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Research Article

Effects of On-Campus and Off-Campus Smartphone Overdependence Prevention Programs Among University Students

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SUMMARY

Purpose: The purpose of this article is to evaluate effects of self-determination theory-based on-campus and off-campus prevention programs on smartphone overdependence among university students.
Methods: This was a pre-posttest quasi-experimental study with a nonequivalent control group (CG). Seventy-eight students were recruited as participants. They were allowed to choose either an experiment group (EG) or a CG. On-campus smartphone overdependence prevention program was provided to participants in experimental group 1 (EG1), while on-campus program combined with off-campus prevention camp was provided to those in experimental group 2 (EG2). Instruments used in this study included a smartphone overdependence self-diagnosis scale, a basic psychological needs scale, and a self-regulation ability scale. Data collection was performed at baseline, immediately after intervention, at 1 month and 3 months after intervention. Data were analyzed using mixed analysis of covariance. Focus group interview was performed for qualitative evaluation.
Results: After the intervention, smartphone overdependence and basic psychological needs exhibited significant interactions between group and time. Smartphone overdependence scores decreased in EG1 and EG2 but increased in CG ($F = 4.56$, $p = .001$). Basic psychological needs improved in EG1 and EG2 but deteriorated in CG ($F = 5.04$, $p = .009$). Focus group interviews revealed that participants strived to control their smartphone usage through individual efforts and by interacting with new friends in college even after completing the program.
Conclusion: In this study, on-campus only program and combined intervention of on- and off-campus programs were both effective in maintaining and managing smartphone use. However, participants perceived that the off-campus program provided an opportunity to apply the theory learned in on-campus to the real world.

Introduction

Smartphone overdependence or addiction is characterized by excessive smartphone use or unable to control smartphone use. It can interfere with daily lives such as work, school, and social activities [1]. Currently, the rate of smartphone usage in the Korean population is 93.6% [2]. About 99.8% of Korean university students have a smartphone, of them 25.0% are at risk of being dependent on smartphones [2]. Smartphone overdependence is associated with poor academic achievement, stress, and difficulty in adapting to college life [3,4]. It has been reported that smartphone addiction is positively associated with anxiety, depression, and obsessive–compulsive disorder [5].

In particular, college freshman year is a time when students network with others and focus on their studies in order to build a foundation for a successful college life and career after graduation [4,6]. Therefore, interventions are needed to modify smartphone overdependence behavior among college freshmen. A previous study has reported that self-regulation is negatively associated with dependence on smartphone use [7]. Accordingly, it is

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necessary to improve students' self-regulatory ability associated with smartphone use.

The self-determination theory (SDT) emphasizes the satisfaction of universal psychological needs and internalization of motivation based on a growth-oriented view of humans [8]. It posits that human behavior is induced, maintained, and continued by intrinsic motivation. In addition, behavior change is viewed as a process of using one's volitional control with an emphasis on self-regulation [8].

According to the SDT, an individual's behavior is motivated and determined by oneself. Basic psychological needs such as autonomy, competence, and relatedness are important promoters of individual growth and satisfaction that can increase intrinsic motivation [9]. Therefore, interventions to facilitate satisfaction with basic psychological needs and increase self-regulation using strategies to promote intrinsic motivation might be effective in overcoming smartphone overdependence based on the SDT [9,10].

Most former intervention studies about smartphone users have focused on psychosocial symptom relief or cognitive behavior changes targeting overdependent smartphone users [11,12]. SDT-based intervention studies have also been performed to modify self-management behaviors of those who suffer from chronic diseases [13,14] or to promote smoking cessation [10]. However, studies on SDT-based intervention for preventing smartphone overdependence among college students who have not yet developed smartphone overdependence are scarce. Thus, the aim of this study was to evaluate effects of SDT-based on-campus and off-campus prevention programs on smartphone overdependence among university students. Specifically, this study has the following objectives: (1) to examine effects of on-campus and off-campus interventions for preventing smartphone overdependence and determine whether such interventions could influence basic psychological needs and self-regulatory ability of college students and (2) to assess changes in feelings and perceptions of smartphone use as results of participating in the program and individual efforts to prevent smartphone overdependence.

Methods

Design

This was a pre-posttest quasi-experimental study with a nonequivalent control group (CG) to determine effects of an on-campus smartphone overdependence prevention program (SOPP) alone and in combination with an off-campus prevention camp. In addition, two focus group interviews (FGIs) were performed to explore subjective perceptions of these programs.

Participants

Participants of this study were freshmen from H University in C city through a convenience sampling. Potential participants were recruited using a poster on campus bulletin board. Inclusion criteria were freshmen who were enrolled in the H University at the time of recruitment, those who could understand Korean language, and those who agreed to participate in this study. Freshmen who are interested in the program were allowed to participate regardless of their degree of smartphone overdependence. Exclusion criteria were those who had addiction problems other than smartphone overdependence.

Potential participants were allowed to choose group allocation (either in an experiment group [EG] or a CG). Participants were divided into three groups: (1) experimental group I (EG1), an on-campus program; (2) experimental group II (EG2), on-campus program + off-campus prevention camp; and (3) CG. FGIs were conducted for participants in EG1 and EG2.

The sample size required for this study was calculated using the G*Power 3.1 program. With a large effect size ($f = .40$) and 80.0% power ($\alpha = .05$), at least 42 subjects were required for mixed analysis of covariance (ANCOVA) at four time points for three groups. The effect size was calculated based on research results of Park and Kim [15]. They tested the effect of self-determination by applying the internet addiction group counseling program for high school students, which yielded a large effect (d = .86).

Considering potential withdrawals from the study, 30 participants were required for each group. A total of 84 students (28 in EG1, 26 in EG2, and 30 in the CG) were enrolled. Of them, two from EG1, three from EG2, and one from the CG withdrew from this study after completing the baseline survey due to their academic schedules. Thus, a total of 78 (92.9%) participants (EG1, n = 26; EG2, n = 23; and CG, n = 29) completed posttests. Among those who completed the intervention, 14 students (seven students from EG1 and seven students from EG2) voluntarily participated in FGIs (Figure 1).

Measurements

Smartphone overdependence

Smartphone overdependence was measured using the smartphone overdependence self-diagnosis scale developed by the National Information Society Agency of Korea [16] with permission from the agency. This 10-item scale comprised three subscales: self-control failure (three items), salience (three items), and serious consequences (four items). Each item was rated on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree), with a higher score indicating a higher risk of smartphone overdependence. The total score ranged from 10 to 40. Based on total scores, individuals were divided into three user groups based on smartphone usage: general users (score: 10–22), potential-risk users (score: 23–30), and high-risk users (score: 31–40) [16]. Cronbach's alpha was .84 in the former study [16]. It was .83 in the current study.

Basic psychological needs

The basic psychological needs scale developed by Lee and Kim [17] was used with permission from the developers. This 18-item tool comprised six items for autonomy, six items for competence, and six items for relatedness. Each item was rated on a 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree), with a higher score indicating a greater basic psychological need. In the study by Lee and Kim [17], Cronbach's α was .87 for the whole scale, .70 for autonomy, .75 for competence, and .79 for relatedness. In this study, Cronbach's α was .86 for the whole scale, .68 for autonomy, .78 for competence, and .83 for relatedness.

Self-regulatory ability

The short form of the Volitional Components Inventory developed by Kuhl and Fuhrmann [18] and modified for Koreans by Yoon [19] was used with permission from the developers. This self-regulatory ability scale consisted of 10 items for self-regulation mode and 11 items for volitional inhibition mode. Cronbach's α was .76 for self-regulation mode and .75 for volitional inhibition mode [19]. Each item was rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The total score ranged from 21 to 105, with a higher score indicating a greater self-regulatory ability. Cronbach's α of this scale was .82 in the present study. It was .76 for the self-regulation mode and .80 for the volitional inhibition mode.

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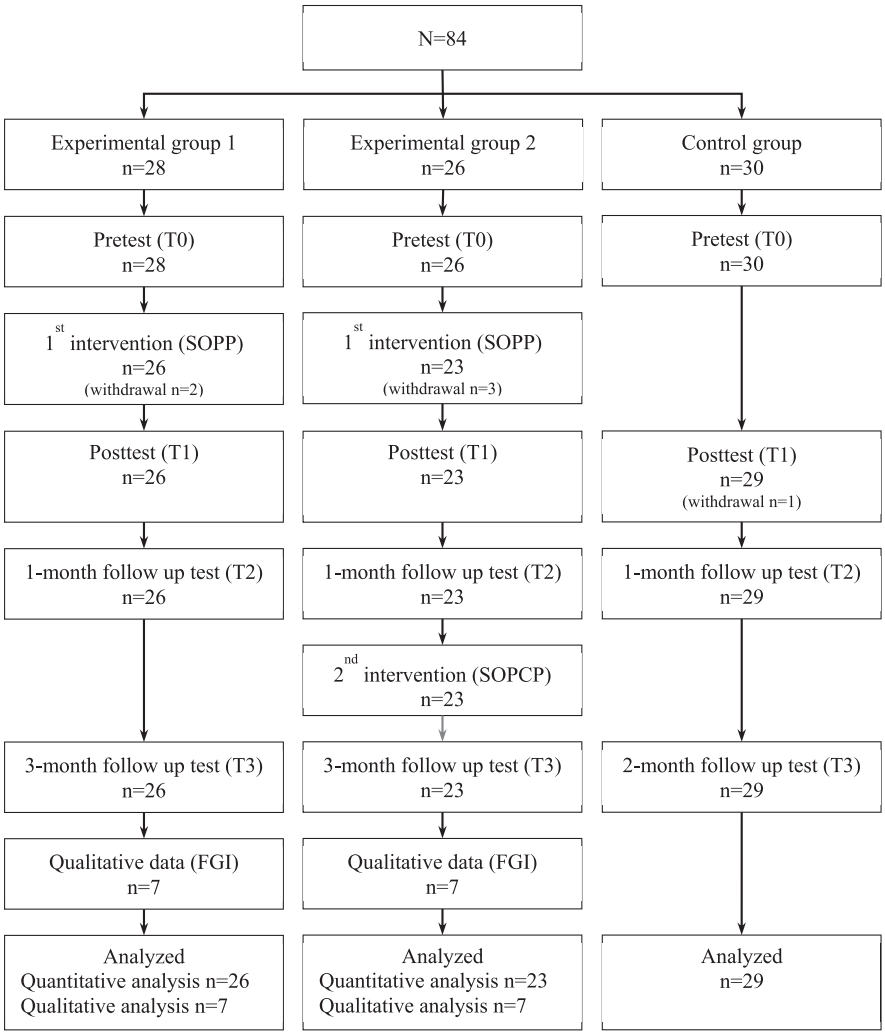

Note. SOPP=Smartphone overdependence[오전1 prevention program; SOPCP=Smartphone overdependence prevention camp program

Figure 1. Flow Chart of the Study.

Intervention

Two interventions were used in this study. EG1 was provided with an on-campus program (SOPP), while EG2 was provided with both an on-campus program and an off-campus camp program. First, an on-campus, eight-session SDT-based SOPP was provided to EG1 and EG2 to improve autonomy, competence, and relatedness of participants. SOPP was a modified version of the former program developed by Kwon and Yu [20]. The eight-session program consisted of two 90-minute sessions per week for 4 weeks between April 22, 2019, and May 16, 2019. Contents of the SOPP included building intimate relationship with participants, promoting motivation and reinforcement for control of smartphone use by identifying strengths and weaknesses, and exploring and practicing alternative activities to control smartphone use. The program also included reassessment of modified behaviors and commitment to action for further behavior changes [20]. Second, a three-day/two-night off-campus smartphone overdependence prevention camp program (SOPCP) was offered to EG2 in an environment with limited internet access from June 14, 2019, to June 16, 2019. The camp program was operated on weekends, avoiding midterm and final exam periods. SOPCP was focused on planning and practicing appropriate use of smartphones (Table 1). In the current study, sequences of on-campus program activities were modified, and off-campus program was added to the intervention of the former study [20].

EG2 was also provided SOPP at the same period as EG1. In other words, EG1 participated only in an SOPP, while EG2 additionally participated in a SOPCP within 1–3 months after the SOPP to maintain intervention effects. Both programs were conducted by a counselor, an expert in the field of smartphone addiction prevention. The counselor also participated in the development of the program used in the current study.

Procedure

Data were collected via self-report questionnaire from April 15, 2019, to September 11, 2019. Data were collected at four points: baseline, immediately after, 1 month after, and 3 months after the intervention. Participants were informed that confidentiality would be maintained throughout the study. Pretest and posttest data were collected by two research assistants.

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Table 1 *Contents of Smartphone Overdependence Prevention Camp Program.*

Day	Objective	Activities	BPN	Operating time
1st day	Orientation	• Program orientation • Group activity by art	R	2 hours
2nd day	Explore and plan alternative activities	• Explore and running alternative activities • Presenting and sharing alternative activities.	A, C, R	2 hours
	Implementation and restructuring of alternative activities Creating UCC	• Readjustment of alternative activities • UCC shooting about alternative activities • Sharing practice of alternative activities • Making UCC for correct use of smartphone or enjoying alternative activities	A, C, R A, C, R	2.5 hours 2.5 hours
3rd day	Wrap-up	• Presentation produced UCC • Make a commitment to control your smartphone use.	A, C, R	1.5 hours

Note. BPN=basic psychological needs; A=autonomy; C=competence; R=relatedness.

Two rounds of FGIs were performed from November 26, 2019, to November 28, 2019, after data were collected from the 3-month follow-up. FGIs were conducted in a quiet and soundproof lecture room within the H University. Seven volunteers from EG1 and seven volunteers from EG2 participated in FGIs. The interview lasted for 60–90 minutes. The audio was recorded after obtaining permission from participants. Open and semistructured questions were used to allow participants to freely describe their experiences. Interview questions were developed with advice from an expert panel (four counseling experts, one psychiatrist, one psychiatric nursing professor, one community nursing professor, and one advertising and public relations professor). Questions for EG1 and EG2 were: "What has changed after participating in the program?" "What are you currently doing to prevent smartphone overdependence?" and "What content or activities should be added to the SOPP?" An additional question was asked for EG2 as follows: "How were the SOPP and SOPCP different?" These FGIs were conducted on different dates for each group. Three researchers participated in the interview. These researchers listened to recordings repeatedly immediately after the interviews to transcribe ad verbatim. Personally identifiable information was deleted from the transcript.

Data analysis

All data were analyzed using SPSS WIN 25.0 software. Shapiro–Wilk test for normality revealed that all dependent variables were normally distributed (W = .92-.97, p = .053-.655). Sociodemographic characteristics were analyzed using descriptive statistics. Homogeneity of sociodemographic characteristics and dependent variables was analyzed using the χ^2 test, Fisher's exact test, and analysis of variance. To test the effectiveness of the program, a mixed ANCOVA was conducted with main effects of group (three groups) and time (four time in points) and interaction effect of group*time. If the assumption of Mauchly's sphericity was not met, a Greenhouse–Geisser correction was applied. In the mixed ANCOVA, gender was included as a covariate, which showed a significant difference among groups. ANCOVAs were performed to examine differences among groups at four time points. Post hoc tests were performed to examine differences between groups and within groups using the Scheffé test and the Games–Howell test, respectively.

FGI data were analyzed using content analysis. First, three researchers (one counseling expert, one nursing professor with experience in qualitative study, and one nursing PhD student with experience in developing and implementing a program) read the transcripts to gain an overall understanding of the raw data. They read the transcripts repeatedly to identify key statements for each question. The validity of the data was further examined by two nursing professors with experience in student counseling and qualitative methodology.

Ethical considerations

This study was approved by the Institutional Review Board of H University (approval number: HIRB-2017-024-3-CRM). The first IRB approval was obtained in 2017. IRB extension was approved twice in 2018 and 2019. Participants signed a consent form after being informed of the purpose and procedure of this study, their freedom to participate and withdraw from the study, the use of collected data for research purposes only, and audio-recording of interviews. Participants were also informed that no extra point would be awarded for grade or test and that there would be no penalty for nonattendance or withdrawal. This study excluded students who were taking classes instructed by the principal investigator. Participants were provided a copy of the information sheet and consent form. Benefits of participation were communicated. Each participant was given a small gift (10 USD per participation) upon completion of the study.

Results

Homogeneity test of participant characteristics and measured variables

A total of 78 subjects were enrolled in this study: 26 in EG1, 23 in EG2, and 29 in CG. The mean age of participants was 19.04 ± 0.33 years. Female students accounted for 82.1% and biomedical students constituted 59.0% of participants.

Among the three groups (EG1, EG2, and CG), gender ($x^2 = 7.78$, p = .017) and smartphone overdependence (F = 5.77, p = .005) differed significantly at baseline. EG1 had the highest proportion (96.2%) of female participants, and EG2 had the highest proportion (34.8%) of male participants. Mean score for smartphone overdependence was the highest in EG2 (25.09 ± 5.24) but the lowest in CG (20.83 ± 4.31). Other dependent variables such as basic psychological needs (F = 1.93, p = .152) and self-regulatory ability (F = 0.39, p = .675) were not significantly different among groups at baseline (Table 2).

Effects of program

For mixed ANCOVA results of smartphone overdependence, the interaction between group and time was found to be statistically significant (Wilks' lambda = 0.80, F (4.91, 181.49) = 4.56, p = .001, η^2_p = 0.13). However, the main effect of group (F (2, 74) = 2.37, p = .100, η^2_p = 0.06) and the main effect of time (Wilks' lambda = 0.97, F (2.45, 181.49) = 0.87, p = .441, η^2_p = 0.03) were not significant. Group comparison by each time point using a simple ANCOVA indicated that differences among groups in smartphone overdependence were not statistically significant at T1, T2, or T3 (all p > .05). Similarly, within-group differences by time point were not statistically significant in EG1 or CG (p > .05). However, smartphone

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Table 2 *Homogeneity Test of General Characteristics and Measured Variables in Groups (N = 78).*

Characteristics	Categories	EG1[a](n = 26)	EG2[b](n = 23)	CG[c](n = 29)	x^2/F	*p*
		n (%)/M±SD	n (%)/M±SD	n (%)/M±SD		
Gender	Men	1 (3.8)	8 (34.8)	5 (17.2)	7.78	.017[d]
	Women	25 (96.2)	15 (65.2)	24 (82.8)		
Age		19.12 ± 0.33	19.09 ± 0.29	18.93 ± 0.38	1.97	.147
Department	Social science and humanities	5 (19.2)	4 (17.4)	5 (17.2)	1.40	.844
	Nature science	6 (23.1)	7 (30.4)	5 (17.2)		
	Biomedical science	15 (57.7)	12 (52.2)	19 (65.5)		
Satisfaction with college life	Satisfied	21 (80.8)	14 (60.9)	20 (69.0)	2.38	.305
	Unsatisfied	5 (19.2)	9 (39.1)	9 (31.0)		
Satisfaction with family life	Satisfied	20 (76.9)	19 (82.6)	26 (89.7)	1.64	.479[d]
	Unsatisfied	6 (23.1)	4 (17.4)	3 (10.3)		
Usage motivation	Latest trend	9 (34.6)	9 (39.1)	11 (27.9)	9.75	.112
	Information searching	1 (3.8)	1 (4.3)	(4 (13.8)		
	Relation with people	16 (61.5)	8 (34.8)	11 (37.9)		
	Others	0 (0.0)	5 (21.7)	3 (10.3)		
Mainly used function of smartphone[e]	Voice call and SMS	4 (15.4)	1 (4.3)	4 (13.8)	1.70	.450[d]
	Entertainment function (gaming, hobby etc.)	2 (7.7)	3 (13.0)	1 (3.4)	1.68	.429[d]
	Web searching	6 (23.1)	9 (39.1)	12 (41.4)	2.32	.364
	Playing music, movie and YouTube	11 (42.3)	15 (65.2)	11 (37.9)	4.24	.127
	SNS (kakao talk etc.)	24 (92.3)	17 (73.9)	22 (75.9)	5.03	.077
Daily smartphone using time (hours)	1≤~<3	4 (15.4)	6 (26.1)	5 (17.2)	1.82	.769
	3≤~<6	15 (57.7)	13 (56.5)	19 (65.5)		
	≥6	7 (26.9)	4 (17.4)	5 (17.2)		
Satisfaction of smartphone usage[e]	Information searching	16 (61.5)	18 (78.3)	23 (79.3)	0.18	.835
	Networking through SNS	18 (69.2)	10 (43.5)	19 (65.5)	1.12	.333
	Relieve stress	9 (34.6)	8 (34.8)	4 (13.8)	1.16	.320
	Others (Financial effect, use for learning)	7 (26.9)	7 (30.4)	8 (27.6)	0.03	.971
Dissatisfaction of smartphone usage[e]	High smartphone bill	5 (19.2)	4 (17.4)	4 (13.8)	0.41	.929[d]
	Decreased health	11 (42.2)	10 (43.5)	13 (44.8)	0.04	.982
	Decreased academic achievement	13 (50.0)	16 (69.6)	16 (55.2)	2.03	.362
	Others (including conflict with parents)	8 (47.1)	9 (39.1)	12 (41.4)	0.71	.700
Health status[e]	Sleep deprived.	4 (15.4)	5 (21.8)	9 (31.0)	1.92	.382
	Loss of vision/dry eye	6 (23.1)	9 (39.1)	9 (31.0)	1.48	.478
	Headache/memory loss	2 (7.7)	2 (8.7)	2 (6.9)	0.29	>.999[d]
	Etc. (including decreased physical condition)	4 (15.4)	0 (0.0)	2 (6.9)	3.70	.151[d]
Smartphone overdependence		22.58 ± 3.95	25.09 ± 5.24	20.83 ± 4.31	5.77	.005
Basic psychological needs	Total	86.88 ± 6.28	82.39 ± 9.38	84.21 ± 8.41	1.93	.152
	Autonomy	30.73 ± 2.51	29.13 ± 3.57	29.66 ± 1.91	2.30	.107
	Competence	25.77 ± 3.70	25.52 ± 3.94	25.52 ± 3.97	0.04	.965
	Relatedness	30.38 ± 2.06	27.74 ± 4.78	29.03 ± 3.90	3.11	.051
Self-regulatory Ability		65.96 ± 9.79	63.57 ± 13.97	63.62 ± 9.46	0.39	.675

[a] EG1 = experimental group 1.
[b] EG2 = experimental group 2.
[c] CG=control group.
[d] Fisher's exact test.
[e] Multiple response.

overdependence was significantly decreased in EG2 after the intervention ($p = .027$) (Table 3). Smartphone overdependence scores trended consistently decreased in EG1 and EG2 but increased in CG (Figure 2).

Considering basic psychological needs, the main effect of the group was statistically significant ($F(2, 74) = 5.04$, $p = .009$, $\eta^2_p = 0.12$). The mean score of basic psychological needs was higher in EG1 (88.29 ± 1.52) than in EG2 (82.48 ± 1.63) and CG (82.22 ± 1.40). Scores of basic psychological needs increased in EG1 and EG2 but decreased in CG. However, the main effect of time (Wilks' lambda = 0.96, $F(3, 222) = 0.39$, $p = .759$, $\eta^2_p = 0.01$) and the interaction between group and time (Wilks' lambda = 0.85, $F(3, 222) = 1.82$, $p = .097$, $\eta^2_p = 0.05$) were not statistically significant (Table 3).

Among subfactors of basic psychological needs, the main effect of the group on autonomy was statistically significant ($F(2, 74) = 6.39$, $p = .003$, $\eta2_p = 0.15$), where the autonomy score was higher in EG1 (30.55 ± 0.53) than in EG2 (28.16 ± 0.56) and CG (28.26 ± 0.49). However, the main effect of time (Wilks' lambda = 0.84, $F(5.39, 199.23) = 0.10$, $p = .949$, $\eta^2_p = 0.00$) and the interaction between group and time (Wilks' lambda = 0.72, $F(2.49, 184.29) = 0.52$, $p = .634$, $\eta^2_p = 0.01$) were not statistically significant (Table 3).

Considering competence, the main effect of group ($F(2, 74) = 2.47$, $p = .091$, $\eta^2_p = 0.06$), the main effect of time (Wilks' lambda = 0.91, $F(2.44, 180.66) = 0.03$, $p = .982$, $\eta^2_p = 0.00$), and the interaction between group and time (Wilks' lambda = 0.72, $F(2.49, 184.29) = 1.80$, $p = 0.117$, $\eta^2_p = 0.01$) were not statistically significant (Table 3). Competence scores trended to increase in EG1 and EG2 but decrease in CG (Figure 2).

Considering relatedness, the interaction between group and time (Wilks' lambda = 0.78, $F(2.49, 184.29) = 4.21$, $p = .001$, $\eta^2_p = 0.10$) and the main effect of group ($F(2, 74) = 8.87$, $p < .001$, $\eta^2_p = 0.19$) were statistically significant. However, the main effect of time (Wilks' lambda = 0.72, $F(2.49, 184.29) = 0.52$, $p = .634$, $\eta^2_p = 0.01$) was not statistically significant (Table 3). Relatedness score maintained or improved over the follow-up period among participants in EG1 and EG2, while it fluctuated among those in CG (Figure 2). Group comparison by each time point using a simple ANCOVA indicated that differences among groups in relatedness were statistically significant at T1 only ($p < .001$), with CG showing the lowest mean score (24.69 ± 3.01). However, neither group showed significant within-group differences by time point ($p > .05$) (Table 3).

Considering self-regulatory ability, the main effect of group ($F(2, 74) = 1.53$, $p = .224$, $\eta^2_p = 0.04$), main effect of time (Wilks'

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Table 3 *ANCOVA for the Effects of Smartphone Overdependence Prevent Program (N = 78).*

Variables	Groups	T0	T1	T2	T3	Source	F (*p*)	η^2_p
		M±SD	M±SD	M±SD	M±SD			
Smartphone overdependence	EG1[a] (n = 26)	22.58 ± 3.95	20.85 ± 2.77	19.65 ± 4.66	19.12 ± 4.12	T	0.87 (.441)	0.01
	EG2[b] (n = 23)	25.09 ± 5.24	22.48 ± 4.72	21.65 ± 5.04	20.13 ± 4.49	G	2.37 (.100)	0.06
	CG[c] (n = 29)	20.83 ± 4.31	21.34 ± 4.58	22.31 ± 5.22	20.41 ± 4.26	T*G	4.56 (.001)	0.11
Basic psychological needs	EG1[a] (n = 26)	86.88 ± 6.28	88.69 ± 8.95	88.15 ± 8.20	88.62 ± 6.94	T	0.39 (.759)	0.01
	EG2[b] (n = 23)	82.39 ± 9.38	81.30 ± 9.06	83.17 ± 9.27	84.04 ± 9.56	G	5.04 (.009)	0.12
	CG[c] (n = 29)	84.21 ± 8.41	81.48 ± 10.52	80.31 ± 9.54	82.83 ± 7.75	T*G	1.82 (.097)	0.05
Autonomy	EG1[a] (n = 26)	30.73 ± 2.51	30.50 ± 3.58	30.08 ± 3.64	30.42 ± 3.21	T	0.01 (.949)	0.00
	EG2[b] (n = 23)	29.13 ± 3.57	27.57 ± 3.88	28.30 ± 3.77	28.22 ± 3.41	G	6.39 (.003)	0.15
	CG[c] (n = 29)	29.66 ± 1.91	27.93 ± 4.40	27.38 ± 3.62	28.03 ± 2.91	T*G	0.99 (.431)	0.03
Competence	EG1[a] (n = 26)	25.77 ± 3.70	27.69 ± 5.18	27.31 ± 3.81	27.27 ± 3.75	T	0.03 (.982)	0.00
	EG2[b] (n = 23)	25.52 ± 3.94	25.48 ± 4.33	25.83 ± 5.04	26.52 ± 4.82	G	2.47 (.091)	0.06
	CG[c] (n = 29)	25.52 ± 3.97	25.00 ± 4.25	24.14 ± 4.49	25.93 ± 3.23	T*G	1.80 (.117)	0.05
Relatedness	EG1[a] (n = 26)	30.38 ± 2.06	30.19 ± 2.28	30.77 ± 2.72	30.92 ± 2.12	T	0.52 (.634)	0.01
	EG2[b] (n = 23)	27.74 ± 4.78	26.87 ± 2.14	29.04 ± 4.05	29.30 ± 2.70	G	8.87 (<.001)	0.19
	CG[c] (n = 29)	29.03 ± 3.90	24.69 ± 3.01	28.79 ± 3.63	28.86 ± 4.22	T*G	4.21 (.001)	0.10
Self-regulatory ability	EG1[a] (n = 26)	65.96 ± 9.79	66.69 ± 7.55	68.65 ± 9.94	69.19 ± 11.30	T	2.30 (.087)	0.03
	EG2[b] (n = 23)	63.57 ± 13.97	61.61 ± 12.40	62.48 ± 14.59	64.09 ± 13.03	G	1.53 (.224)	0.04
	CG[c] (n = 29)	63.62 ± 9.46	62.62 ± 9.64	64.69 ± 8.12	64.55 ± 8.02	T*G	0.97 (.438)	0.03
Group comparisons by time-point and time-point comparisons by groups								
Smartphone overdependence	EG1[a] (n = 26)	22.58 ± 3.95	20.85 ± 2.77	19.65 ± 4.66	19.12 ± 4.12		0.21 (.892)	
	EG2[b] (n = 23)	25.09 ± 5.24	22.48 ± 4.72	21.65 ± 5.04	20.13 ± 4.49		3.28 (.027)	
	CG[c] (n = 29)	20.83 ± 4.31	21.34 ± 4.58	22.31 ± 5.22	20.41 ± 4.26		0.44 (.660).	
	F(*p*)	5.77 (.005) (b>c)[d]	1.47 (.237)	2.83 (.065)	1.11 (.336)			
Relatedness	EG1[a] (n = 26)	30.38 ± 2.06	30.19 ± 2.28	30.77 ± 2.72	30.92 ± 2.12		0.16 (.845)	
	EG2[b] (n = 23)	27.74 ± 4.78	26.87 ± 2.14	29.04 ± 4.05	29.30 ± 2.70		2.24 (.113)	
	CG[c] (n = 29)	29.03 ± 3.90	24.69 ± 3.01	28.79 ± 3.63	28.86 ± 4.22		2.15 (.127)	
	F(*p*)	3.11 (.051)	30.89 (<.001) (a>b>c)[d]	1.83 (.168)	2.78 (.068)			

Note. T0=Prestst; T1=Posttest; T2=1 month follow up; T3=3 month follow up; T=Time; G=Group; T*G=Time*Group.
[a] Experimental group 1.
[b] Experimental group 2.
[c] Control group.
[d] Scheffe test.

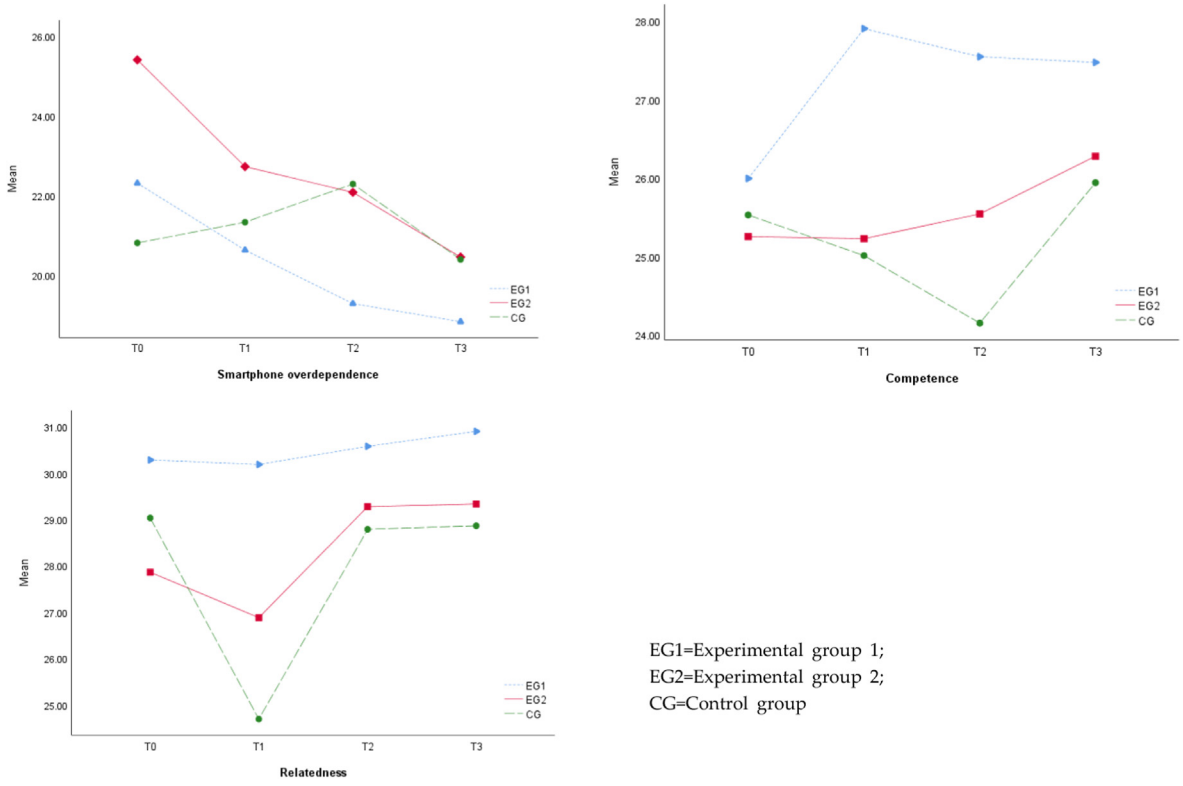

Figure 2. Average trend of the groups.

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lambda = 0.92, F (2.63, 194.80) = 1.53, $p = .224$, $\eta^2_p = 0.04$), and the interaction between group and time (Wilks' lambda = 0.92, F (2.63, 194.80) = 0.97, $p = .438$, $\eta^2_p = 0.03$) were not statistically significant (Table 3).

Subjective effects on program experience

The interview was focused on the following: changes after program participation, personal effort to prevent smartphone overdependence, things to be corrected or added for future programs, and benefits of the off-campus camp program.

Changes after program participation

Participants reported improved confidence, autonomy, determination, and self-control, which are components of basic psychological needs. Regarding competence, participants realized how much they used their smartphones and expressed an improvement in self-esteem. Regarding relatedness, participants looked forward to meeting friends from varying backgrounds and stated that they observed improvements in their health such as better sleep, recovery from fatigue, and reduced headache.

> "The program wasn't simply a lecture but more like a group activity, where you have to keep expressing your opinions. I think my self-confidence and autonomy have improved compared to before." (1A, F/19)

> "Through this program, I was able to check the amount of time I spent on it on my own and I realized that I really did use my smartphone a lot. I tried to control that." (2A, F/19)

Personal effort to prevent smartphone overdependence

Applying three engineering control mechanisms (substitution, isolation, and ventilation) [21], participants substituted smartphone use with other activities such as talking to family or friends, watching a movie, or exercising. They were isolated from their smartphones by turning on the "do not disturb" mode or using the smartphone screen time feature. Using the ventilation mechanism, they read letters they had written to themselves or looked at the certificate they had received during the program.

> "How should I spend my leisure time?… I will take a walk or go on a trip. I am trying to go out every weekend with my family except during midterms or finals." (2A, F/19)

> "I think it was the letter that I wrote … when I feel like I am kind of becoming addicted to my smartphone again, I read the letter and motivate myself again." (3A, F/19)

Strengths of the camp program

The SOPP was theoretical. However, the SOPCP allowed participants to engage in various alternatives to smartphones while staying at the camp without a smartphone. The camp provided students an opportunity to pay attention to others and realize they could spend time without their smartphones. They also grew confident and explored new hobbies.

> "… like the camp better because the campus activity was more theoretical and the camp was real world stuff …" (4B, M/19)

> "There's no Wi-Fi, and I can't make calls. I think I discovered new hobbies through this camp." (1B, F/19)

Suggestions for the program

Suggestions made by participants are summarized as follows: (1) lengthening the program duration; (2) forming social support groups by networking with friends or providing continuous monitoring; (3) providing advanced education for smartphone overdependence; (4) analyzing the relationship between health and smartphone overdependence; and (5) providing an undergraduate-specific education program that could reflect the latest trends.

> "Reducing smartphone usage cannot be achieved in a short period of time … I think if you want to see changes in the long-term, it would be better to extend the program to the second semester …" (6A, F/19)

> "This is for smartphone prevention … I thought it would be better if the program was more advanced … then I think people would realize how serious the issue is." (1B, F/19)

Discussion

This study aims to apply an SDT-based SOPP to college students and to determine the program's effects. We developed two types of interventions and tested them on two experimental groups. Participants in EG1 received SOPP, while those in EG2 received SOPCP in combination with SOPP. Effects of these interventions were assessed using self-report surveys, while FGIs were performed as a supplementary process to obtain qualitative evaluations. Accordingly, the discussion was conducted focusing on quantitative research results. FGI results were also provided as backup data to help us understand quantitative results and to provide in-depth information for the study phenomenon.

Interventions based on the SDT were intended to promote basic psychological needs (autonomy, competence, and relatedness) in the current study. To promote autonomy, students were asked to set specific goals for controlling smartphone use. To enhance competence, the program focused on the strengths of students and explored alternative activities over smartphone use. Relatedness was supported through collaborative activities. Combined effects of these activities might have produced significant changes in basic psychological needs, which in turn influenced the self-regulatory ability of participants about smartphone use.

In this study, the level of smartphone overdependence significantly changed in all groups, consistent with a previous study [13]. During the follow-up period, smartphone overdependence scores continued to decrease in EG1 and EG2, but increased in CG. Further analysis by time point revealed that within-group differences were statistically significant in EG2 only, indicating that combined intervention of SOPP and SOPCP was more effective in modifying behavior regarding smartphone overdependence than SOPP or SOPCP alone. In the current study, participants strived to prevent smartphone overdependence using substitution, isolation, and ventilation methods described in a previous study [21]. Example strategies included substituting smartphones with other activities, isolating themselves from the smartphone, and covering the screen so that they could use the smartphone less often. Findings of the current study are in line with previous results showing that smartphone overdependence is reduced even after completion of the program when participants learn how to use smartphones appropriately [12]. EG2 participants who received SOPCP (off-campus camp) showed a greater change in the score for smartphone overdependence across four time points than EG1 participants although such difference was not statistically significant between the two groups. FGIs revealed that EG2 participants

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perceived the on-campus program as a theoretical process. However, they recognized SOPCP as an experiential learning program where they could learn how to actually use a variety of alternative activities during the camp. This study introduced alternative activities to participants and provided them with an opportunity to explore alternatives that they could practice on their own. Alternative activities such as art, meditation, and physical activities have been suggested as effective methods to alleviate smartphone overdependence [11,22,23]. Therefore, continuous encouragement and support are needed so that students can apply various measures they have learned during the camp to prevent smartphone addiction. However, in the current study, we did not consider the level of smartphone overdependence for study participants recruited. General users were included in the study. Therefore, future intervention studies should recruit potential- or high-risk users for smartphone overdependence.

In this study, there were significant differences in basic psychological needs among groups after the intervention. EG1 and EG2 showed an increase in basic psychological needs at 3 months after the intervention compared to baseline, whereas basic psychological needs decreased in CG participants during the same period. This is similar to the results of a previous study on internet addiction counseling programs [15]. Among the three basic psychological needs, autonomy significantly differed among groups, similar to the results of previous studies on internet addiction in high school students [15] and smoking cessation in adults [10]. Interventions in the current study might have promoted autonomy among experimental group participants by providing clear evidence for the negative impact of smartphone overreliance. The intervention also included various alternatives to replace smartphone overuse so that participants could choose their own control methods [24]. FGI participants reported that group discussions and hands-on experience improved their confidence and motivated them to control their smartphone usage, which in turn increased their autonomy. Autonomy encompasses a property in which an individual acknowledges and accepts a problem and is willing to maintain healthy behaviors as an agent of change [24]. This calls for various tailored strategies to promote autonomy. Meanwhile, although competence scores were not statistically significant, EG1 showed a decrease in competence score at 3-month follow-up, while EG2 showed an increasing trend. These results suggest that the off-campus camp program could facilitate an effective interaction with the social environment and that the positive feedback might have contributed to the improvement in competence [25]. Additionally, it was speculated that overcoming the environment with limited smartphone access and engaging in new activities might have motivated participants to reduce smartphone use even after the program ended. Relatedness significantly differed among the three groups. EG1 and EG2 showed a significant increase in relatedness compared to CG immediately after the intervention. In particular, college freshmen have the burden of adapting to the changing external environment and building interpersonal relationships [24]. The sense of belonging formed through group activities with common interests at the beginning of the semester can have a positive effect on improving relatedness [8,15]. Considering that participants of this program were college freshmen, positive relationships built by the program and group efforts to control smartphone use might have contributed to enhanced relatedness [20]. Since intimate relationships have a positive effect on the control of smartphone use [25], social support is needed to maintain relationships formed through the program.

In the present study, the self-regulatory ability showed an increase during the follow-up period in EG1 and EG2 although such increase was statistically insignificant. This result was similar to results of a previous study on smartphone overdependence among college students [20]. We speculate that with the support of peers, participants could recognize their problematic behavior regarding smartphone use. Additionally, development of their own action plans to control smartphone use [20] might have contributed to the improvement of their self-regulatory ability. Failure to self-regulate can increase media use [26] and the risk for smartphone addiction [27]. College students who have experienced smartphone overuse want to change this problem behavior. However, they find it difficult to self-regulate their smartphone use [24]. Thus, it is necessary for them to recognize, pay attention, and correct wrong behaviors by observing themselves [25]. In particular, feedback from close family or friends offers a stronger motivation for individuals to evaluate themselves. Such relationships as a social support resource and increased motivation by competition have positive effects [25]. Therefore, it is necessary to create an environment where they can receive continuous monitoring from colleagues through the formation of social network relationships.

However, participants of this study were exposed to external influence because they participated in the program while performing their daily activities. Therefore, tension and academic stress due to their regular exam schedules might have impacted study results. The lack of control for external influences was a limitation of this study. Nevertheless, the camp program (SOPCP) helped students clearly recognize their problems and provided a stronger motivation for them to change their behaviors with their external environment being controlled. Contrary to most theories, it has been reported that the SDT may help sustain behavioral changes when basic psychological needs are met [10]. Therefore, by using various social networks, interventions such as support, encouragement, and monitoring are required to maintain modified behaviors [25]. However, pressure and influence from external environments should be minimized to maintain personal autonomy [10]. Some participants mentioned that long-term programs that could span for more than one year and social support groups are needed to ensure control of smartphone usage in the long term. As part of the program, participants wrote letters to themselves during the intervention period and sent these letters to themselves at 3 months after the intervention was finished. It provided an opportunity to check their current smartphone usage behavior among study participants after the program ended. Long-term quantitative evaluation was not performed for more than 3 months in the current study. However, FGI participants stated that the letter motivated them to continue controlling their smartphone usage and to maintain their changes. Long-term support for college students who have the motivation to control smartphone use is required. A previous study reported that maintenance of tobacco abstinence was achieved when the 6-month smoking cessation program was extended to 12 months based on the needs of participants [10]. If the period for maintaining behavioral changes is considered 6 months to 5 years [28], a short-term intervention cannot produce long-term outcomes. Thus, subsequent studies should provide extended interventions with long-term evaluations of at least 6 months to 1 year to maintain long-term behavioral changes.

Study limitations

This study has some limitations. Since participants were recruited during the semester, it was difficult to control for exogenous variables such as midterms and finals, which might have influenced participants' intention to participate in the program, increasing the possibility of withdrawal. In addition, this study did not employ random sampling methods. Participants were allowed to choose their group assignments, which might have caused a systematic selection bias. Indeed, some study variables differed

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significantly at pretest among the three groups, which might have influenced results of this study. Therefore, care should be taken when interpreting research results of this study.

Conclusion

This study implemented and evaluated effects of a program developed based on strategies to improve components of basic psychological needs (autonomy, competence, and relatedness) of college students by applying the SDT. Results of this study confirmed the effectiveness of the program in reducing smartphone overdependence by improving basic psychological needs. This study was significant as it verified the effectiveness of on-campus and off-campus interventions for smartphone overdependence prevention based on SDT and provided a comprehensive evaluation of the research phenomenon by exploring practical experiences of smartphone use through a qualitative approach. In conclusion, results of this study revealed that on-campus only program and combined intervention of on- and off-campus programs were both effective in maintaining and managing smartphone use. However, the off-campus program has the advantage of providing an opportunity to apply the theory learned from the on-campus program to practice. Therefore, combined intervention of theory and practice would be a practical strategy to induce and improve behavior modification of university students for smartphone use. Incorporating these programs into university curricula and extracurricular activities will encourage students to have an appropriate use of smartphones.

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Declaration of interest

The authors declare no conflict of interest.

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