerance based on CBT and DBT (16).

YARA application includes a daily exercise training video to increase physical activity, a morning meditation exercise, a yoga video before bed, and standard wordless relaxing music from nature that helps the individual fall asleep more easily (22).

BRITE application includes a personalized safety plan for adolescents, distress tolerance, and emotional regulation skills. It recommends relaxing activities for adolescents with high levels of distress (14).

BrighterSide application is based on CBT, DBT, ACT, and positive psychology, and includes self-directed suicide prevention interventions. The application consists of five modules: "Understand, Prevent Crisis, Manage Your Emotions, Manage Your Thoughts, and Plan for the Future" (15).

3.2.2 Accessibility of mobile applications

BrighterSide, BRITE and CALMA mobile applications examined within the scope of the study are compatible with iOS and Android platforms, while other applications were developed by the researcher for users.

3.2.3 Effectiveness of mobile applications

The effectiveness of a mobile application refers to how successfully the application achieves the specified goals (2). Different measurement tools were not used to determine the effectiveness of the mobile application. The four studies examined within the scope of the study evaluated the use of mobile applications in addition to a routine application (mindfulness training, psychotherapy or medical treatment). In addition to general mindfulness training in construction workers, the MATESmobile application had a weak effect on the intention and behavior to seek help for suicidal thoughts (95% CI 0.09-0.85, d=-0.14) (11); the LifeApp mobile application used in addition to psychotherapy did not effect depression symptoms (p= 0.732, d= 0.05 at T0 and p= 0.467, d= 0.11 at T1), but the group in which psychotherapy was combined experienced a decrease in suicide risk after treatment (p= 0.008, d= 0.46) (20); The CALMA mobile application used in addition to dialectical behavior therapy was found to be acceptable and useful in reducing non-suicidal and suicidal self-harming behaviors (85%CI = 0.08-0.628) (12). However, when used in conjunction with the suicide education intervention, it was determined that the BRITE application alone did not have a sufficient effect, and that it reduced the rate of hospitalization due to suicide attempts and the suicide attempt rate (p= 0.01), and extended the time between suicide attempts (p= 0.020) (14).

In addition, three studies compared mobile applications for suicide with another intervention or routine treatment. When a different mobile application (providing non-therapeutic information) was compared with the LifeBuoy mobile application, it provided significant improvement in reducing severe suicidal ideation alone ($p < 0.001$, $d = 0.45$ at T1 and $p = 0.007$, $d = 0.34$ at T2) but had no effect on secondary mental health problems ($p = 0.069$-0.896) (16); when routine treatment was compared with the BrighterSide mobile application, it did not provide significant improvement in suicidal ideation alone ($p = 0.677$ at T0 and $p = 0.272$ at T1) and attempts ($p = 1{,}000$ at T0 and $p = 0.403$ at T1) (15); when routine care (doctor visits, medication prescriptions and monthly psychiatric consultations) was compared with the YARA mobile application, it was found to be effective in improving anxiety and sleep quality in depressed patients alone ($p < 0.001$), but had no effect on suicidal thoughts ($p \geq 0.05$) (22).

3.2.4 Usability and acceptability of mobile applications

Usability in mobile applications is related to the user-friendliness of the application, speed and reliability, ease of habituation, being easily accessible and understandable. The higher the usability, the easier it is for users to access the information or functions they need with minimal effort (24). Usability is an important criterion for managing crisis situations in mobile applications developed for mental health, especially suicide (9). Acceptability in mobile applications refers to how the application is received by the target audience. Users' feedback on liking the application, using it frequently and recommending it, and its usefulness are important in terms of acceptability (24).

Usability and acceptability of mobile applications were evaluated with satisfaction surveys and qualitative data. Studies have indicated that mobile applications are easily accessible and usable (11, 12, 14–16, 21, 22). However, in studies on CALMA (12), LifeBuoy (16), and BRITE (14) applications; it was found that users welcomed the applications positively and were satisfied; It has been determined that the applications are largely acceptable. However, in the studies on MATESmobile, LifeApp, BrighterSide, YARA applications, sufficient information about user experiences could not be obtained.

4. Discussion

In this systematic review conducted to evaluate the effectiveness of mobile applications used for suicide prevention, seven randomized controlled trials on mobile applications were examined. It is stated in the literature that randomized controlled studies on mobile applications for suicide are limited in number and that the existing studies make significant contributions to the literature (9). The data obtained within the scope of the study were discussed under two headings.

4.1 Effectiveness of Mobile Applications for Suicide Prevention

The studies examined within the scope of the study show that mobile applications have different levels of positive results in reducing the risk of suicide; however, these

results may vary across depending on the characteristics of the sample, the content of the application, and whether it is used in addition to a treatment support. It is seen that the results are similar in the literature on systematic analysis studies. Jiménez-Muñoz et al. (25) examined 19 ecological instant mobile interventions for suicide prevention published until September 2021; it was stated that the most commonly used intervention model was the safety plan, which allows the user to apply coping and distraction strategies in case of suicidal ideation, and that the interventions provide some advantages, but the evidence on their effectiveness is still insufficient. In 22 studies on internet and mobile applications for suicide prevention published until July 2019, reviewed by Malakouti et al. (26), it was reported that users generally had a decrease in suicidal ideation scores, but no evidence of a decrease in impulsivity after the use of the applications was reported. In a study conducted by Castillo-Sánchez et al. (27) on 16 mobile applications for preventing suicide in virtual stores, it was stated that although there were positive approaches to the use of applications for suicide prevention and monitoring, their design should also be supported by healthcare personnel; there were problems with updating the applications (only 45% were updated in the last year). On the other hand, in seven studies conducted by Melia et al. (10) between 2013 and 2018 on mobile applications for preventing suicide, it was concluded that there was insufficient solid evidence evaluating the effectiveness of mobile applications on suicide outcomes and that mobile applications did not significantly reduce suicidal thoughts when compared to the control group. In the study conducted by Jha et al. (2) examining 80 mobile applications developed for suicide prevention available in application stores and academic journals, it was stated that suicide prevention applications using persuasive strategies (interactive systems designed to help users change their behavior) may be promising and that more studies should be conducted. Arshad et al. (9) reported in 22 studies published until March 2019 on internet and mobile applications developed for suicide prevention that internet and mobile-based interventions are promising, but more controlled trials focusing on suicidal behavior are needed. Sarubbi et al. (13) reported in 32 studies examining mobile applications developed for suicide prevention between January 2010 and May 2022 that mobile applications are effective; they can provide real-time monitoring of people at risk, personalized tools for coping with suicide, and instant access to specific support. Accordingly, it can be concluded that mobile applications may be a potential application that can help individuals at risk of suicide; however, there is no definitive evidence.

In the four studies examined within the scope of the study, it was concluded that psychotherapy-based mobile applications applied together with face-to-face intervention (such as psychocopy, psychoeducation) more positive results in reducing the risk of suicide (12, 16, 21). There are also results in the literature regarding the effectiveness of mobile applications based on DBT (9, 16) and CBT (26). However, the positive results of psychotherapy-based mobile applications do not mean that definitive evidence has been generated (2, 9). Toole et al. (21) found that mobile applications used in addition to psychotherapy (face-to-face intervention) significantly reduced the severity of suicidal thoughts; however, the researchers have concerns about when and how the mobile application integrated with psychotherapy will be integrated and clearly state that further research is needed. In addition, it is stated in the studies that the small sample group, the application in a limited sample, and the decrease in the sample during the follow-up period may negatively affect the level of effectiveness and generalizability of mobile applications (6, 9, 11). In the studies examined, it is seen that the number of sample group are between 18 and 1084 people and has similar characteristics. It is also stated in the studies that this situation is an important limitation regarding the generalizability of the research results. On the other hand, in a study examined within the scope of the study, it was determined that a mobile application based on CBT, DBT, ACT and positive psychology, compared to routine treatment, did not lead to a significant improvement in suicidal ideation compared to the control group (15). Similarly, in the studies conducted with some applications in the literature, it was concluded that the effectiveness of psychotherapy-supported mobile applications was not sufficient (5, 6, 9). Witt and colleagues (28) stated in their meta-analysis study that this situation is related to the difficulty of mobile application users in adapting to interventions related to suicidal thoughts. Accordingly, it can be said that there are uncertainties regarding the use of mobile applications alone in individuals at risk of suicide; therefore, it can be said that they can be used as an auxiliary tool supporting routine treatment or face-to-face therapy. However, in order to increase the evidence quality of this result, randomized controlled studies with large samples, sufficient follow-up period, compliance with the interventions and continuity of use should be increased (9, 26, 29).

4.2. Usability and Acceptability of Mobile Applications

It was determined that the mobile applications examined within the scope of the study were easily accessible and usable. However, studies have indicated that users dropping out early from the interventions may be related to usability issues (5); it was emphasized that applications with features such as faster and easier to use, personalized, gamification, and adaptability should be developed (25, 29, 30).

As a result of the evaluation made using different methods in the studies, it was determined that the three mobile applications examined were significantly acceptable. However, no data was found regarding the acceptability of some mobile applications. It is also stated in the literature that the research results regarding the acceptability of mobile applications are limited (9). Therefore, it is important to detail the data regarding acceptability in order to evaluate the effectiveness of the application in the studies to be conducted. The development of mobile applications with a multidisciplinary team collaboration (such as psychologist, psychiatrist, psychiatric nurse, software developer, engineer) can increase the acceptability and usability of the applications (30).

5. Conclusion

In this systematic analysis evaluating the effectiveness, usability and acceptability of mobile applications used for suicide prevention; seven different mobile applications

(CALMA, YARA, BRITE, MATESmobile, BrighterSide, LifeApp and LifeBuoy) were examined in seven randomized controlled trials. It is observed that different results were obtained regarding the effectiveness, acceptability and usability of mobile applications for suicide. When considered in general, the research results can be said that mobile applications can be a potential support tool in reducing the risk of suicide, but there is no definitive evidence regarding their usability alone; the level of effectiveness may vary depending on the content of the application and whether it is a treatment support. It was concluded that psychotherapy mobile applications, especially those applied together with face-to-face interventions, are more effective in reducing the risk of suicide. At the same time, it was determined that mobile applications are usable but data on their acceptability is limited. More evidence-based research, reliable measurements and results are needed regarding mobile applications for suicide prevention. For this reason, it is important to increase the number of randomized controlled trials with a high level of evidence, with a large sample size, and a long follow-up period to determine the effectiveness of mobile applications. In addition, the inclusion of detailed explanations regarding the usability and acceptability of applications in the studies to be conducted will be an important indicator of the effectiveness of the application.

The research results are important in terms of considering the randomized controlled studies with a level of evidence in the literature in the last five years. It is thought that the results will create awareness about mobile applications for preventing suicide, guide experimental studies on mobile applications to be conducted later, and contribute to the literature.

6. Contribution to the Field

With the recent development in technology mobile applications aimed at preventing suicide have gained attention due to their advantages, such as easy accessibility, accurate reporting, and reduced stigma compared to face-to-face interventions. These applications often offer users the chance to seek help, provide emotional support, cope with suicidal thoughts, and access psychotherapy. A large number of mobile applications have been developed for suicide prevention. This study found that in high-quality evidence studies conducted over the last five years, mobile applications have shown potential as a support tool for reducing suicide risk. However, there is no definitive evidence regarding their effectiveness on their own. For researchers, the results reveal the need to increase the number of randomized controlled studies with high level of evidence in a large sample to evaluate the effectiveness of mobile applications for suicide prevention.

For mobile application developers, the results show that mobile applications to be developed should eliminate uncertainties regarding the protection of personal data, auditable, have accessibility, sustainability usability and reliability features. For this reason, it is important for mental health professionals to be included in the research team in studies on mental health mobile applications to be developed. It will strengthen the programs in terms of correct intervention and ethical practices. For mental health professionals, the results are important in terms of raising awareness that mobile applications can be used to improve the quality of care for patients at risk of suicide.

Conflict of interest

There is no conflict of interest regarding any person and/or institution.

Authorship Contribution

Concept: ABA, SCE; **Design:** - **Supervision:** ABA; **Funding:** - **Materials:** - **Data Collection/Processing:** - **Analysis/Interpretation:** - **Literature Review:** ABA, SCE; **Manuscript Writing:** ABA, SCE; **Critical Review:** ABA.

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