

SCOPE HEALTH EDUCATION MODULE: A HEALTH BELIEF MODEL-BASED DIGITAL BEHAVIOR CHANGE INTERVENTION FOR INTERNET ADDICTION PREVENTION AMONG HIGHER EDUCATION STUDENTS IN MALAYSIA – A CLUSTER RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

The rapid growth of Internet usage has raised urgent concerns about Internet addiction. The prevalence of Internet addiction among undergraduate students is notably high, necessitating timely interventions. However, there is a lack of evidence surrounding preventive interventions such as health education programs that are used to address this issue. The efficacy of health education programs depends heavily on employing appropriate theories. Our study aimed to develop, implement, and assess the impact of the SCoPE (Self-efficacy, Cues to take action, and PErcption) health education module for Internet addiction prevention among undergraduate students using Health Belief Model (HBM) theory. The primary outcome was aimed at reducing Internet addiction test scores while secondary outcomes included knowledge of Internet addiction and constructs of HBM theory (perceived barriers to reducing Internet use, perceived susceptibility, severity, benefit of reducing use, cues to action, and self-efficacy in reducing Internet use). A two-arm, parallel, single-blind cluster randomized controlled trial was conducted among undergraduate students at a Malaysian public university. Clusters were divided into two groups: the SCoPE group and a waitlist control group. The SCoPE group received the SCoPE health education module based on the health belief model, which comprised six animated videos with a total duration of 28 minutes, posted on a private YouTube platform, along with synchronous digital group discussions. Participants adhered to a structured five-day schedule, devoting ten minutes to each video session and 20 minutes to discussion sessions daily. Data were collected at baseline, immediately post-SCoPE, and at three months using validated questionnaires. Data analysis was conducted with generalized linear mixed models with covariates. The study included 252 participants with a 28.2% (71/252) attrition rate. The SCoPE health education module significantly improved knowledge of Internet addiction ($\beta=2.089$, $P < .001$) in intervention group compared to the control group. However, it was short lived. The module did not significantly reduce Internet addiction test scores or other HBM constructs. While the SCoPE health education enhanced participants' knowledge, it did not significantly reduce Internet addiction and other HBM constructs. Addressing high attrition rates and broader contextual factors like peer influences are crucial in the development of future interventions. Incorporating a combination of online and face-to-face methods, longer module durations, and exploring additional behavioral theories may enhance the efficacy of Internet addiction prevention programs.

Trial Registration: Thai Clinical Trial Registry TCTR20230408003

<https://www.thaiclinicaltrials.org/show/TCTR20230408003>

Keywords: Internet addiction prevention; Health belief model; Cluster randomized controlled trial; undergraduate students

INTRODUCTION

Background

In today's world, people are increasingly dependent on the Internet for their daily activities. In a survey conducted by the Malaysian Communications and Multimedia Commission in 2020, Internet users have increased by 1.3% from 87.4% in 2018 to 88.7% of the total population in 2020 [1]. This growing dependence on the Internet has contributed to a higher prevalence of Internet addiction, particularly among young adults [2, 3]. Internet addiction refers to excessive Internet usage that negatively impacts an individual's mental, emotional, academic, occupational, and social well-being [4]. Various terms including "Excessive Internet Use," "Problematic Internet Use," or "Technological (behavioral) Addiction" have been used to describe Internet addiction [5]. There is an ongoing debate and lack of consensus on the precise definition of Internet addiction [6]. For this study, the term Internet addiction refers to excessive Internet use and addictive online behaviors, including online gambling, gaming, cybersex, social networking, and messaging [5-7]. The World Health Organization (WHO) acknowledges the debate around Internet addiction and its health implications [8]. Globally, studies have shown varying prevalence rates of Internet addiction, with a recent meta-analysis indicating a 20.0% prevalence of Internet addiction in Southeast Asia [9, 10]. The COVID-19 pandemic has also led to an increase in Internet addiction rates, as reported in some studies [11-14]. Internet addiction has been associated with various physical, psychological, and social consequences. Physically, Internet addiction can result in obesity, pain, vision and hearing problems, and sleep disturbances [15-17]. Mentally, it is also associated with negative coping mechanisms, anxiety, irritability, and difficulty in concentrating, all of which resemble symptoms of depression [18, 19]. Apart from that, Internet addiction can also contribute to poor quality of life and increase the likelihood of cyberbullying [20, 21].

Given these implications, it is crucial to prevent and reduce Internet addiction. Various prevention strategies at the primary, secondary, and tertiary levels must be strengthened to address the root causes, enhance early detection, and promote overall well-being [22]. These strategies encompass public awareness campaigns, educational programs, screening, counseling, and targeted interventions for vulnerable groups.

University students are highly predisposed to Internet addiction [23], as highlighted by previous studies involving college students [24, 25]. Past research consistently underscores the high

prevalence of Internet addiction ranging from 21.4% to 83.5% among undergraduate students [25-27]. For instance, a previous study at the University Putra Malaysia revealed that 64.3% of students were either addicted to the Internet or exhibited problematic Internet use [7]. According to previous studies, risk factors for Internet addiction among adolescents and university students encompass individual, interpersonal, and environmental domains [28-34]. Some of the more prominent factors include time spent online, accessibility to the Internet, health beliefs, and peer influences.

Despite the gravity of the situation, past research on Internet addiction in Malaysia focused mainly on risk factors and implications of Internet addiction. Studies related to interventions mainly targeted Internet gaming disorders using approaches such as abstinence, Cognitive Behavioral Therapy (CBT), and pharmacotherapy [35-37]. Studies about intervention strategies among adolescents and school-aged children have been mainly theory-based and delivered through various methods, with some achieving positive outcomes [38-40]. However, there is a gap in research surrounding the prevention efforts to reduce Internet addiction among university students. Addressing this gap is crucial to design and implement effective and comprehensive prevention strategies to tackle Internet addiction in this population.

Building on this knowledge, we aimed to develop, implement, and evaluate a health education module for Internet addiction prevention among undergraduate students at a public university in Malaysia. We set out to develop the SCoPE (Self-efficacy, Cues to take action, and PEreception) health education module, and to test its effectiveness as a brief preventive intervention with minimal disruption in view of the busy academic schedules among undergraduate students. A systematic review of the prevention of problematic Internet use highlighted the importance of developing prevention programs based on behavioral theories [41]. These theories, such as the health belief model (HBM), social-cognitive theory, theory of planned behavior, and empowerment theory, have been utilized in previous studies [38, 39, 42-44]. For this study, we specifically applied the HBM to guide the SCoPE health education module. This theory is relevant as individual factors like Internet usage time, accessibility, and health beliefs have been identified as significant risk factors for Internet addiction [28, 30-32, 34]. HBM is an evidence-based framework that provides measurable outcomes [32], allows for tailored

interventions[43], and is comprehensive [45]. We hypothesized that the SCoPE health education module is effective to reduce Internet Addiction Test (IAT) scores and enhance knowledge, perceived susceptibility, severity, benefits, cues to action, self-efficacy, and reduce perceived barriers to reducing Internet use among undergraduate students.

METHODOLOGY

Study Design

We conducted this study among undergraduate students at a Malaysian public university from October 2021 to December 2024, using a two-arm, parallel, cluster randomized controlled trial (RCT) design. Cluster RCT design was chosen for its robustness and efficacy in evaluating healthcare interventions, especially to avoid potential issues such as intervention contamination. Hence, providing a clearer evaluation of the health education module's true impact. The use of individual RCTs could have been challenging due to potential contamination risks within shared university environments. Therefore, this study opted for a cluster RCT design by treating faculties as the unit of randomization. The intervention group received SCoPE module as compared to the waitlist control group.

Setting and recruitment

This study established specific inclusion criteria for faculties and undergraduate students. To begin with, faculties must offer at least bachelor courses with the agreement from the heads of faculties to participate. Undergraduate students from these faculties were included if they were aged between 18 and 24, full-time Malaysian citizens, willing to complete assessments, and enrolled in the 2022/2023 academic session. We excluded students who self-reported having psychiatric issues under treatment.

After screening the faculties, 12 out of 16 met the criteria. Randomization was performed to categorize the 12 eligible faculties into the SCoPE intervention group and waitlist control group. Individual participants were based on the clusters (i.e. faculties) they represented.

Sample size calculation

The sample size was calculated using the formula for comparing two population means as described by Lemeshow et al. (1990). To address the potential design size effect, an intraclass correlation (ICC) of 0.05 was factored in. Additionally, the cluster size (m) was determined based on a fixed number of clusters (k = 6) and a potential dropout rate of 20%

was considered [46, 47]. These adjustments led to a sample size requirement of 127 participants per group. Therefore, a total of 254 undergraduate students must be recruited to achieve the desired sample size in both groups.

Randomization and blinding

The study utilized faculties as the randomization unit to minimize contamination, employing a random sequence generation using Random.Org software (Random.Org LLC) [48] for a 1:1 allocation between the groups received health education module and waitlist control groups. Allocation concealment was ensured using an opaque, sealed envelope method, with sequence generation and faculty coding handled by a third-party research assistant. The randomization code only revealed post-recruitment and after baseline measurements to maintain allocation concealment. Implementation involved two research assistants: one generated the random sequence and provided codes, and the other, unaware of allocations, recruited individual level participants using simple random sampling from undergraduate lists. A single-blinding technique was performed whereby only participants were unaware of their group allocation. The allocation was known to researcher who was involved in providing the SCoPE health education module. By following this approach, bias was minimized, and the study's credibility was enhanced.

Health education module

The health education module adopts a comprehensive strategy integrating health education as well as screening and facilitating referrals for those with high Internet addiction scores. The development process of the module was rigorous, involving extensive consultations with a panel of health experts comprised of two public health physicians and a clinical psychologist. The SCoPE (Self-efficacy, Cues to take action, and PEception) health education module developed for this study used HBM theory and consisted of five perception-related sections. These perception-related sections focused on perceived susceptibility to Internet addiction, perceived severity of Internet addiction, perceived benefits and barriers of reducing Internet use, cues to take action to reduce Internet use, and self-efficacy for reducing Internet use. In addition to incorporating HBM, the SCoPE module also utilized several techniques from Behavioral Change Techniques (BCTs) as adapted from Michie et al. (2013). BCTs are defined as consistent, observable, and adaptable components of an

intervention designed to alter behavior [49]. The BCTs used in the SCoPE module included shaping knowledge, natural consequences, feedback and monitoring, and enhancing self-belief. A summary of the content descriptions of the SCoPE health education module is provided in Appendix 1.

The module featured six animated video sections totaling 28 minutes, along with synchronous digital group discussions. The component of the animated video in the module was validated using a questionnaire adapted from a prior study [50]. Content validity was established through assessment by a panel of public health specialists and a clinical psychologist. Cultural suitability was assessed through pilot testing with undergraduate students from one faculty not participating in the main study.

The module was delivered by the primary researcher, over six days. Each participant in the SCoPE group was allocated ten minutes daily for video watching and an additional 20 minutes for group discussion. YouTube was used as the platform for video distribution to ensure easy accessibility for all participants taking into account participants' academic schedules, examination periods, and semester breaks. It was exclusive access for SCoPE group participants via private settings. In addition, a private WhatsApp group was formed to facilitate the sharing of video links and online questionnaires to enhance participant engagement.

The group discussions, facilitated by the primary researcher, provided an interactive platform for participants to engage with the researcher about the video content, ask questions, and provide personalized feedback. Past research suggested the utilization of an online platform like WhatsApp for group discussions would encourage active participation and foster a comfortable environment for opinion-sharing [51]. Young adults, particularly, are more keen to use digital means such as WhatsApp for communication and expressing opinions [52]. Digital format also allows the integration of multimedia elements, interactive features, and real-time data collection during the study, hence enhancing the learning and engagement experiences of the participants. Immediately after they viewed the videos, participants were reminded via WhatsApp to complete post-test online questionnaires. The waitlist control group received the module after the study concluded.

Outcome Measure

The self-administered questionnaire included four sections. Part A captured personal information such as gender, race/ethnicity, family income, cumulative grade point average (CGPA), and

Internet usage habits. Parts B and C focused on secondary outcomes. Part B assessed knowledge of Internet addiction while Part C explored HBM constructs using Likert scales to measure health beliefs like susceptibility, severity, benefits, barriers, cues to action, and self-efficacy regarding Internet addiction. Part D utilized the Internet addiction test (IAT) to assess the primary outcome.

Primary Outcome

The primary outcome of this study was Internet addiction based on the Internet Addiction Test. It comprises 20 items rated on a five-point Likert scale, ranging from 0- "not applicable" to 5- "always". The total score was computed by summing all responses, where higher scores indicated a more pronounced Internet addiction and 100 being the maximum scores. The questionnaire was considered reliable in Malaysian samples based on a Cronbach's alpha of 0.91 in a previous study [53]. The addiction levels are categorized into four groups: (i) normal Internet use if the score was below 31, (ii) mild addiction for scores between 31 and 49, (iii) moderate addiction for scores between 50 and 79, and (iv) severe addiction if the score exceeded 80 [54]. In our study, the scores were treated as continuous data, reflecting the intensity of Internet addiction.

Secondary Outcomes

The secondary outcomes included the knowledge of Internet addiction, perceived susceptibility to Internet addiction, perceived severity of Internet addiction, perceived benefits of reducing Internet use, perceived barriers to reducing Internet use, cues to take action to reduce Internet use, and self-efficacy for reducing Internet use. All these measures have been utilized in previous studies to assess the effectiveness of Internet addiction prevention programs.

Knowledge of Internet Addiction

This component involved assessing participants' understanding of Internet addiction, including its definition, signs, causes, and social effects. One point (1) was assigned for each correct answer and zero (0) for incorrect answers or "don't know" responses [55]. The questionnaire included 20 items with a total score of 20. A higher score indicates a greater level of knowledge. Younis et al. (2020) conducted the reliability test for this component and yielded a Cronbach's alpha value of 0.78.

Perceived Susceptibility to Internet Addiction

Perceived susceptibility to Internet addiction refers to individuals' beliefs regarding their risk of developing Internet addiction. This aspect was evaluated using a five-point Likert scale with three items adapted from Wang et al. (2016) and Bakhsh (2022), ranging from definitely disagree (1) to

definitely agree (5). The items were “Having Internet addiction is currently a possibility for me, my chances of suffering from Internet addiction in the coming years are high, and I’m concerned about the likelihood of having Internet addiction in the near future.” The scores ranged from 3 to 15, with higher scores indicating a higher level of perceived susceptibility.

Perceived Severity of Internet Addiction

This component assessed participants’ beliefs about the severity of Internet addiction and its consequences. It included four items adapted from Wang et al. (2016), with additional items included based on previous studies regarding the mental and physical health impact of Internet addiction [15, 56, 57]. The items were “I believe the consequence would be very harmful if I had Internet addiction, I believe Internet addiction will cause a negative impact on my physical health, such as causing vision deterioration, I believe I will have poor sleep quality and quantity if I have Internet addiction, and I believe Internet addiction will cause a negative impact on my mental health, such as causing depression.” All items were rated on a five-point Likert scale, ranging from definitely disagree (1) to definitely agree (5). Scores ranged from 4 to 20, with higher scores indicating a higher perceived severity.

Perceived Benefits of Reducing Internet Use

This component measured participants’ beliefs in the effectiveness of actions aimed at reducing Internet use. It consisted of five items assessed on a five-point Likert scale, ranging from definitely disagree (1) to definitely agree (5). The items were adapted from a previous study, with a Cronbach’s alpha value of 0.80 [58]. Total scores ranged from 5 to 25, with higher scores indicating stronger perceived benefits. The items were “I believe reducing Internet use could prevent oneself from getting involved in addiction unawareness, I believe by reducing Internet use could prevent mental disorders, I believe by reducing Internet use could prevent a negative effect on my physical health, I believe by reducing Internet use could prevent other social problems such as cyberbullying, and I believe reducing Internet use could prevent from getting involved in debt.”

Perceived Barriers to Reducing Internet Use

This component assessed participants’ beliefs regarding obstacles to reducing Internet use achieving a Cronbach’s alpha value of 0.82 adapted from previous study [32]. It included five items rated on a five-point Likert scale, ranging from definitely disagree (1) to definitely agree (5), giving a range of scores from 5 to 25, with higher scores indicating greater perceived barriers. The

items were “I believe reduction of Internet use would result in less communication with my friends, I believe reduction of Internet use would cause me to lag behind in knowing what others do, where they go, and with whom (missing out), I believe reduction of Internet use would result in a boring life, I believe reduction of Internet use would result in feeling old fashion, and I believe I can’t reduce my Internet use as I don’t have any idea how to spend time except by using Internet.”

Cues to Take Action to Reduce Internet Use

This aspect evaluated participants’ readiness and strategies to reduce Internet use. It comprised four statements rated on a five-point Likert scale, ranging from definitely disagree (1) to definitely agree (5) with Cronbach’s alpha of 0.63 [32]. Scores ranged from 4 to 20, with higher scores indicating a higher level of cue to take action. The items were “I know the health risk of Internet addiction, thus it will keep me from excessive use of the Internet; I know the way to remind me to reduce my Internet use; I know that Internet addiction can cause me to neglect my study, thus it will restrain me from excessive use on the Internet; and I recognize the signs and symptoms of Internet addiction, thus it will restrain me from excessive use of the Internet.”

Perceived Self-efficacy for Reducing Internet Use

This component assessed participants’ confidence in their ability to reduce Internet use. It included four items rated on a five-point Likert scale from definitely disagree (1) to definitely agree (5). The total scores ranged from 4 to 20, with higher scores indicating greater self-efficacy. The items were “If I wanted to, I’m sure I could limit my Internet usage; I find it difficult to reduce Internet use (reverse coding); I don’t know the right action to reduce my risk of developing an Internet addiction (reverse coding); and I have the ability to overcome any potential obstacles that may arise when reducing my Internet use. The Cronbach’s alpha value for this section was 0.63.

DATA COLLECTION

Online data collection was conducted between July 2023 and December 2023 using a Google Form. Informed consent was obtained from the participants before they filled out the baseline questionnaire (T0). Once the health education module was completed in the intervention group, both groups were asked to fill out the same questionnaire except for the sociodemographic information (T1). Three months later, participants were reassessed on these measures (T2) to evaluate the effects of the health education module over time. The participants from both groups received

MYR 10 (approximately US \$2.20) via e-wallet as a token of appreciation for each completed questionnaire, totaling MYR 30 (approximately US \$6.50).

Data Analysis

Data analysis was conducted using Statistical Package for Social Sciences (SPSS) version 25.0 (IBM Corp, 2016). Data cleaning was done before checking for normal distribution across continuous variables. A significance level of 0.05 was set. The analysis followed an intention-to-treat approach, where all randomized participants were included regardless of whether they completed the SCoPE program or had their outcomes measured. Each participant's data was evaluated based on the group to which they were originally assigned. Descriptive statistics like percentages and frequencies were generated to understand participants' characteristics. Variables such as sociodemographic, knowledge of Internet addiction, perceived susceptibility and severity of Internet addiction, perceived benefits and barriers of reducing Internet use, cues for action, self-efficacy for reduction, and IAT scores were presented as means and standard deviations for normally distributed data, and median with interquartile range for non-normally distributed data. For continuous data, independent t-tests or Mann-Whitney U tests were applied. Chi-square or Fisher's exact tests were used for categorical data. A comparison was performed to ensure no significant differences in baseline characteristics and key factors between the waitlist control and intervention groups.

The data was then transformed into a long form for analysis using the Generalized Linear Mixed Model (GLMM), chosen for its ability to handle missing data, accommodate flexible scheduling, and model nonlinear data. The models were also adjusted for the clustering effect at the faculty level. GLMM was run for each outcome. For each model, the faculty was set as the random effect, whereas the fixed effects included were group, time, and interaction between group and time. The

group \times time interaction effect was the primary variable of interest in each model. Covariates like CGPA, sex, and baseline score of each respective outcome variable were included in the analysis.

Ethics Approval

Ethical approval was obtained from the Ethics Committee for Research Involving Human Subjects at the University of Putra Malaysia (JKEUPM-2022-1015). Written consent was provided from participants. Participation was voluntary and they were ensured of the anonymity and confidentiality of their data. Participants found to have severe Internet addiction were offered further assistance such as referral to counseling services. Data security measures included a password-protected database accessible only to investigators were taken. Data will be securely archived for five years' post-study completion; after which it will be destroyed.

RESULT

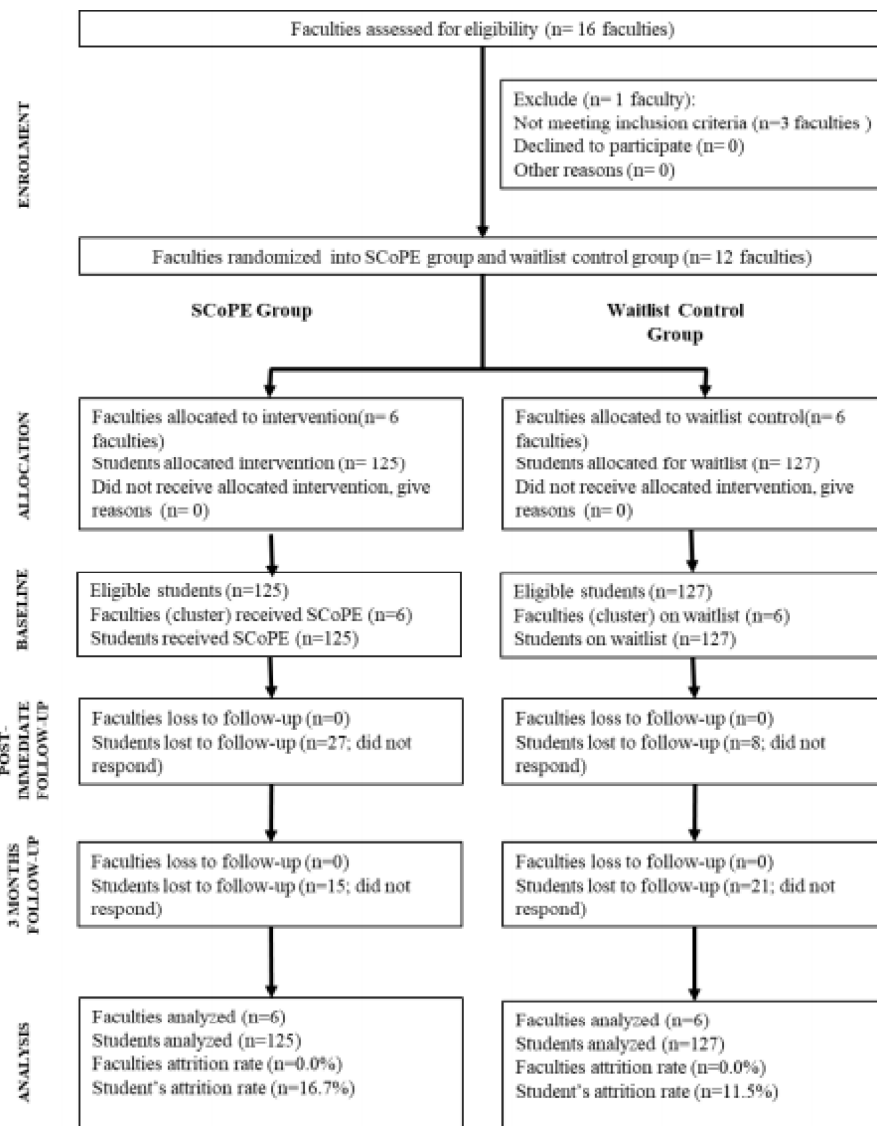
Participants' detail

In this cluster RCT, 12 faculties were recruited, giving a 100% participation rate at the cluster level. Out of 254 eligible students, 252 participated, resulting in a 99% (252/254) participation rate at the individual level. The study population was predominantly female, accounting for 72.2% (182/252). The age range was 18 to 25 years, with a median age of 22. Their median family income was RM 3,000. Most participants were of Malay ethnicity (69.8%, 176/252), with good Internet access (98.4%, 248/252).

Figure 1 shows the CONSORT flow diagram of the recruitment and progress of all participants throughout the study period. The overall retention rate was 71.8% (181/252), with an attrition rate of 28.2% (71/252). Little's MCAR test indicated that missing data ranged from 0-28.2% and was randomly distributed ($P = .12$). Comparisons between retained participants and dropouts revealed no significant differences in gender, race, age, CGPA, or most outcome measurements, except for perceived severity ($P = .018$).

Figure 1. The CONSORT (Consolidated Standards of Reporting Trials) diagram of the recruitment and progress of participants throughout the study period.

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Baseline comparison

At baseline, there were significant differences in sex and CGPA between the SCoPE and waitlist control groups (Table 1). These variables were controlled during further analyses. No significant differences were observed in IAT scores ($t = 0.217, P = .83$) between the groups, with both groups showing moderate Internet addiction. Additionally, there were no significant differences in all secondary outcomes between the SCoPE intervention group and waitlist control groups at baseline.

Table 1. Baseline comparison between SCoPE and waitlist control groups (N=252)

Characteristics	SCoPE group (n=125)	Waitlist control group (n=127)	Differences between the conditions	
			t test ^a	P value
Sex, n (%)			6.81 ^b	.009
Male	44 (62.9)	26 (37.1)		
Female	81 (44.5)	101 (55.5)		
Race, n (%)			7.42 ^b	.06
Malay	81 (46.0)	95 (54.0)		
Chinese	13 (81.3)	3 (18.8)		
Indian	13 (52.0)	12 (48.0)		
Others	118 (51.4)	17 (48.6)		
Internet accessibility, n (%)			N/A ^c	.059
Good	121 (48.8)	127 (51.4)		

Poor	4 (100.0)	0 (0.0)		
Age, median (IQR)	22 (2)	22 (2)	-0.53 ^d	.59
CGPA, median (IQR)	3.5 (0.3)	3.6 (0.3)	-2.76 ^d	.006
Family income, median (IQR)	RM 3,500 (5,550)	RM 3,000 (3,635)	-0.74 ^d	.46
Hours spent online on weekdays, median (IQR)	5 (4)	6 (4)	-0.32 ^d	.75
Hours spent online on weekends, median (IQR)	6 (4)	7 (5)	-0.90 ^d	.37
Internet addiction test, mean (SD)	52.1 (16.69)	52.6 (18.19)	0.22	.83
Knowledge, median (IQR)	15 (4)	15 (4)	-0.61 ^d	.54
Perceived susceptibility, median (IQR)	10 (3)	10 (3)	-0.90 ^d	.37
Perceived severity, median (IQR)	17 (5)	18 (5)	-0.40 ^d	.69
Perceived benefit, median (IQR)	20 (6)	20 (6)	-0.19 ^d	.85
Perceived barrier, median (IQR)	15 (7)	16 (6)	-0.79 ^d	.43
Cues to take action, median (IQR)	16 (5)	16 (4)	-0.29 ^d	.77
Self-efficacy, median (IQR)	13 (3)	13 (3)	-0.54 ^d	.59

^a The *t*-test was two-tailed

^b Chi-Square

^c Fisher's exact test (Fisher's exact test was used as more than 20% of cells have expected cell count less than 5)

^d Mann-Whitney U

N/A: not applicable

Effect of SCoPE Health Education Module Using Intention-to-Treat Principle

Table 2 presents the GLMM results for the effect of group, time, as well as group x time interaction on the primary outcome and the secondary outcome. After adjusting for sex, CGPA, and the baseline

score of each respective outcome, there was no significant difference in IAT scores ($\beta=-1.34$, 95% CI -5.93 to 3.24; $P=.57$) between the SCoPE group and waitlist control group when observed over three months. As for the knowledge of Internet addiction, there was a significant increase over time ($\beta=1.39$, 95% CI 0.69 to 2.10; $P<.001$), thus indicating that participants' knowledge improved significantly during the study period. However, there was no significant group and time interaction effect ($\beta=-0.08$, 95% CI -1.16 to 1.01; $P=.89$). At three months, the findings show no significant group and time interaction for all the study outcomes.

Table 2. Effects of the group, time, and group x time on the primary and secondary outcomes adjusted for sex, CGPA, and baseline scores of each respective outcome

Outcomes and parameters	Adjusted β	SE	95% CI	P-value
Internet addiction test				
Group	-.73	2.11	-4.87 to 3.41	.73
Time	2.89	1.53	-0.11 to 5.89	.06
Group and time	-1.34	2.33	-5.93 to 3.24	.57
Knowledge				
Group	-.06	0.36	-0.77 to 0.65	.87
Time	1.39	0.36	0.69 to 2.10	<.001 ^b
Group and time	-.08	0.55	-1.16 to 1.01	.89
Perceived susceptibility				
Group	-.09	0.29	-0.67 to 0.50	.78
Time	-.07	0.28	-0.63 to 0.49	.81
Group and time	-.18	0.43	-1.03 to 0.67	.68
Perceived severity				
Group	-.01	0.42	-0.84 to 0.83	.99
Time	-.46	0.41	-1.27 to 0.35	.26
Group and time	-.57	0.63	-1.80 to 0.67	.37

Perceived benefit					
	Group	.15	0.455	-0.74 to 1.04	.74
	Time	.20	0.46	-0.70 to 1.09	.67
	Group and time	-.38	0.70	-1.75 to 0.99	.58
Perceived barrier					
	Group	-.05	0.48	-0.99 to 0.89	.92
	Time	.42	0.48	-0.52 to 1.37	.39
	Group and time	-1.11	0.74	-2.56 to 0.34	.13
Perceived self-efficacy					
	Group	.06	0.48	-0.88 to 1.00	.88
	Time	-.25	0.34	-0.91 to 0.41	.46
	Group and time	.47	0.51	-0.54 to 1.48	.36
Cues to take actions					
	Group	.07	0.35	-0.63 to 0.76	.85
	Time	.14	0.35	-0.56 to 0.84	.70
	Group and time	-.60	0.54	-1.66 to 0.47	.27

^aUsing generalized linear mixed model adjusted for the sex, CGPA, and baseline outcomes.

^bSignificant at $P < .05$.

^cRef = Reference category, which serves as a baseline for comparison.

DISCUSSION

Principal Findings

The SCoPE health education module, grounded on the HBM, aimed to reduce Internet addiction test score among undergraduate students using animated videos and WhatsApp group discussions. Although the module initially improved knowledge about Internet addiction, the effect was not sustained. Furthermore, there were no significant changes observed in IAT scores, perceived barriers, susceptibility, severity, benefits, cues to action, or self-efficacy.

Our study shows moderate Internet addiction as indicated by the mean IAT scores was consistent with other research [2, 59, 60]. A meta-analysis by Lozano-Blasco et al. (2022) that included various psychometric tests also reported a moderate level of addiction among young adults. The meta-analysis concluded that, while not pathological, the addiction level is excessively high for the average population [60], hence highlighting the urgency of the issue of Internet addiction and the need for effective intervention strategies.

Our findings align with previous studies that reported no significant changes following interventions aimed at reducing Internet addiction [61, 62]. Ahmadi et al. (2021) applied the Health Belief Model by providing an educational booklet and sending ten text messages via email and SMS to inform participants about the risk factors of Internet addiction. However, no significant changes were observed in the behavior or frequency of Internet addiction. Meanwhile, although not applying any specific theory, Busch

et al. (2013) implemented health-promoting principles in schools by involving school policy, creating a healthy environment, using educational materials, and integrating public health services into teachers' training. While significant behavioral changes were reported in extreme alcohol use, smoking, sedentary time, and bullying, there were no changes in the compulsiveness of video game playing.

In comparison, our study, besides being based on the HBM, also incorporated BCT in each section of the SCoPE module and delivered the health education module online, making it more accessible and convenient for undergraduate students. The online digital approach is particularly relevant in the current age, especially when involving situations requiring remote interaction. However, regardless of the innovative intervention delivery approaches, some studies faced similar challenges in achieving significant behavioral change [61, 62]. This is not surprising in view of the complexity of the contributing factors to Internet addiction. Hence, continuous research is needed to identify the most comprehensive and effective interventions to mitigate Internet addiction [63, 64].

With regard to the perceived susceptibility to Internet addiction, there were no significant changes following our health education module. This was in contrast with the finding of Ahmadi et al. (2021). A study found that university students who were normative Internet users had better family functioning compared to those who were moderately addicted to the Internet [65].

Therefore, combining HBM with other theories could offer a more holistic approach to mitigating Internet addiction in young adults such as undergraduate students. For example, integrating Social Cognitive Theory (SCT) that includes environmental factors into the HBM may enhance intervention effectiveness. Additionally, this approach considers not only the individual but also peer groups, teachers, and family, thereby increasing the effectiveness and sustainability of prevention programs [66].

Similarly, there were no significant changes observed in the perceived severity of Internet addiction, contrasting with the results reported by Ahmadi et al. (2021) and Maheri et al. (2017). This discrepancy may be due to differences in the study population. Our study included both genders in a university setting, whereas the other two studies focused solely on female college students. Thus, gender-specific factors might explain this contradictory finding [67]. Rom Korin et al. (2013) found that women who believed heart disease could be prevented had a lower incidence of coronary heart disease events compared to those who did not hold this belief but a similar association was not observed in men. These findings suggest that gender-specific perceptions of severity and the belief in the preventability of health issues can significantly influence health behaviors, thus explaining the differences observed in our study.

Apart from that, our study also found no significant changes in the perceived benefits of reducing internet use following the intervention. This was consistent with the results of Ahmadi et al. (2021). This could be due to factors such as poor exposure to education and advertisement, insufficient opportunity for accurate training related to perceived benefits, the intangibility of the complications of Internet addiction, and the indirect nature of the educational intervention (via email and SMS) instead of direct face-to-face methods. In addition, factors like social loafing and majority rule, where widely accepted behaviors are seen as safe, might also explain this [68]. Often, users may recognize the benefits of internet use, especially given its integration into education systems. However, they may not be aware of the benefits of reducing it [69]. Hence, future research should delve deeper into the influence of majority opinions on the perceived benefits of internet use versus reducing internet usage.

Similarly, there were no significant differences observed in perceived barriers to reducing Internet use, aligning with Khoshgoftar et al. (2019). However, other studies showed a significant reduction in perceived barriers following the intervention [43, 62]. This inconsistency may be

due to cognitive processes influenced by personal judgments, past experiences, and social support [70]. For instance, during the COVID-19 pandemic, mask-wearing compliance increased significantly with policy enforcement, despite initial perceived barriers and objections. Therefore, similar policy enforcement in educational settings can be considered to reduce perceived barriers to addressing Internet addiction [71, 72].

In terms of cues to action scores, there were no significant changes following the SCoPE intervention, thus indicating its limited impact in motivating participants to reduce Internet use. This contrasts with a recent study that reported significant improvements in cues to action [43]. The SCoPE module focused on internal cues such as theoretical knowledge rather than external cues from mass media and interpersonal advice [73, 74]. Theoretical knowledge in this context encompasses information and strategies provided to participants on how to properly use the internet and reduce internet use, specifically through the MaNSUKI technique inspired by Young's therapeutic approach to treating Internet addiction [75]. To address this limitation, future interventions can incorporate more external cues to action. Notably, participants provided positive feedback for focus mode applications, kid's mode, or online extensions like LifeAt.io for blocking specific websites. Additionally, a study demonstrated that interventions involving contingency management and automated usage notifications were associated with a significant decrease in problematic social media use and subsequent addictive behaviors among students [76].

Moreover, no significant changes in self-efficacy scores were observed, contrasting with two previous studies [43, 77]. The SCoPE module applied mental rehearsal, an element from BCT, together with various "If then" scenarios that emphasize imaginative experiences as a key component of self-efficacy. However, another key element of self-efficacy is vicarious experiences [78]. Witnessing the success of others can significantly impact an individual's self-efficacy. In other words, people are more likely to believe in their ability to succeed when they see other individuals accomplishing similar tasks. A study on mobile phone addiction among female students in Iran effectively used peer role models to improve self-efficacy [79]. Unfortunately, the online nature of the SCoPE module limited such role modeling, potentially impacting its effectiveness. Although some participants shared their experiences during WhatsApp group discussions, future interventions can tap into this by incorporating videos of individuals who have

successfully overcome Internet addiction, or using a hybrid platform that enables active engagement and human interaction.

Furthermore, the lack of significant behavior change in our study could also be attributed to the intervention's content. Even though the SCoPE module provided valuable information and employed natural consequences from BCT by portraying real cases of the negative impact of Internet addiction, it may not have been sufficient to alter the perceived severity. Research shows that interventions incorporating surprise-induced content can be more effective in engaging participants and prompting behavioral change [80]. Surprise-induced content includes unexpected elements and startling statistics designed to capture attention and induce a stronger emotional impact, as used in the video by Turel et al. In view of that, future interventions should consider the inclusion of more elements designed to surprise and deeply engage participants in order to enhance their understanding and perception of the severity of Internet addiction.

Last but not least, the short duration of the SCoPE module, lasting only one week, might have constrained its effectiveness. However, this duration was chosen to minimize disruption to participants' academic schedules and to test the feasibility of a brief intervention. In the literature, successful interventions often involved longer durations from three weeks to 12 months [40, 43]. As the module delivery coincided with many end-of-term activities in the universities, Internet usage would have been higher among the participants for academic purposes, hence potentially confounding the results. Additionally, the timing of the intervention which coincided with mid-term examinations could have also resulted in a higher attrition rate among the participants.

To enhance the effectiveness of future interventions, several recommendations can be considered. Firstly, extending the duration of the intervention can facilitate more sustained behavioral changes. Furthermore, scheduling the intervention during less academically intensive periods can reduce confounding factors related to academic internet use. Even though the digital format of intervention delivery like the SCoPE module offers flexibility and broader reach, it may lack the personal interaction provided by human touch, a crucial element to drive effective behavior changes. Therefore, future interventions will benefit from the incorporation of human interaction elements, such as hybrid models or

periodic face-to-face sessions, to enhance engagement and efficacy.

Strengths and Limitations

Our study contributes significantly to the field of interventional research on Internet addiction, an area with a critical gap in public health. The RCT study design ensures high internal validity and robust methodology. Adherence to the CONSORT statement further enhances the study's transparency, credibility, and reproducibility. By utilizing the HBM as a theoretical framework, the study provides a coherent basis for understanding the strategies of the health education module. Nevertheless, several study limitations should be acknowledged. The generalizability of the study findings is limited and the results cannot be extended to other demographics such as adolescents, older adults, and working young adults. The high attrition rate (28.2%) poses a challenge to internal validity, potentially introducing bias. Despite strategies to mitigate attrition such as regular follow-ups and provision of incentives, there is a valid concern with regard to the robustness and generalizability of the findings. In addition, self-reported measures were used to assess all outcomes, potentially leading to social desirability and response biases. Participants might be inclined to provide socially acceptable answers rather than their true experiences, particularly given the sensitive nature of addiction-related topics. Moreover, monitoring participant adherence to the intervention was challenging as the animated video was delivered via YouTube. Additionally, producing an engaging and tailored animated video requires skilled individuals and reputable production services.

CONCLUSION

In this two-arm parallel cluster RCT, we developed, delivered, and assessed the impact of a brief preventive intervention module, namely SCoPE module designed based on the HBM. The results show that the module did not significantly reduce Internet addiction test scores or any of the HBM constructs, hence indicating that the module did not achieve sustained behavior change across the groups. Often, engaging students in health education is challenging due to their busy schedules. Digital-based interventions such as online videos used in our study may capture students' attention and improve their knowledge, making them a valuable tool for health education. However, future research should evaluate strategies that incorporate face-to-face interactions

or hybrid approaches to improve participant engagement and retention, Furthermore, integrating the HBM with other theories and extending the intervention duration beyond one

week could also facilitate the internalization of the strategies to ensure better outcomes.

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Data Availability

The data sets generated and analyzed from this study are available from the corresponding author upon reasonable request.

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