Efficacy of a mobile app-based coaching program for addiction prevention among

apprentices: a cluster-randomized controlled trial

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Abstract

Background: A large proportion of apprentices shows addictive behaviors like cigarette smoking, alcohol, cannabis, or compulsive Internet use. *ready4life* is a mobile app-based coaching program for apprentices, which takes into account the heterogeneity of adolescent addictive behavior by promoting life skills and reducing risk behaviors. This study aimed at testing the efficacy of *ready4life* for addiction prevention among apprentices in Switzerland within a controlled trial. **Methods:** Two-arm, parallel group, cluster-randomized controlled trial with assessments at baseline and follow-up assessment after 6 months. Participants of the intervention group received individualized coaching by a conversational agent (chatbot) for a period of 16 weeks. Primary outcome was a composite measure for addictive behaviors including (1) at risk-drinking, (2) tobacco/e-cigarette smoking, (3) cannabis use, and (4) problematic Internet use. **Results:** A total of 2,275 students from 159 Swiss vocational school classes, were invited to participate in the study. Of these, 1,351 (59.4%) students (mean age 17.3 years (SD=3.0), 56.6% male) participated in the study. 6-month follow up assessments were completed by 962 (71.2%) study participants. The results concerning the primary outcome showed a stronger decrease of addictive behaviors between baseline and follow up in the intervention group compared to the control group (OR_{ITT}=0.77, CI=0.67; 0.88, *p* <.01; OR_{CC}=0.71, CI =0.61; 0.83, *p* <.01). In particular, significant effects were observed for at-risk drinking and problematic Internet use, while no significant effects were observed for tobacco/e-cigarette smoking and cannabis use. **Conclusions:** The majority of apprentices invited for program participation within vocational schools participated in the *ready4life* program for addiction prevention. This mobile app-based coaching approach proved to be effective in preventing the onset and escalation of addictive behaviors such as at-risk drinking and problematic Internet use at 6-month follow up.

Trial Registration: ISRCTN 59908406 (registration date: 21/10/2020).

Keywords: substance use; addiction, prevention; apprentices, adolescents; mobile app

Introduction

For adolescents, starting an apprenticeship and entering work life are accompanied by several changes and new challenges. Financial independence and social detachment from their parents result in a higher degree of autonomy. At the same time, the responsibility for one's own actions increases and the workplace environment confronts them with the reality of work, which is often associated with stress, time and success pressure. Dealing with colleagues, superiors and business partners or customers also places new demands on the social skills of the apprentices. Accordingly, the beginning of the apprenticeship is associated with health risks, especially increased substance use. A representative study among adolescents from Switzerland aged 15 to 19 years showed a significantly higher proportion of regular (at least monthly) tobacco smokers (21% vs. 12%) and alcohol users (60% vs. 52%) among adolescents in vocational than general education, whereas there were no significant differences concerning regular cannabis use (12% vs. 8%) [1]. Apprentices, typically in the age of 15-18 years, represent a very heterogeneous group in terms of protective and risk behaviors with a small proportion showing no substance use or addictive behaviors and the predominant share showing at least one or co-occurring addictive behaviors [2-4]. According to international reviews, general life-skills training programs that address social skills and simultaneously address social influences, e.g. by media or the peer group, are particularly suitable for preventing substance use or delaying the onset of addictive behaviors in younger adolescents and those who have not yet started using addictive substances [5]. In adolescents already using substances, interventions based on motivational and cognitive-behavioral principles are promising, however the findings are mixed and the effects sizes typically small [5, 6]. Due to the age and heterogeneous risk profiles among apprentices, both general life-skills training programs and motivational, cognitive-behavioral programs to reduce specific substances, show potential.

Although schools provide access to large numbers of students, the implementation and dissemination of general life-skills or addiction prevention programs in schools pose serious challenges [7]. First, teachers and other professionals need the time, motivation, knowledge and skills to deliver the program. Second, extensive resources in terms of personnel, money, and time are required to administer such programs.

Digital interventions have great potential to overcome the above-mentioned implementation obstacles, as they can achieve extensive reach at low cost and offer the option of delivering uniquely-personalized content automatically, content that also is accessible anytime and anywhere.[8] Furthermore, digital interventions might be more appealing because they are better than traditional programs at ensuring anonymity and tailoring contents to personal needs [9, 10].

A 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.[11] 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.

One promising way to deliver preventative services, besides through conventional personal computers, is to do so remotely via mobile phones. Almost all (99%) adolescents between the ages of 12 and 19 in Switzerland, as in most other developed countries, own a mobile phone [12]. Recent reviews particularly 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.[10, 13, 14]

A controlled trial on a text messaging-based intervention to reduce problem drinking in vocational and upper secondary school students in Switzerland showed a significant intervention effect on the prevalence of binge drinking, which decreased by 6% in the

intervention group and increased by 3% in the control group, relative to that of baseline assessment [15].

Another Swiss study showed the acceptance and potential effectiveness of previous version of *ready4life*, a text messaging-based life-skills training program for substance use prevention among vocational school students [2]. The program was based on social cognitive theory and addressed self-management skills, social skills, and substance use resistance skills. Active program engagement was encouraged through interactive features such as quiz questions, message and picture-contests, and integration of a friendly competition with prizes in which program users collected credits with each interaction. Four out of five eligible students participated in the program and the associated study. Pre-post comparisons revealed decreased perceived stress and at-risk alcohol use between baseline and a follow-up assessment at month 6 [2].

Within the current study, we tested the efficacy of the current *ready4life* version, a mobile app-based program for addiction prevention in apprentices, within a controlled trial. The program takes into account the heterogeneity of apprentice`s risks and resources by promoting life skills (coping with stress, social skills) on the one hand and reducing various risk behaviors (problematic Internet use, tobacco/e-cigarette smoking, cannabis use, at-risk drinking) on the other. Our main hypothesis was that the individually tailored 4-month intervention program would be more effective than assessment only, in preventing the onset and escalation of addictive behaviors including (1) at risk-drinking, (2) tobacco/e-cigarette smoking, (3) cannabis use, and (4) problematic Internet use at 6-months follow-up.

Materials and Methods

Objectives and study design

This study aimed at testing the efficacy of *ready4life*, a mobile app-based coaching program for addiction prevention among apprentices. A two-arm, parallel group, cluster-randomized

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controlled trial was conducted with assessments at baseline and follow-up after 6 months. The efficacy of the intervention was compared to an assessment-only control condition.

Participants, setting and procedure

In most European countries, vocational schools are post-secondary public schools that are analogous to American community colleges. They are part of the dual educational system that combines apprenticeships in a business context and vocational training in a school context. Vocational schools provide general education and specific skills for each particular profession.

Based on data from the Swiss Federal Statistical Office, approximately half of all Swiss adolescents ages 16 to 19 currently attend vocational schools [16], with the highest proportions among adolescents ages 17 (males: 60%, females: 47%) and 18 (males: 57%, females: 45%). Vocational schools in the German speaking part of Switzerland were invited to participate in the study by cooperating regional centers for addiction prevention. Prevention specialists from these regional centers for addiction prevention were trained and informed on the *ready4life* intervention program. These specialists arranged sessions in the participating vocational school classes, lasting 30 minutes during regular school lessons reserved for health education. Within this session, the students were informed about the program and invited to participate in a study testing innovative channels for the delivery of health-related information and life skills. The students were informed about the study's aims, design, assessments, reimbursement, and data protection. The chatbot coaching program, its friendly competition and the chance to win prizes were described in detail, using a teaser video (www.r4l.swiss). To ensure sufficient participation and thus representativeness of the sample [17], students were informed that they would also receive a reward for participating in the follow-up assessment (cash 10 CHF (US $10.50)). Participating students downloaded the app on their smartphone and completed online study registration and baseline assessment.

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After giving informed consent, study participants were invited to choose a username and provide their mobile phone number.

Subsequently, participants of intervention classes received an individual profile on their risks and resources and could select two out of the following six topics: stress, social skills, social media & gaming, tobacco/e-cigarette smoking, cannabis, and alcohol. On their two chosen topics, they received coaching, for a period of four months (two months per topic) by the chatbot. Participants of the assessment only control classes did not receive the intervention program. However, they were invited to participate in the program after completion of the follow-up assessment in month 6. Follow-up assessment were conducted in both study groups using a similar procedure: participants were invited to complete the online follow-up assessments via SMS text messaging. Non-responders were additionally addressed via computer-assisted telephone interviews conducted by research assistants.

Ethical Review

The study protocol was approved by the the Ethics Committee of the Faculty of Arts and Sciences at the University of Zurich (approval number 20.10.12; date of approval October 16th, 2020). The trial was executed in compliance with the Helsinki Declaration.

Randomization and allocation concealment

To avoid spillover effects within school classes, we conducted a cluster-randomized controlled trial using school class as a randomization unit. Due to the heterogeneity of students in the different vocational schools, we used a separate randomization list for each school (stratified randomization). Furthermore, to approximate equality of sample sizes in the study groups, we used block randomization with computer generated randomly permuted blocks of 4 cases [18].

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The prevention specialists 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. Furthermore, the research assistants who performed the computer-assisted follow up assessments for primary and secondary outcomes were blinded to the group allocation.

Sample size calculation

Based on reviews on electronically-delivered programs for the prevention of addictive disorders [13, 19-22], we expected a small effect size for the main outcome of this study, the non-parametric composite measure of addictive behaviors. Based on an expected Cohen`s d of 0.2, a sample size of n=412 in each study group was required to have 80% power for a Wilcoxon-Mann-Whitney-test (α=5%, 2-sided) in order to detect this difference based on a calculation using G-Power.

As vocational school students are nested within school classes, we additionally needed to consider a potential design effect for the calculation of the sample size for our study. Based on previous efficacy studies in vocational schools [15] [2], an average cluster size of 13 study participants per school class and an intra-cluster correlation coefficient of 0.05 was expected. This resulted in a design effect of 1.60. Multiplying this design effect by the required size for an unnested sample (n=412) resulted in a required sample size of n=659 per study group and a total of n=1318 study participants.

Intervention program

ready4life (www.r4l.swiss) is a mobile app-based addiction prevention program for adolescents that takes into account the heterogeneity of adolescent addictive behavior by promoting life skills on the one hand and reducing risk behaviors on the other. The program

provides individually tailored coaching by a conversational agent. Details of the intervention program are presented in the study protocol of this trial [23].

After choosing a male or female avatar, participants were invited by the chatbot to provide demographic data (age and sex) and to complete the baseline assessment on stress, self-efficacy, social skills, Internet, tobacco/e-cigarette, cannabis, and alcohol use. Subsequently, an individual feedback was generated based on this survey conducted via smartphone. Using the three traffic light colors, this feedback showed areas in which a participant had sufficient resources (green) and in which there was a need for coaching (yellow and red). Based on this feedback, participants could select two out of the following six program modules: stress, social skills, social media & gaming, tobacco/e-cigarette smoking, cannabis, and alcohol. Using the individual data from the baseline assessment for tailoring of intervention contents, participants received coaching for a period of 8 weeks for each of the two selected topics. During this 4-month coaching the virtual coach motivated the participants to deal sensibly with addictive substances, gave feedback on current consumption and life skills, and provided individually tailored information in weekly dialogues. Participants were notified of a new module every Tuesday via push message. The time required to process a weekly dialog was between two and five minutes. Participants could also start a conversation with the chatbot themselves by selecting one of several predefined topics within each module (e.g. "quiz on myths about alcohol" within the alcohol module or "using body language effectively" within the module on social skills). In a separate chat within the app ("Ask the Expert") the participants could pose personal questions to regional addiction prevention experts. In order to stimulate active program engagement, several interactive elements such as quiz questions, contests and a playful competition were integrated into *ready4life*. Program users could collect credits for each completed weekly dialogue with the chatbot. The more credits participants collected, the higher their chances were of winning one of several attractive prizes, which were part of a prize draw after program completion. Participants were able to

retrieve their number of credits compared to the number of credits of other program participants' of their group (similar starting date) at any time from an individual profile page. Each program module had a similar structure and contained similar intervention elements based on principles of the Social-Cognitive Theory (e.g., goal-setting, self-monitoring, observational learning) [24], the Social Norms Approach (e.g., normative feedback) [25] and Motivational Interviewing (e.g., decisional balance) [26].

Assessments and outcomes

At baseline, we assessed individual demographic variables (age, sex) as well as characteristics of the schools and school classes (type of vocational school, apprenticeship profession, number of students present within school class).

Baseline- and follow-up assessments included the following addictive behaviors and life skills addressed in the intervention program:

1. At risk-drinking in the preceding 30 days, according to guidelines of the Swiss Federal Office of Public Health [27]. At risk-drinking was present, if (1) the maximum consumption on one occasion in the preceding 30 days was higher than 4/5 (female/male) alcoholic standard drinks (10-12 gram of pure alcohol) or (2) the total consumption in the preceding 30 days was higher than 20/40 (female/male) drinks or (3) the number of alcohol consumption days in the preceding 30 days was higher than 20.

2. 30-days point prevalence for tobacco/e-cigarette smoking, defined as having smoked at least a puff within the past 30 days, in accordance with Society for Nicotine and Tobacco Research criteria [28].

3. Number of tobacco cigarettes smoked in the preceding 30 days by multiplying the number of tobacco cigarettes smoked on a typical smoking day and the number of smoking days.

4. Cannabis use days in the preceding 30 days.

5. Problematic Internet use assessed by the Short Compulsive Internet Use Scale (CIUS-5) with a cut-off of nine points [29].

6. General self-efficacy assessed by the Short Scale for Measuring General Self-efficacy Beliefs [30].

7. Self-perceived stress assessed by a single-item measure of stress symptoms [31].

The primary outcome of the planned study was a composite measure (range: 0-4) for addictive behaviors, reflecting the number of risk behaviors (at-risk drinking in the preceding 30 days, 30-days point prevalence for tobacco/e-cigarette smoking, 30-days point prevalence for cannabis use, problematic Internet use) that a person displays.

Secondary outcomes were dichotomous measures reflecting the single risk behaviors (1) at risk drinking in the preceding 30 days, (2) 30-days point prevalence for tobacco/e-cigarette smoking, (3) 30-days point prevalence for cannabis use, and (4) problematic Internet use as well as metric measures reflecting (5) total number of alcoholic drinks consumed in the preceding 30 days, (6) number of tobacco cigarettes smoked in the preceding 30 days, (7) number of cannabis use days in the preceding 30 days, (7) extent of problematic Internet use (CIUS-5 total score) [29], (9) general self-efficacy [30] and (10) self-perceived stress [31].

Statistical Analysis

We examined baseline differences between participants of the two groups by performing chi-square tests for categorical variables and t-tests for continuous variables. To assess whether participants lost to follow-up differed from the respondents, we performed (generalized) linear mixed models (GLMMs) while modeling a random intercept for school class. GLMMs were used to assess intervention effects for binary outcomes and Linear Mixed Models (LMM) for continuous outcomes [32, 33]. The primary outcome representing the

composite measure for addictive behaviours (range: 0-4) was analysed as a binomial variable (number of non-risks, number of risks) with a GLMM as described in [34].

Within each (G)LMM, a random intercept was modelled for school class. Analyses of binary and continuous outcomes included follow-up scores as the dependent variable. Independent variables included group as a predictor, as well as baseline values for each respective variable. To identify potential moderators, (G)LMMs with a random intercept for school class were modelled. In addition, interaction terms for age, sex, the dichotomous baseline variables and study group were included, one at a time. All data were analyzed according to complete case analysis and the intention-to-treat principle (ITT). For ITT analyses, multiple imputation procedures were used [35]. Imputations were performed for each group separately to preserve within-group homogeneity and potential interventional effects. Overall predictors of missing data at follow-up were sex, age, school class, and particularly for the intervention group engagement. The remaining variables that were used as predictors were those that displayed at least a weak correlation ($r>0.10$). Binary outcomes were imputed using logistic regression and continuous outcomes using predictive mean matching. After examining 20 datasets, no systematic bias in convergence was revealed. The results from the imputed dataset were crosschecked with the non-imputed data. A type I error rate of $p<.05$ on two-sided tests was considered statistically significant when evaluating intervention main effects and moderator effects. All analyses were performed using R, version 4.1.2. Multiple imputations were conducted with R's mice package [35] and (G)LMMs with the lme4 package [36].

Results

Study Participants

Figure 1 depicts participants' progression through the trial. At online screening assessment, 2,275 students were present in 159 vocational school classes. Of these, 1,351 (59.4%) provided informed consent and a mobile phone number and ultimately participated in the

study. A total of 688 students from 76 school classes were randomly assigned to the

intervention group, 663 students from 77 classes were assigned to the control group. Primary

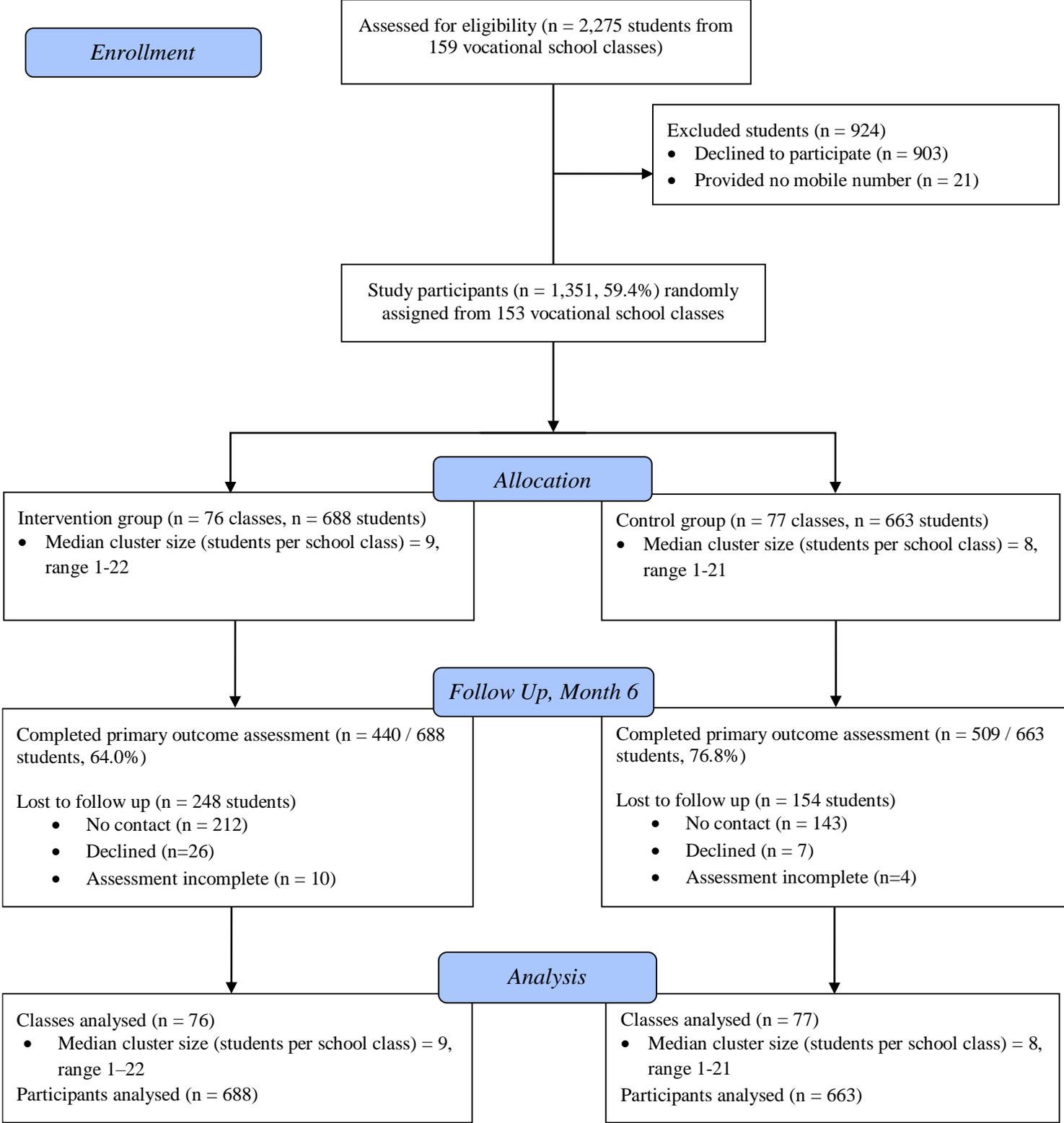outcome assessment at six-month follow-up was completed by 949 students (70.2%).

Figure 1: Flow of study participants.

Baseline characteristics for the study sample are shown in Table 1. The mean age was 17.3

years (SD 3.0) and 43.4% of the participants were female.

Table 1: Baseline characteristics of the study sample. Values represent n (%), unless stated
otherwise.

Variable	Intervention	Control	Total	p [a]
	$n = 688$	$n = 663$	$N = 1,351$	
Sex				.21[b]
Male	401 (58.3%)	363 (54.8%)	764 (56.6%)	
Female	287 (41.7%)	300 (45.2%)	587 (43.4%)	
Age, *M (SD)*	17.3 (2.7)	17.4 (3.2)	17.3 (3.0)	.27[c]
Composite measure of risk behaviors, *M (SD)*	1.5 (1.2)	1.5 (1.2)	1.5 (1.2)	.74[b]
0 risks	176 (25.6%)	155 (23.4%)	331 (24.5%)	
1 risk	226 (32.8%)	235 (35.4%)	461 (34.1%)	
2 risks	135 (19.6%)	138 (20.8%)	273 (20.2%)	
3 risks	101 (14.7%)	89 (13.4%)	190 (14.1%)	
4 risks	50 (7.3%)	46 (6.9%)	96 (7.1%)	
At risk-drinking in the preceding 30 days				.12[b]
No	475 (69.0%)	430 (64.9%)	905 (67.0%)	
Yes	213 (31.0%)	233 (35.1%)	446 (33.0%)	
Total number of alcoholic drinks consumed in the preceding 30 days, *M (SD)*	14.8 (34.5)	15.1 (33.0)	14.9 (33.7)	.86[c]
Tobacco/e-cigarette smoking, preceding 30 days				.59[b]
No	393 (57.1%)	368 (55.5%)	761 (58.3%)	
Yes	252 (36.6%)	246 (37.1%)	498 (36.9%)	
Quantity of cigarettes smoked, preceding 30 days, *M (SD)*	89.9 (199.9)	78.0 (176.0)	84.1 (188.5)	.25[c]
Cannabis use, preceding 30 days				.19[b]
No	521 (75.7%)	523 (78.9%)	1,044 (77.3%)	
Yes	167 (24.3%)	140 (21.1%)	307 (22.7%)	

Cannabis use days, preceding 30 days, *M (SD)*	2.5 (6.9)	2.1 (6.2)	2.3 (6.6)	.27[c]
Problematic Internet use (CIUS-5)[d]				.59[b]
No	321 (46.7%)	320 (48.3%)	641 (47.4%)	
Yes	367 (53.3%)	343 (51.7%)	710 (52.6%)	
CIUS-5 score, range 0-20, *M (SD)*	8.9 (4.2)	9.0 (4.0)	8.9 (4.1)	.90[c]
General self-efficacy, range 1-5, *M (SD)*	3.7 (0.7)	3.8 (0.7)	3.7 (0.7)	.46[c]
Self-perceived stress, range 1-5, *M (SD)*	3.1 (1.1)	3.2 (1.1)	3.2 (1.1)	.12[c]

[a] *p* values for the comparison of the intervention and control group

[b] χ^2 test

[c] *t* test

[d] CIUS-5: Short Compulsive Internet Use Scale.

There were no baseline differences between the intervention and control group. Participants who dropped out reported a greater quantity of cigarettes smoked in the preceding 30 days (OR=1.93; CI=1.01; 3.70, *p*=.048) and were more likely to be cannabis users (OR=1.37; CI=1.02; 1.84, *p*=.04). No differential dropout between the study groups was observed.

Program use

The initial feedback dialogue, showing areas in which a participant had sufficient resources and in which there was a need for coaching or counselling, was retrieved by 627/688 (91.1%) participants of the intervention group. The most frequently provided coaching topic was stress (67.6%), followed by social media & gaming (48.7%), social skills (25.6%), tobacco/e-cigarette smoking (25.3%), alcohol (20.9%), and cannabis (11.9%).

During the 4 months intervention period, participants were invited via weekly push notification to participate in 16 coaching dialogues (8 for each of the two selected topics). The mean number of completed weekly dialogues among the 688 participants of the intervention group was 2.1 (*SD*=3.5). Four of ten participants (n=280/688, 40.7%) did not complete any

dialogue, another four of ten (271/688, 39.4%) completed one or two dialogues. One of ten

participants (n=67/688, 9.7%) completed between 3 and 6 dialogues and another one of ten

participants (70/688, 10.2%) completed between 7 and 16 dialogues.

Valid follow-up data concerning program evaluation were available from 378 (52.8%-54.9%)

of the 688 intervention group participants. Of these, 93.4% (n=353/378) indicated that the

language and content of the program were comprehensible, 83.1% (n=314/378) reported that

the tips and information provided were helpful and 81.2% (309/378) indicated that they

perceived the contents as individually tailored to them. Participants in the intervention group

who were more engaged, i.e., completed more weekly dialogues, were significantly less likely

to drop out compared to the less engaged participants (OR=0.86; CI=0.81;0.92; p <.01).

However, we did not find an association of engagement with the extent of risk reduction

based on the primary outcome, suggesting that there was no dose-response effect for our

intervention group.

Efficacy of the intervention program

The results concerning the primary outcome showed a stronger decrease of addictive

behaviors between baseline and follow up in the intervention group compared to the control

group (OR_{ITT}=0.77, CI=0.67; 0.88, p <.01; OR_{CC}=0.71, CI =0.61; 0.83, p <.01). Indicating

that the odds of an additional risk behavior at follow-up in the intervention group is 0.77 times

the odds of an additional risk behavior in the control group. Regarding the secondary

outcomes, significant group effects were observed for the following dichotomous measures:

at-risk drinking in the preceding 30 days (OR_{ITT}=0.68, CI=0.52; 0.89; OR_{CC}=0.60, CI=0.43;

0.84), 30-days point prevalence for tobacco/e-cigarette smoking (OR_{CC}=0.62, CI =0.40; 0.96)

but not for the ITT analysis, and problematic Internet use (OR_{ITT}=0.61, CI=0.46; 0.81;

OR_{CC}=0.56, CI =0.40; 0.79). Furthermore, significant group effects were observed for the

following continuous measures: Total number of alcoholic drinks consumed in the preceding

30 days (Cohen's d_{ITT}= 0.07, d_{CC} = 0.11), number of cannabis use days in the preceding 30 days (Cohen's d_{CC} = 0.14) but not for the ITT analysis, self-perceived stress (Cohen's d_{ITT}= 0.27; d_{CC} = 0.18), and extent of problematic Internet use (Cohen's d_{ITT}= 0.27; d_{CC} = 0.25). The results of the complete-cases (CC) and intention-to-treat (ITT) analyses concerning the dichotomous and continuous outcomes are summarized in Tables 2 and 3. No significant moderators were identified with our moderation analyses.

Table 2: Intervention effects for dichotomous outcomes. Values represent n (% within sub-sample), unless stated otherwise.

	Intervention group			Control group						
	Baseline	Follow-up	Diff. %	Baseline	Follow-up	Diff.%	*Coeff*	*p*	OR	95% CI
Complete-cases analysis[a]	*n*=440	*n*=440		*n*=509	*n*=509					
At-risk drinking past 30 days	140 (31.8%)	83 (18.9%)	-12.9	176 (34.6)	139 (27.3%)	-7.3	-0.51	<.01	0.60	0.43; 0.84
Tobacco/e-cigarette use past 30 days	153 (34.8%)	119 (27.0%)	-7.8	178 (35.0%)	166 (32.6%)	-2.4	-0.48	.03	0.62	0.40; 0.96
Cannabis use past 30 days	98 (22.3%)	82 (18.6%)	-3.7	99 (19.4%)	82 (16.1%)	-3.3	0.10	.63	1.11	0.73; 1.70
Problematic Internet use	237 (53.9%)	144 (32.7%)	20.7	265 (52.1%)	219 (43.0%)	-9.1	-0.58	<.01	0.56	0.40; 0.79
Intention-to-treat analysis[a]	*n* = 688	*n* = 688		*n* = 663	*n* = 663					
At-risk drinking past 30 days	213 (31.0%)	138 (20.1%)	-10.9	233 (35.1%)	182 (27.5%)	-7.6	-0.38	<.01	0.68	0.52; 0.89
Tobacco/e-cigarette use past 30 days	252 (36.6)	179 (26.0%)	-10.6	246 (37.1%)	209 (31.5%)	-5.6	-0.30	.06	0.74	0.55; 1.01
Cannabis use past 30 days	167 (24.3%)	128 (18.6%)	-5.7	140 (21.1%)	99 (14.9%)	-6.2	0.26	.16	1.29	0.90; 1.85
Problematic Internet use	367 (53.3%)	222 (32.3%)	-21.0	343 (51.7%)	280 (42.2%)	-9.5	-0.49	<.01	0.61	0.46; 0.81

[a] Generalized mixed models with a random effect for school classes, group as a fixed factor, follow-up scores as outcomes and baseline scores as covariates.

Table 3: Intervention effects for continuous outcomes.

	Intervention group			Control group					
	Baseline	Follow-up	Diff.	Baseline	Follow-up	Diff.	*Coeff*	*p*	*d*[a]
Complete-cases analysis[b]	*n*=440	*n*=440		*n*=509	*n*=509				
Quantity of alcohol use past 30 days, *M (SD)*	14.5 (31.8)	7.0 (15.7)	-7.5	13.9 (31.2)	9.8 (17.4)	-4.1	-2.81	.01	0.11
Quantity of cigarettes smoked past 30 days, *M (SD)*	81.4 (195.5)	55.3 (155.4)	-26.1	71.7 (167.8)	57.9 (148.7)	-13.8	-8.58	.20	0.07
Cannabis smoking days past 30 days, *M (SD)*	2.5 (7.0)	1.5 (5.3)	-1.0	1.8 (5.7)	1.7 (6.1)	-0.1	-0.61	.03	0.14
Perceived stress past 30 days, *M (SD)*	3.1 (1.1)	2.7 (1.1)	-0.4	3.2 (1.1)	3.0 (1.1)	-0.2	-0.26	<.01	0.18
General self-efficacy, *M (SD)*	3.7 (0.7)	3.8 (0.7)	-0.1	3.8 (0.7)	3.7 (0.7)	-0.1	0.07	.16	-0.29
Problematic Internet use, *M (SD)*	8.9 (4.2)	6.8 (4.1)	-2.1	8.9 (3.9)	7.8 (4.0)	-1.1	-1.03	<.01	0.25
Intention-to-treat-analysis[b]	*n* = 688	*n* = 688		*n* = 663	*n* = 663				
Quantity of alcohol use past 30 days, *M (SD)*	14.8 (34.5)	6.8 (15.3)	-8.0	15.1 (33.0)	9.5 (16.9)	-5.6	-2.66	<.01	0.07
Quantity of cigarettes smoked past 30 days, *M (SD)*	89.9 (199.9)	54.2 (155.4)	-35.7	78.0 (176.0)	55.5 (144.9)	-22.5	-6.0	.40	0.07
Cannabis use days past 30 days, *M (SD)*	2.5 (6.8)	1.7 (5.7)	-0.8	2.1 (6.3)	1.7 (6.0)	-0.4	-0.07	.81	0.06
Perceived stress past 30 days, *M (SD)*	3.1 (1.1)	2.7 (1.1)	-0.4	3.2 (1.1)	3.1 (1.1)	-0.1	-0.28	<0.01	0.27
General self-efficacy, *M (SD)*	3.7 (0.7)	3.8 (0.8)	0.1	3.8 (0.7)	3.8 (0.7)	0	0.05	.24	-0.14
Problematic Internet use, *M (SD)*	8.9 (4.2)	6.8 (4.0)	-2.1	9.0 (4.0)	8.0 (4.0)	-1	-1.20	<.01	0.27

[a] Effect sizes Cohen's *d* were calculated based on baseline-follow-up differences between the two study groups [37].
[b] Linear mixed models with a random effect for school classes, group as a fixed factor, follow-up scores as outcomes and baseline scores as covariates.

Discussion

Principal Results

This study tested the efficacy of a mobile app-based addiction prevention-coaching program among apprentices recruited in vocational schools in Switzerland. Three main findings were revealed: (1) Six of ten vocational school students (59%) participated in the study, showing a relatively high interest in this interventional approach, (2) program use was relatively low in relation to intended use (3) the program was effective in preventing the onset and escalation of addictive behaviors, particularly at-risk drinking and problematic Internet use.

The proactive invitation for program and study participation in vocational schools, in combination with offering a low-threshold mobile app-based coaching, allowed reaching six of 10 apprentices for participation in the *ready4life* program and the associated study. Given the program duration of 16 weeks and that program participants needed to download a separate app on their Smartphone, this participation rate of 59% is comparatively high. A recent study on the [38] Health4Life app, an intervention to prevent six key risk behaviors among secondary school students in Australia revealed that of the 3610 students provided access to the app, 407 (11%) accessed it. Mobile phone-based programs to reduce problem drinking or to support smoking cessation, conducted in Swiss and German vocational and upper secondary schools, involving similar recruitment procedures, achieved comparable participation rates between 50% and 75% [15, 39-43].

Concerning program use, the results show that with an average of 2.1 out of 16 completed weekly dialogues, the average program use was relatively low. However, the low engagement rates are in line with the findings of other reviews on digital interventions to promote mental health [44, 45] or to prevent substance use [20, 46] in young people that also point at the relatively low levels of user engagement [20, 46]. In the case of the previously mentioned Health4life app, students who accessed the app used it for an average duration of 9.7 days. [38].

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Concerning program efficacy, both the ITT and CC results showed a stronger decrease of addictive behaviors between baseline and follow up in the intervention group compared to the control group. Looking at the secondary outcomes, significant intervention effects were revealed for at-risk drinking and the related quantity of alcohol use, problematic Internet use and perceived stress, while no significant effects were found for cannabis use and tobacco/e-cigarette smoking. Regarding tobacco/e-cigarette smoking prevalence, the CC analysis showed a significant intervention effect, which, however, was narrowly missed in the ITT analysis. Although the effect sizes achieved were small, the study was able to show, in contrast to the findings reported by Champion et al [11], that a school-based digital intervention to prevent multiple risk behaviors can also be effective in reducing addictive behaviors like problematic Internet and alcohol use.

Limitations

Main limitations of the current study are (1) all data rely on self-report and the associated possibility that results may have been influenced by social desirability and a potential recall bias. (2) The study was conducted in 2021/22 during the corona pandemic with varying restrictions depending on the time and place of recruitment. These restrictions also influenced the social life and substance use of young people and accordingly the generalizability of the results of this study. (3) Beyond the corona restrictions, the results could not be generalized to vocational school students in Switzerland, as we recruited a convenience sample of school classes willing to participate in the study.

Conclusions

ready4life is the first mobile app-based coaching program for addiction prevention in apprentices that was tested within a controlled trial. The results of this study suggest that this

universally implementable but individually tailored intervention approach is effective in increasing life skills and reducing risk behaviors in a group of adolescents with a particular high risk of addictive behaviors. Given that the program could be presented and introduced by teachers or addiction prevention specialists within one school lesson, it could be easily and economically implemented.

Author contributions

Severin Haug: Funding acquisition; conceptualization; investigation; methodology; resources; supervision. Nikolai Boumparis: data curation; formal analysis; methodology; validation. Andreas Wenger: data curation; formal analysis; methodology; validation. Michael Schaub: conceptualization; methodology; supervision. Raquel Paz Castro: Conceptualization; project administration; methodology; validation.

Conflict of interest

The funding institution did not influence the design and conduct of the study; the management, analysis or interpretation of data; or the preparation, review or approval of the manuscript.

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