International Journal of Public Health Science (IJPHS)
Vol. 15, No. 3, September 2026, pp. 887~892
ISSN: 2252-8806, DOI: 10.11591/ijphs.v15i3.27129

NFC technology improving depressive symptoms in adolescents with depression: quasi-experimental study

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Article Info

Article history:

Received Apr 27, 2026
Revised Jul 12, 2026
Accepted Jul 21, 2026

Keywords:

Adolescent
CES-D
Depressive symptoms
Mental health
Near field communication

ABSTRACT

Depression is a critical global mental health problem that occurs frequently in adolescent in Thailand and can lead to severe consequences, including suicide. Near field communication (NFC) provides a new way for accessing user to data of mental health care. The objectives this study was to determine the effects of NFC on depressive symptoms. A quasi-experimental two-group pretest-posttest was designed. The provincial school was randomly allocated to the control group CON, NFC groups. Each group consisted 50 participants aged 16-18 years who had depression scores 22 on the Center for Epidemiological Studies-Depression Scale (CES-D). The NFC group used NFC-enabled smartphones and NFC tags for four weeks in their home environment. The first paticipants were assigned developing self awareness, the second were assigned emotional expression, third were assigned coping strategies, the finally the participants were recieved reflection activity, and SC group received standard care and followed their normal daily routines. After completing intervention, participans responded CES-D. The results indicated that depressive symptoms in the NFC group significantly decreased post-intervention compared to the baseline $p < .05$. Furthermore, the NFC group demonstrated significantly lower depression scores than the control group after completing the program $p < .05$. In conclusion, NFC technology is an effective decreasing depressive symptom in adolescents with depression.

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1. INTRODUCTION

Depression is a highly prevalent, usually recurrent or chronic, sometimes they are life-threatening disease [1]. The World Health Organization announced that depression is one of the leading causes of illness and disability worldwide [2]. Depressive symptoms have been increasing among adolescents worldwide since approximately 2010. The reported prevalence of depression ranges from mild to severe (21.3%), moderate to severe (18.9%), and severe (3.7%). Overall, approximately one in every five children and adolescents worldwide experiences depression or depressive symptoms, and the prevalence continues to rise. These symptoms can have a substantial negative impact on school attendance and academic performance. Furthermore, social withdrawal associated with depression may increase feelings of isolation and loneliness, while also elevating the risk of self-harm [3]-[7].

There are various treatment options for depression in adolescents, including non-pharmacological, pharmacological, and combination treatments. Although there are many psychotherapy approaches with strong evidence supporting their promotion of adolescent mental health, many adolescents face barriers to accessing traditional face-to-face therapy, e.g., social stigma, financial problems, travel difficulties, and inconvenient

appointment times. Thus, alternative approaches to providing care are needed. Digital technologies provide new opportunities to improve the health and well-being of adolescents, particularly because digital devices have become an integral part of their daily lives. Previous studies have emphasized the importance of adopting adolescent-centered design approaches to enhance the acceptability, usability, and overall effectiveness of digital health interventions [8]-[11]. While early web-based mental health interventions did not successfully increase help-seeking behavior among adolescents, the explosive growth of mobile applications over the last ten years has fundamentally transformed digital mental health care. Currently, major app platforms offer upwards of 40,000 health and medical applications [12]. Given that 95 of adolescents now own or use smartphones, mobile apps are uniquely positioned to offer highly accessible, appealing, and cost-effective mental health support to youth exactly when and where they need it most and then, recent systematic review suggests that the majority of current digital health tools lack an empirical foundation and show inconclusive evidence for treating conditions beyond anxiety and depression, evidence-based digital interventions tell a different story. A meta-analysis of 80 studies evaluating 83 evidence-based mobile health programs demonstrated that they effectively reduce distress, enhance general well-being, and improve symptoms across a diverse range of psychological disorders [13]-[16].

Consequently, evidence-backed digital platforms represent a highly promising avenue for improving adolescent mental health. Specifically, digitally delivered brief coping skills have been shown to boost mood and help young people navigate intense emotions before they become unmanageable, acting as a preventative measure against deeper mental health challenges. Furthermore, app-based positive psychology interventions designed to amplify positive emotions and decrease negative ones have proven effective in shielding older adolescents from loneliness and depression, enhancing sleep quality, and easing the transition into college [17], [18]. Although some digital mental health tools achieve positive user engagement and adherence under specific conditions, many applications fail to retain users past the initial registration phase. This high drop-off rate among adolescents is primarily driven by poor user experiences and negative perceptions regarding the actual usefulness of the apps [19].

In recent years, increasing emphasis has been placed on the importance of involving individuals with lived experience in the development of mental health interventions, particularly by engaging adolescents in the design of digital health technologies intended for their age group. Near field communication (NFC) technology was developed to support adolescent mental health through the integration of digital educational content, interactive care activities, skills-based coaching provided by trained paraprofessionals, early identification of mental health needs with appropriate referral to clinical services, and in-app crisis support features connected to live crisis assistance when necessary [20]-[23]. The coaching and skills-training components incorporated into the NFC intervention are based on well-established, evidence-based approaches for adolescents, including cognitive behavioral therapy (CBT) [24]-[26]. Several research findings demonstrate that NFC-enabled mobile devices can significantly improve emotions and behavior for adolescents with autism spectrum disorder [27]-[30]. However, there is limited empirical evidence to support the use of NFC as a treatment program for depression in adolescents. Therefore, we examined depressive symptoms in adolescents using NFC for 30 days.

2. METHOD

2.1. Subjects

A total of 100 adolescents with depressive symptoms aged 16-18 years were recruited from the two high schools in Samut Prakan Province, Thailand. These schools are funded by the Thai government and manage resources, develop up-to-date curricula, and enact laws to control quality, and were randomly allocated into two groups: control group CON; n = 50 and experimental group NFC; n = 50. The inclusion criteria included mild-to-moderate depression as defined by the Center for Epidemiological Studies-Depression Scale (CES-D) score of over 22, no history of psychiatric illness, and no current psychiatric medications. Only subjects who owned an Android or iOS smartphone were admitted to the study.

2.2. Intervention

2.2.1. Overview

NFC technology is derived from radio frequency identification (RFID) and functions at a frequency of 13.56 MHz. In everyday applications, an NFC reader can interact with an NFC tag to instantly identify family members through a backend system while enabling the monitoring of individual health information. In the present study, the NFC system was implemented in reader/writer mode, whereby data were transmitted from the NFC tag to the NFC-enabled device.

2.2.2. Content

The intervention instrument developed for this study integrates NFC technology with the LINE Official Account (LINE OA) platform. Grounded in human-computer interaction (HCI) principles to ensure

usability, the user interface UI architecture consists of a four-function main menu structured according to psychological coping and emotional intelligence frameworks. The functional specifications of the instrument are categorized as follows: i) Function 1 Building self-awareness: The smartphone screen displays a digitized version of the Center for Epidemiologic Studies Depression Scale (CES-D) via interactive flex messages, allowing immediate, real-time screening of depressive symptoms; ii) Function 2: Emotional expression: a secure digital environment on the device for mood journaling and constructive affective release; iii) Function 3: Coping strategies: An evidence-based repository accessible via the smartphone, offering targeted relaxation techniques and educational media; and iv) Function 4: Reflection and counseling: An interactive channel connecting the user's device directly to professional nursing and psychological support for real-time counseling.

2.2.3. Research protocol for NFC GROUP

The experimental group received a 4-week NFC intervention 3 days per week, executed as follows:

- NFC activation: Participants tap their smartphones against the NFC tag to automatically launch the LINE Official Account LINE OA platform.
- LINE-based coaching and motivation: Throughout the 4-week period, the system delivers scheduled, automated motivational messaging and coaching prompts via LINE OA. This strategy is designed to empower participants, maintain engagement, and ensure program adherence.
- Sequential execution of functions: Participants complete the four core psychological functions sequentially during each session.
- Finally, upon completion of the 4-week intervention, all participants in the experimental group complete the final CES-D as a post-test assessment.

In contrast, the control group received standard care and followed their normal daily routines, with pre-test and post-test assessments conducted at the same intervals as the experimental group.

2.3. Measurements

Depressive symptoms: CES-D developed by Radloff [30], was translated into the Thai language by Bai *et al.* [31]. The scale consists of 20-item questions with a 4-point Likert scale and has a score range of 0-60 self-report instrument designed to measure the frequency and severity of depressive symptomatology over the past week. The primary tool was the Thai version of the CES-D, which contains 20 items rated on a 4-point Likert scale 15. The total score ranges from 0 to 60, with scores of 22 or more indicating depressive symptoms. In this study, the subjects with scores of 22 or more were recruited.

2.4. Statistical analyses

Descriptive statistics, including frequencies, percentages, means, and standard deviations (SD), were used to summarize the demographic characteristics of the participants. The effectiveness of the NFC technology intervention on depressive symptoms was first evaluated using a paired *t*-test to compare pre-intervention and post-intervention scores within both the intervention and control groups. This statistical test was selected because it is appropriate for normally distributed data and enables the assessment of changes within each group over time. Subsequently, analysis of covariance (ANCOVA) was performed to compare post-intervention mean scores between the intervention and control groups while accounting for baseline differences. Statistical significance was established at $p < 0.05$, indicating that any observed differences were considered statistically significant and unlikely to have occurred by chance.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Demographic characteristics

Table 1 summarizes demographic characteristics of the participants, divided equally between the NFC group (n = 50) and the control group (n = 50). Regarding age distribution, the majority of participants in the NFC group were 18 years old (58.00%), whereas a substantial majority in the control group were 17 years old (74.00%). In terms of gender, both groups were predominantly female, accounting for 64.00% in the NFC group and 88.00% in the control group. Looking at the field of study, the largest proportion of participants in both groups were enrolled in the science-mathematics track, representing 58.00% of the NFC group and 74.00% of the control group. For academic performance, measured by grade point average (GPA), the highest percentage of participants in both groups maintained a GPA between 3.51 and 4.00, with 38.00% in the NFC group and 46.00% in the control group.

3.2. Effects of NFC on depression scores

The within-group analysis using the paired t-test revealed a statistically significant reduction in depression scores within the NFC experimental group following the intervention. The mean depression score decreased from 27.06 ± 2.80 at pre-test to 18.18±4.84 at post-test ($p < 0.05$). Conversely, no significant

improvement was observed in the control group (CON), where depression scores remained relatively unchanged from pre-test 26.62 ± 2.82 to post-test 27.12±6.41. These results are summarized in Table 2.

Table 1. Demographic characteristics

Variables		NFC group (N = 50)		CON group (N = 50)	
		n	%	n	%
Age years	17	21	42.00	37	74.00
	18	29	58.00	13	26.00
Gender	Male	18	36.00	6	12.00
	Female	32	64.00	44	88.00
Field of study	Science-mathematics	29	58.00	37	74.00
	Arts-mathematics	10	20.00	4	8.00
	Arts-languages	11	22.00	18	64.00
GPA	1.00 - 2.50	12	24.00	3	6.00
	2.51 - 3.00	6	12.00	10	20.00
	3.01 - 3.50	13	26.00	14	28.00
	3.51 - 4.00	19	38.00	23	46.00

Table 2. Comparison of depression scores within groups before and after in NFC group and CON group

Variable	Stages of study	Groups	
		NFC (Mean±SD)	CON (Mean±SD)
Depression scores	Pre-test	27.06±2.80	26.62±2.82
	Post-test	18.18±4.84 *	27.12±6.41

*p < 0.05vs. Pre, using Paired t-test

Table 3 shows that an analysis of covariance (ANCOVA) was conducted to evaluate the effect of the intervention group on the post-test scores while controlling for the participants' baseline pre-test scores. The results revealed a statistically significant difference between the groups, F (1,97) = 113.37, $p < .001$. Additionally, the baseline pre-test score used as a covariate was significantly related to the post-test outcome, F (1, 97) = 11.12, p = .001. The overall corrected model was statistically significant, F (2, 97) = 59.82, p < .001. The model demonstrated strong explanatory power, with the combination of the group intervention and pre-test scores accounting for 55.2% of the variance in the post-test scores (R^2 = .552, Adjusted R^2 = .543).

Table 3. ANCOVA for post-test depression scores by group, controlling for pre-test baseline

Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected model	2202.82*	2	1101.41	59.82	.000
Intercept	83.89	1	83.89	4.56	.035
Pretest	204.73	1	204.73	11.12	.001
Group	2087.34	1	2087.34	113.37	.000
Error	1785.93	97	18.41		
Total	55291.00	100			
Corrected total	3988.750	99			

*R squared = .552 (Adjusted R squared = .543)

4. DISCUSSION

The primary objective of this study was to evaluate the effectiveness of an NFC technology-based intervention on reducing depressive symptoms among adolescents. The within-group analysis showed a highly significant reduction in depression scores within the NFC experimental group, dropping from a baseline mean of 27.06±2.80 to 18.18±4.84 after the 4-week study period ($p < 0.05$). Conversely, the control group (CON) exhibited no significant improvement (26.62±2.82 at pre-test vs. 27.12±6.41at post-test). This is consistent with findings from relevant literature that emphasize the positive impact of NFC technology on positive effects amongst adolescents [32]. The findings of our outcomes were largely consistent with previous studies of internet-based and smartphone-based can be efficacious in treating depression and that the treatment effect can be sustained to at least 6 weeks after the end of treatment.

To eliminate any potential confounding variables caused by baseline variations in quasi-experimental designs, an ANCOVA was executed. The ANCOVA results confirmed a highly significant main effect for the intervention group, F(1, 97) = 113.37, p < .001, demonstrating that the reduction in depressive symptoms was directly driven by the NFC intervention rather than pre-existing differences or random error. The model also demonstrated strong explanatory power, with the combination of the group intervention and pre-test scores accounting for 54.3% of the adjusted variance (Adjusted R^2 = .543). This indicates that the 4-week digital framework provides a stable and highly dependable predictive capacity for adolescent mental health outcomes.

The success of the NFC intervention can be attributed to its structured, multi-phase psychological design and its seamless integration into the daily home environment of adolescents. Over the 4-week period, participants progressed from self-awareness and emotional expression to acquiring active coping strategies and engaging in final reflection activities. By utilizing NFC tags and smartphones, this framework bypassed traditional barriers to mental health literacy, such as stigma or limited access to counseling, by turning passive mental health support into an interactive, self-paced digital experience. These findings strongly align with prior literature emphasizing that mobile health (mHealth) and digital innovations significantly empower younger populations to recognize emotions and practice timely self-management [32]. The substantial variance explained by the model (Adjusted R^2 = .543) supports the consensus in digital health research that structured, micro-learning modules (such as weekly emotional reflection via smartphone interaction) result in higher adherence, greater user engagement, and ultimately superior clinical outcomes compared to standard, passive care routines.

5. CONCLUSION

The findings of this quasi-experimental study confirm that NFC-based interventions can significantly reduce depressive symptoms among adolescents, offering a practical and accessible alternative to traditional face-to-face therapy. By integrating self-awareness, emotional expression, coping strategies, and reflection into a structured digital framework, NFC technology effectively empowers adolescents to manage their mental health in their daily environments. Importantly, the results highlight the potential of NFC-enabled mobile health tools to overcome barriers such as stigma and limited access to counseling, suggesting that this approach could be scaled to broader adolescent populations and incorporated into school-based or community mental health programs.

ACKNOWLEDGMENTS

We wish to extend our sincere gratitude to all the adolescents who participated in this study for their time, dedication, and invaluable contributions. We also express our deep appreciation to the school administrators, teachers, and parents for their cooperation, coordination, and steadfast support throughout the data collection process.

FUNDING INFORMATION

This research was made possible through the financial support of Siam University; the authors gratefully acknowledge the research funding provided under Grant No. 003/10/2566.

ETHICAL APPROVAL

The study was approved by the Ethical Review Committee for Research Involving Human Research Subjects at the Faculty of Nursing, Siam University.

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