Longer-Term Efficacy of a Digital Life-Skills Training for Substance Use Prevention

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DOI: https://doi.org/10.1016/j.amepre.2022.06.017

American Journal of
Preventive Medicine

RESEARCH ARTICLE

Longer-Term Efficacy of a Digital Life-Skills Training for Substance Use Prevention

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Introduction: The main objective of this study was to test the longer-term and differential efficacy of a mobile phone–based life-skills training program designed to prevent substance use among adolescents.

Study Design: A 2-arm, parallel-group, cluster RCT with assessments at baseline and follow-up after 6 and 18 months was conducted. The efficacy of the intervention was compared with that of an assessment-only control condition.

Setting/Participants: A total of 1,473 students with a mean age of 15.4 years were recruited in 2019/2020 within 89 Swiss secondary and upper secondary school classes.

Intervention: The automated intervention program included online feedback and individually tailored text messages provided over 22 weeks. The contents were based on social cognitive theory and addressed self-management, social, and substance use resistance skills.

Main Outcome Measures: Primary outcomes included 30-day prevalence rates for problem drinking and tobacco use.

Results: The 18-month follow-up assessments were completed by 1,232 study (83.6%) participants. Those in the intervention group reported lower tobacco-smoking prevalence than the controls (OR=0.67; 95% CI=0.47, 0.96), but no significant difference in problem drinking (OR=0.84; 95% CI=0.61, 1.17) was observed. Among secondary outcomes, the intervention was effective at reducing cannabis-smoking prevalence (OR=0.55; 95% CI=0.39, 0.76) and cannabis use days (Cohen's d= −0.19; 95% CI= −0.29, −0.09), whereas no effects were observed for quantity of alcohol use, quantity of cigarettes smoked, well-being, or social skills. No significant moderators of the primary outcomes were observed.

Conclusions: An automated mobile phone–based life-skills training program produced longer-term effectiveness in preventing tobacco smoking and cannabis use, whereas no effects were observed for problem drinking. These results suggest that digitally delivered life-skills training programs are similarly effective and are an easy-to-implement alternative to training conducted within a school curriculum.

Trial Registration: This study is registered at ISRCTN41347061 (registration date: 21/07/2018).

Am J Prev Med 2022;000(000):1−10.

INTRODUCTION

Adolescence is associated with increased alcohol, tobacco, and other illicit drug use as well as increased susceptibility to mental and substance use disorders.[1−3] Relative to early (age 10−13 years) and late (age 18−21 years) adolescence, the

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0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2022.06.017

prevalence of alcohol, tobacco, and cannabis use increases sharply in mid-adolescence among those aged 14–17 years.[4,5] In Switzerland, regular (at least monthly) use of alcohol has been documented to increase from 24% among those aged 15 years to 61% among those aged 17 years; the proportion of adolescents who reported having smoked cigarettes regularly increased from 6% to 15% in those aged 15 years versus in those aged 17 years, and the prevalence of cannabis use increased from 5% to 12% at this age interval.[4] Therefore, mid-adolescence appears to be a critical period for introducing adolescents to substance-use-prevention interventions within school settings because such settings facilitate their delivery and adolescents' access to them.

One published overview on the prevention of tobacco, alcohol, and illicit drug use in youths revealed promising effectiveness of interventions that provide life-skills training in educational settings.[6] Life-skills training programs designed to prevent substance use typically combine training in self-management skills (e.g., coping with stress), social skills (e.g., assertiveness), and skills to enhance resistance to substance use (e.g., opposing peer pressure to use substances).[7] Although such life-skills training appears to be effective at preventing the onset of specific substances[8−10] and decreasing problematic substance use,[11] its implementation and dissemination in schools can be challenging. This is for a variety of reasons, which include the time, training, knowledge, and skills required for teachers and other professionals to prepare and administer such programs.[12,13]

Digital interventions have great potential to overcome the implementation obstacles mentioned earlier because they can achieve extensive reach at a low cost and offer the option of delivering personalized content automatically, which also is accessible anytime and anywhere.[14] Furthermore, digital interventions might be more appealing because they are better than traditional programs at ensuring privacy and tailoring contents to personal needs.[15,16]

One systematic review of digitally delivered prevention programs for alcohol and other drugs identified 9 trials, among which 6 showed statistically significant, although modest effects for alcohol and/or other drug use outcomes.[17] All these programs were universal and were primarily based on the principles of social learning theory,[18] a social influences approach,[19] and social cognitive theory.[20,21] Although the findings from this review provided some evidence of the efficacy of digital interventions in preventing the use of alcohol and other drugs among adolescents, little is known about their longer-term effectiveness and sustainability. Only 1 of the 9 trials examined longer-term outcomes beyond 12-month follow-up, whereby no intervention effect was shown in this trial with assessments at 8, 20, and 32 months.[17,22]

A more recent review on digital interventions addressing multiple lifestyle risk behaviors conducted in a school setting identified short-term effectiveness for programs targeting dieting, physical activity, and screen time; however, no effect was observed for alcohol or tobacco use.[23] As limitations, the authors mention in particular that none of the studies examined mobile health interventions and that there is little evidence on longer-term effectiveness beyond immediately after the intervention. They recommend for future studies that longer-term follow-up is needed to explore how effects can be maintained throughout adolescence, especially for tobacco smoking and alcohol use, for which they expect to observe a natural increase in use.[23]

Because of the widespread use of mobile phones among adolescents, one promising way to deliver preventive services, other than conventional personal computers, is to do so remotely through mobile phones.[24] Recent reviews underline the potential efficacy of text messaging–based interventions for reducing alcohol and tobacco use among different at-risk target groups, including adolescents and young adults.[16,25,26]

SmartCoach was the first mobile phone-based life-skills training program for substance-use prevention among adolescents to be tested in a controlled trial.[27,28] Program participants were 1,473 secondary school students with a mean age of 15.4 years. The program was based on social cognitive theory and addressed self-management skills, social skills, and substance use resistance skills. At the beginning of the program, participants received individually tailored web-based feedback on stress and coping strategies. Subsequently, they received up to 4 weekly text messages over a period of 22 weeks to stimulate (1) positive outcome expectations, (2) self-efficacy, (3) observational learning, (4) facilitation, and (5) self-regulation. Initial findings regarding the program's appropriateness and short-term efficacy revealed good acceptance, with 84% of eligible students participating in the program and the associated study. On average, program participants responded to half (23.6 of 50) of the prompted activities. The results on short-term efficacy, through 6 months of follow-up, also were promising, with intention-to-treat analyses for 3 of the 9 outcomes (quantity of alcohol use, quantity of tobacco use, and level of perceived stress) exhibiting statistically significant improvement.

This study complements these initial findings by examining the efficacy of this program somewhat longer term through an assessment conducted at 18 months of follow-up. It thus complements the sparse literature on the longer-term effectiveness of digital addiction

prevention programs.[17,23] Furthermore, potential demographic moderators of primary outcomes were tested to identify the subgroups experiencing differential intervention effects. The a priori primary hypothesis was that this individually tailored intervention program would prove more effective than undergoing an assessment only at preventing both the onset and escalation of problematic substance use.

METHODS

Study Sample

The intervention program was tested in secondary and upper secondary school students, typically between ages 14 and 17 years. In cooperation with regional Centres for Addiction Prevention and the Cantonal Department of Education in the Canton of Zurich, secondary and upper secondary schools in the Cantons of Zurich and Argovia were invited to participate in the study. Employees at these centers arranged 60-minute information sessions in selected secondary school classes during regular school lessons that had been reserved for health education. Further details on the recruitment and informed consent process are provided in a paper on program acceptance and initial program efficacy.[27]

Students (1) of a minimum age of 14 years, (2) who owned a mobile phone, and (3) who had informed parental consent if under the age of 15 years were invited to participate in the study. Informed consent was obtained online from all study participants. Subsequently, they were invited to choose a username, provide their mobile phone number, and complete the baseline assessment directly on their mobile phone. Participants in the intervention group additionally received a list of 9 potential stressors from which they could choose the 2 most meaningful to them. These data were also used for tailoring the intervention content and, subsequently, providing tailored web feedback on stress and coping strategies. However, answering these additional items was not mandatory for program participation because default values were set for those who did not complete this assessment. Over the following 22 weeks, participants in the intervention group received individually tailored mobile phone–based life-skills training. Participants in the assessment-only control group received no intervention after their baseline assessment.

To ensure adherence to the study protocol and representativeness of the sample,[29] an incentive of CHF10 ($10.90) was offered for participation in each of the 2 follow-up assessments. Follow-up assessments in both study groups were conducted using a similar procedure: participants were invited to the online follow-up assessments by Short Message Service text messaging, which included a link to the follow-up survey. Nonresponders were additionally contacted for computer-assisted telephone interviews conducted by trained research assistants. Study participants were recruited between March 2019 and March 2020. The 6-month follow-up assessments were conducted between August 2019 and September 2020, with 18-month follow-up assessments conducted between August 2020 and September 2021. No major changes to methods were implemented after trial commencement.

The full study protocol was published in 2018.[28] The study protocol was approved by the Ethics Committee of the Faculty of Arts and Sciences at the University of Zürich. The trial was executed in full compliance with the Declaration of Helsinki.

A 2-arm, parallel-group, cluster RCT was conducted with assessments at baseline and follow-up after 6 and 18 months. The efficacy of the intervention was compared with that of an assessment-only control condition. To avoid spill-over effects within school classes, school class was used as the randomization unit. Because of the heterogeneity of students in the different secondary schools, separate randomization lists were used for each school (stratified randomization). Furthermore, to generate study groups of approximately equal sample size (allocation ratio 1:1), a block randomization was used with computer-generated, randomly permuted blocks of 4.[30]

Junior scientists supervising the baseline assessment were blinded to the group allocation of school classes. In addition, group allocation was not revealed to participants until they had provided their informed consent, username, mobile phone number, and baseline data. The research assistants who performed the computer-assisted follow-up assessments for both the primary and secondary outcomes also were blinded to group allocation.

Intervention

Details on the theoretical and technologic background of the program and its contents are provided elsewhere.[27,31] The interventional elements of the program were based on social cognitive theory.[20,21] Individually tailored web-based feedback was provided to study participants in the intervention group immediately after they completed the baseline online assessment within their school classroom. This web-based feedback consisted of 7 screens, which included textual and graphical feedback on general stress, levels of stress in various domains, individual-applied and suggested coping strategies, and individual levels of social skills.

For a period of 22 weeks, program participants received between 2 and 4 individualized text messages per week on their mobile phones. These messages were generated and sent by the fully automated system. For the first 7 weeks, the messages focused on self-management skills (e.g., coping with stress, emotional self-regulation, and management of feelings of anger and frustration). In weeks 8−17, the messages focused on social skills (e.g., making requests, refusing unreasonable requests, and meeting new people). In weeks 18−22, the text messages focused on substance use resistance skills (e.g., recognizing and resisting media influences, social norms of alcohol and tobacco use, and the associations between both self-management and social skills and substance use). The messages were tailored on the basis of data from the baseline assessment (age, sex, individual stressors, individual social skills, alcohol and tobacco use) and on the basis of text messaging assessments that occurred over the course of the program (recent individual alcohol and tobacco use). An example Short Message Service text messaging feedback to a quiz question that takes into account sex (male), age (15 years), and recent substance use (regular alcohol use but no tobacco use) would be: “Hi Nico, actually there are fewer regular alcohol drinkers than you stated! A survey in Switzerland showed that only 24% of men aged 15 years, drink regularly. The majority of young people your age never or rarely drink alcohol.”

The program offered several interactive features—such as quiz questions, tasks to create individually tailored if-then behavior plans, interactive challenges, and message and picture contests.

To participate in the contests, the participants had to upload a picture or post a motivational text message on a website within 2 days. This was followed by a 2-day window for voting on all posts and a presentation of the 3 contributions with the highest votes. The prompts encouraging the subject's participation in quizzes, self-challenges, and individual stress or social skills training could easily be answered by typing a single letter or number using the mobile phone's text messaging application. Furthermore, hyperlinks to audio files, video clips, pictures, and related websites were integrated into the program.

To stimulate active program engagement, program use was associated with a friendly competition, which allowed program users to collect credits for each interaction (e.g., answering text messages, participating in quizzes, accessing video links integrated into text messages). The more credits that participants collected, the higher their chance of winning 1 of 10 prizes that were part of a prize draw (cash 10×50 CHF [$54]) after program completion.

Measures

At baseline, information on participants' demographic characteristics (age, sex, immigration background) and type of school (secondary or upper secondary school) was collected. Baseline and follow-up assessments included the following:

1. Problem drinking and alcohol use in the preceding 30 days, assessed using the short form of the Alcohol Use Disorders Identification Test.[32] On the basis of a validation study among adolescents, a cut off score ≥5 was used to identify problem drinking.[33]
2. The *30-day point prevalence of tobacco smoking*, defined as having smoked at least a puff within the past 30 days, in accordance with Society for Nicotine and Tobacco Research criteria.[34]
3. Quantity of cigarettes smoked in the preceding 30 days, calculated by multiplying the number of smoking days by the typical number of cigarettes smoked per smoking day.
4. Cannabis use in the preceding 30 days, assessed using an item extracted from the Health Behaviour in School-aged Children study addressing the number of cannabis consumption days.[35]
5. Well-being, assessed using the Well-Being-Index of the WHO. Scores range from 0 (low well-being) to 100 (high well-being) (α=0.77).[36]
6. Social skills, assessed utilizing the brief version of the Interpersonal Competence Questionnaire-10 (α=0.68), which encompasses the following 5 domains: (1) initiation of relationships, (2) negative assertions, (3) disclosure of personal information, (4) emotional support, and (5) conflict management.[37]

Primary outcomes, as indicated in the published study protocol,[28] were (1) prevalence of problem drinking over the preceding 30 days, as measured using the Alcohol Use Disorders Identification Test, and (2) prevalence of tobacco smoking over the preceding 30 days (having smoked at least a puff, as per Society for Nicotine and Tobacco Research criteria[34]). Secondary outcomes were (1) prevalence of cannabis use over the preceding 30 days (having used cannabis at least once), (2) quantity of alcohol use over the preceding 30 days, (3) quantity of cigarettes smoked over the previous 30 days, (4) frequency of cannabis use over the preceding 30 days, (5) personal well-being, and (6) social skills.

The outcomes were assessed as described in the published study protocol,[28] with the following modification: because of comprehension problems of the target group with the Perceived Stress Scale discovered during the pretest, the Well-Being-Index of the WHO—scores range from 0 (low well-being) to 100 (high well-being)[36]—was used to measure stress and well-being.

Statistical Analysis

Sample size calculations were based on the effect sizes of traditional face-to-face delivered life-skills training programs in educational settings. Full details of effects size calculations are provided in the published study protocol.[28] Ultimately, a sample size of n=656 per study group and a total of n=1,312 study participants were deemed necessary to satisfy both primary outcomes with 95% confidence and 80% power.

In this study, a hierarchical data structure was generated, by design (students nested in school classes). To discern to what extent study outcomes varied across school classes, intraclass correlation coefficients were calculated for all primary and secondary outcomes, with intraclass correlations ranging from 1.8% to 10.6%.

Baseline differences between participants in the intervention and control groups were examined by performing (generalized) linear mixed models ([G]LMMs) while modeling a random intercept for school class. Variables exhibiting baseline differences between the intervention and control groups were included as covariates in all multivariable models examining interventional effects on primary and secondary outcomes.

Furthermore, (G)LMMs were generated to assess the efficacy of the program. Within each (G)LMM, a random intercept was modeled for school class. Analyses of binary outcomes focused on follow-up values, whereas analyses of continuous outcomes included change scores from baseline to follow-up as the dependent variable. Independent variables included group as a predictor as well as baseline values for each respective variable and all relevant covariates (see above).

To identify the moderators of the 2 primary outcomes, (G)LMMs with a random intercept for school class and random slope for group were modeled. Furthermore, interaction terms between all demographic characteristics measured at baseline and study group were included, one at a time, in the previously described models. All data were analyzed according to the intention-to-treat (ITT) principle. For ITT analyses, multiple imputation procedures were used.[38] Imputations were performed for each group separately to preserve within-group homogeneity and potential interventional effects. How imputations were handled for data missing at the 6-month follow-up assessments is described elsewhere.[27] Imputations of missing data for analyses of 18-month follow-up data included 6-month follow-up values, school class, and 18-month follow-up variables that correlated at least moderately (correlation coefficient r>0.30) with the study outcome of interest. Binary outcomes were imputed using logistic regression, categorical outcomes were imputed using multinomial logit models, and continuous outcomes were imputed using predictive mean matching. After examining 50 data sets, no systematic bias in convergence was revealed. Final inferences were derived from this solution. The results from the imputed data set were cross-checked with the nonimputed data set. A Type I error

rate of $p<0.05$ on 2-sided tests was considered statistically significant when evaluating intervention main effects and moderator effects.

All analyses were performed using SPSS, version 25, and R, version 3.6.1. Multiple imputations were conducted with R's mice package,[38] and (G)LMMs were conducted with the lme4 package.[39]

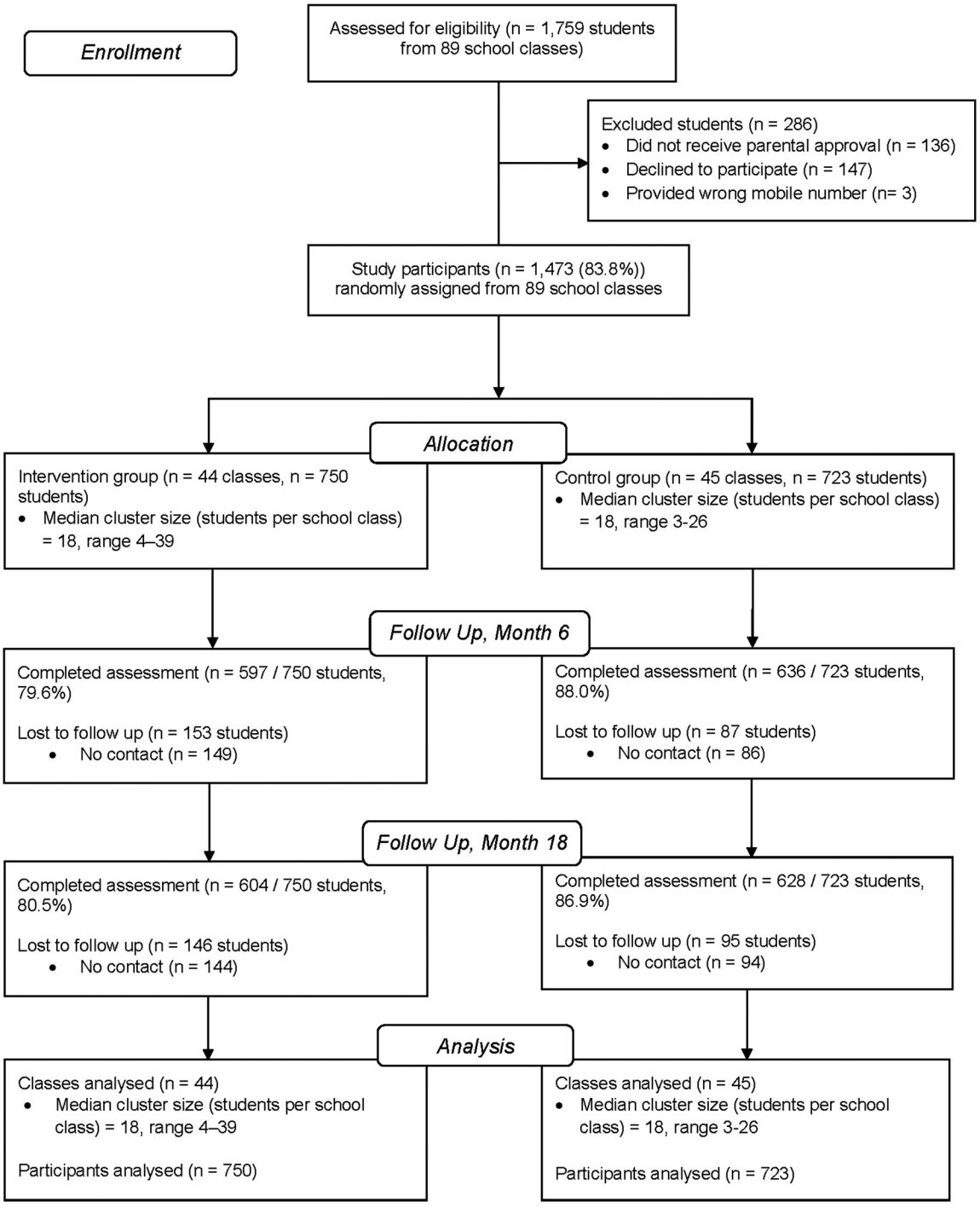

Figure 1. Flow of study participants through the trial.

RESULTS

Figure 1 depicts the participants' progression through the trial. During the online screening assessment, 1,759 students were present in 89 classes. Of these, 1,623 (92.3%) received parental approval to participate, and 1,473 (83.7%) ultimately participated in the study. A total of 44 classes containing 750 students in total were randomly assigned to the intervention group, whereas 45 classes containing 723 students in total were assigned to the control group. The 18-month follow-up assessments were completed by 604 (80.5%) and 628 (86.9%) participants in the intervention and control groups, respectively.

Baseline characteristics for the study sample are summarized in a publication reporting on the initial 6-month follow-up assessment[27] and in Appendix Table 1 (available online). The mean age of participants was 15.4 years (SD=1.0 years), and 55.2% were female. Baseline differences between the intervention and control groups were identified for immigration background, education level, prevalence of tobacco smoking, prevalence of problem drinking, and quantity of alcohol use. Concerning attrition bias, the analysis revealed that intervention group participants who were lost to follow-up reported a higher prevalence of problem drinking at baseline (Wald=7.23; df=1, p<0.01) than controls.

The results of both complete-case (CC) and ITT analysis examining the prevalence rates for problem drinking, tobacco smoking, and cannabis use are summarized in Table 1.

Concerning the primary outcomes, the odds for displaying problem drinking at 18-month follow-up did not differ significantly by group (OR_{ITT}=0.84, 95% CI=0.61, 1.17; OR_{CC}=0.86, 95% CI=0.59, 1.24). However, the odds of having smoked tobacco at 18-month follow-up differed significantly by group in the ITT but not in the CC analysis (OR_{ITT}=0.67, 95% CI=0.47, 0.96; OR_{CC}=0.74, 95% CI=0.48, 1.14). Intervention group participants reported less frequently having smoked at least a puff previous to the follow-up assessment than their counterparts in the control group.

A significant effect was also observed for the secondary outcome prevalence of cannabis smoking (ITT and CC analysis). Intervention group participants reported less frequently having consumed cannabis previous to the follow-up assessment than their counterparts in the control group (OR_{ITT}=0.55, 95% CI=0.39, 0.76; OR_{CC}=0.48, 95% CI=0.32, 0.70).

Results for continuous outcomes are summarized in Table 2. A significant group effect was observed for the secondary outcome frequency of cannabis smoking (+0.12 days in the intervention group vs +0.89 in the

Table 1. Intervention Effects for Dichotomous Outcomes

Analyses and outcome variables[a]	Intervention group (n=750)			Control group (n=723)					
	Baseline	18 months	Difference, %	Baseline	18 months	Difference, %	Coefficient	p-value	OR(95% CI)
Complete cases									
Problem drinking in the past 30 days	114/750 (15.2%)	133/604 (22.0%)	6.8	150/723 (20.7%)	172/628 (27.4%)	6.7	−0.15	0.42	0.86 (0.59, 1.24)
Tobacco smoking in the past 30 days	91/750 (12.1%)	105/604 (17.4%)	5.3	109/723 (15.1%)	148/628 (23.6%)	8.5	−0.29	0.18	0.74 (0.48, 1.14)
Cannabis use in the past 30 days	106/750 (14.1%)	82/604 (13.6%)	−0.5	103/723 (14.2%)	139/627 (22.2%)	8.0	−0.74	**<0.001*****	0.48 (0.32, 0.70)
Intention-to-treat									
Problem drinking in the past 30 days	114/750 (15.2%)	180/750 (24.0%)	8.8	150/723 (20.7%)	207/723 (28.6%)	7.9	−0.17	0.32	0.84 (0.61, 1.17)
Tobacco smoking in the past 30 days	91/750 (12.1%)	138/750 (18.4%)	6.3	109/723 (15.1%)	183/723 (25.3%)	10.2	−0.39	**0.03***	0.67 (0.47, 0.96)
Cannabis use in the past 30 days	106/750 (14.1%)	123/750 (16.4%)	2.3	103/723 (14.2%)	176/723 (24.3%)	10.1	−0.60	**<0.001****	0.55 (0.39, 0.76)

Note: Boldface indicates statistical significance (*p<0.05, **p<0.01, ***p<0.001).
Values represent n (% within subsample), unless stated otherwise.
[a]Generalized mixed models with a random effect for school classes, group as a fixed factor, follow-up scores as outcomes and baseline scores, and immigration background as covariates.

Table 2. Intervention Effects for Continuous Outcomes

Analyses and outcome variables[a]	Intervention group (*n*=750)			Control group (*n*=723)					
	Baseline	18-Months	Difference	Baseline	18-Months	Difference	Coefficient	*p*-value	Effect size *d*(95% CI)
Complete cases									
Quantity of alcohol use in the past 30 days, M (SD)	5.9 (16.3)	8.8 (18.1)	2.9	7.5 (16.4)	9.2 (17.9)	1.7	0.36	0.79	0.11 (0.00, 0.23)
Quantity of cigarettes smoked in the past 30 days, M (SD)	5.3 (41.8)	9.7 (50.2)	4.4	7.9 (47.8)	13.6 (61.9)	5.7	−1.79	0.53	−0.02 (−0.13, 0.09)
Cannabis-smoking days in the past 30 days, M (SD)	0.77 (3.4)	0.75 (3.2)	−0.02	0.78 (3.5)	1.51 (4.9)	0.73	−0.69	**<0.01****	−0.18 (−0.29, −0.07)
Well-being (WHO−5), M (SD)	52.9 (17.3)	52.1 (18.6)	−0.8	51.6 (17.3)	51.7 (17.9)	0.1	−0.44	0.66	−0.08 (−0.19, 0.04)
Social skills (ICQ-10), M (SD)	14.9 (2.2)	15.2 (2.2)	0.3	14.9 (2.2)	15.0 (2.3)	0.1	0.09	0.41	0.01 (−0.11, 0.12)
Intention-to-treat									
Quantity of alcohol use past 30 days, M (SD)	5.9 (16.3)	10.4 (20.0)	4.5	7.5 (16.4)	9.6 (17.4)	2.1	1.12	0.39	0.12 (0.01, 0.22)
Quantity of cigarettes smoked in the past 30 days, M (SD)	5.3 (41.8)	12.3 (58.3)	7.0	7.9 (47.8)	16.8 (68.7)	8.9	−2.86	0.36	−0.03 (−0.13, 0.07)
Cannabis use days in the past 30 days, M (SD)	0.77 (3.4)	0.89 (3.5)	0.12	0.78 (3.5)	1.68 (5.2)	0.89	−0.75	**<0.001******	−0.19 (−0.29, −0.09)
Well-being (WHO−5), M (SD)	52.9 (17.3)	52.5 (18.9)	−0.4	51.6 (17.3)	51.7 (18.0)	0.1	0.29	0.75	−0.03 (−0.13, 0.07)
Social skills (ICQ-10), M (SD)	14.9 (2.2)	15.1 (2.2)	0.2	14.9 (2.2)	15.0 (2.3)	0.1	0.04	0.67	0.00 (−0.10, 0.10)

Note: Boldface indicates statistical significance (**p<0.01, ***p<0.001).
ICQ-10, Brief form of the Interpersonal Competence Questionnaire–scores range from 5 (low social skills) to 20 (high social skills); M, mean; WHO-5, Well-Being-Index of the WHO–scores range from 0 (low well-being) to 100 (high well-being).
[a]Based on linear mixed models with a random effect for school classes, group as a fixed factor, change scores from baseline to follow-up as outcomes, and baseline scores, and immigration background as covariates.

control group; Cohen's d_{ITT}= −0.19, 95% CI= −0.29, −0.09; d_{CC} = −0.18, 95% CI= −0.29, −0.07). No significant group effect was observed for pre–post differences in the other secondary outcomes with either ITT or CC analysis.

No significant moderators of the primary outcomes of problem drinking and tobacco smoking were observed (Appendix Table 2, available online).

DISCUSSION

This is the first study to examine the longer-term efficacy of a mobile phone–based life-skills training program designed to prevent substance use among adolescents. Three main findings were revealed: (1) the intervention significantly reduced tobacco smoking prevalence and the secondary outcomes of cannabis use prevalence as well as the frequency of cannabis smoking, (2) no longer-term intervention effect was observed for the primary outcome of problem drinking and the secondary outcomes of well-being or social skills, and (3) no demographic characteristic moderated the efficacy of the intervention.

The variable effectiveness of the program depending on the substance under consideration (alcohol versus tobacco and cannabis) is consistent with other findings on the longer-term effectiveness of a universal school-based life-skills program assessed in Germany.[8] In this latter study, a significant effect was noted at 4.5 years of follow-up on the frequency of smoking and proneness to illicit drug use but not on alcohol use.[27] In addition, similar to the short-term outcomes of this study, the effects on alcohol use assessed directly after program completion faded in the longer term. The authors' explanation—that drinking alcohol becomes more and more culturally accepted, normative, and strongly associated with youths' social life as they age[8]—is also obvious among young people in Switzerland and is in line with a recent representative survey: among those aged 15−19 years, 39% had smoked cigarettes, 34% had smoked E-cigarettes, and 30% had smoked cannabis, whereas 81% had consumed alcohol.[4] Furthermore, this study showed that although alcohol consumption was rated as bad, unhealthy, and dangerous, it was not rated as unattractive or uncool, unlike the other substances. Hence, one potential interpretation of the missing effect of life-skills training on alcohol use might be that resisting offers of deviant and less-accepted substances, such as cigarettes or cannabis, might be easier than resisting culturally accepted substances such as alcohol.

Beyond the specific findings on the effectiveness of digital life-skills training programs such as the *SmartCoach*, the findings of this study provide valuable

information on the importance of longer-term follow-up surveys in prevention programs. Previous studies on digital substance-use-prevention programs revealed that intervention effects dissipated over time.[40,41] A fading longer-term effect concerning alcohol use was also revealed in this study and the school-based life-skills program assessed in Germany mentioned earlier.[8] However, there are also other outcomes where an intervention effect becomes stronger and only detectable in the longer term, such as for the prevalence of tobacco smoking and cannabis use in this study. Together with the explanation mentioned earlier that tobacco and cannabis use are less culturally accepted and normative, this result could also indicate that it is easier to prevent the onset of a new behavior than its escalation. Although this hypothesis has to be tested in future trials, it would imply that life-skills training programs for substance use prevention should start as early as possible in adolescence.

The lack of statistically significant moderators in this study might be because of a lack of statistical power. The sample size calculation for the study aimed to identify the main effects,[28] and the detection of moderator effects in field studies is less efficient because of increased measurement error.[42] Future studies should be adequately powered to assess the differential impact of digital interventions according to socially stratifying factors.[43]

Limitations

The main limitations of this study are the following:

1. Because all the data were self-reported, the results may have been influenced by social desirability and recall bias.
2. Performing cluster randomization by school class failed to balance all the baseline characteristics. To overcome this, statistical analysis entailed the inclusion of covariates for which baseline differences were found to account for any bias caused by unbalanced samples.
3. The follow-up assessment was conducted during lockdown restrictions because of the coronavirus pandemic. This might have affected the generalizability of the results.
4. The results should not be generalized to all secondary and upper secondary schools in Switzerland because a convenience sample of school classes willing to participate in the study was recruited. By contrast, comparing this study's substance use prevalence rates with those obtained among a representative sample of students aged 15 years in Switzerland[44] revealed no major discrepancies.

CONCLUSIONS

In an RCT comparing the longer-term efficacy of *SmartCoach*, a mobile phone–delivered life-skills training program for substance use prevention among adolescents, with that of an assessment alone, the intervention appeared to be effective at preventing tobacco smoking and cannabis use over an 18-month observation period. Given that the automated program could be introduced within a single school lesson, it could be easily and economically implemented in large groups of adolescents. The importance of longer-term follow-up surveys to assess the effectiveness of digital substance-use-prevention programs is underlined by the different short- and longer-term results.

CREDIT AUTHOR STATEMENT

Raquel Paz Castro: Conceptualization, Data curation, Methodology, Software, Validation, Writing - <Original Draft. Severin Haug: Conceptualization, Funding acquisition, Methodology, Software, Supervision, Writing - Original Draft, Writing - Review and Editing. Andreas Wenger: Data curation, Methodology, Software, Visualization, Writing - Original Draft. Michael P. Schaub: Conceptualization, Methodology, Supervision, Writing - Review and Editing.

ACKNOWLEDGMENTS

The authors thank Andreas Filler and his team from PathMate-Technologies for setting up the server for the program. Furthermore, they like to thank all involved Addiction Prevention Centers for their cooperation in recruiting secondary schools as well as the participating teachers, school classes, and students for supporting the study.

Funding for this project was provided by the Swiss National Science Foundation (grant number 10001C_179222/1).

No financial disclosures were reported by the authors of this paper.

SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2022.06.017.

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