Brief intervention and mindset induction to reduce khat use among Ethiopian students – a randomized controlled trial

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Conflict of interest disclosure

All authors declare no conflict of interest

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Data availability statement

The data supporting the findings of this study are currently available upon request. We plan to publish the data in the manuscript publication process.

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Abstract

University students in Ethiopia often use the natural stimulant khat to boost academic performance. However, excessive khat consumption is related to mental and somatic problems and withdrawal symptoms, but interventions helping to reduce khat use are lacking. This randomized controlled study aimed to investigate the effectiveness of the standardized ASSIST-linked Brief Intervention (BI) in a pre-post design with a control group (CG). Additionally, we explored the effects of a mindset induction just before the intervention hypothesizing a boost effect on khat use outcomes.

In a pre-registered randomized controlled trial, a sample of 322 university students from Jimma, Ethiopia, were randomly assigned (1) to the BI or cognitive tests as a control condition and (2) to either a deliberative or an implemental mindset induction. We used (generalized) linear mixed-effects models to test the effects of the BI and the mindset on khat use outcomes, controlling for covariates (e.g. comorbid psychopathology and motivation to stop khat use).

The results revealed a general decrease in the amount and frequency of khat use in the two weeks after the intervention, with the BI group showing a significant greater reduction in frequency than CG. No significant effects emerged regarding the mindset induction. We found khat use affected by psychopathological symptom load and motivation to change khat use.

The findings indicate that the adapted ASSIST-linked Brief Intervention can be promising in reducing khat use. More research is needed to enhance the effectiveness of khat-reducing brief interventions.

Introduction

The leaves of the khat tree (*Catha edulis*) are a natural psychoactive substance widely cultivated in African and Arab countries and native to Ethiopia (Krikorian, 1984). The psychostimulant effects of its main biochemically active constituents, cathinone and cathine, on the central and peripheral nervous systems are somewhat similar to those of amphetamines (Kalix, 1990). In recent years, khat chewing has become an increasingly common habit beyond original local customs and religious traditions. However, it is associated with numerous somatic and mental health problems, including addiction problems (Odenwald & al'Absi, 2017). Khat users frequently report withdrawal symptoms (i.e., feeling depressed, fatigue, memory impairment, hypersomnia, altered stress response) and impairments in social and occupational functioning (Abdeta et al., 2017; Al-Motarreb et al., 2010; Odenwald & al'Absi, 2017). According to the 2011 Ethiopian demographic health survey data, the khat chewing prevalence rate was 15.3% (Haile & Lakew, 2015). Notably, high rates of khat use have also been reported among university students: Meta-analyses indicated that one in five students in Ethiopian universities used khat, with the highest prevalence observed in the Oromia region (Alemu et al., 2020; Gebrie et al., 2018). Students reportedly often start chewing khat during their first year of university (Abdeta et al., 2017) and do so mainly for khat's supposed property to boost concentration levels and alertness as well as facilitate relaxation, socializing, and stress relief (Adane et al., 2021). Empirically, however, khat use is associated with poor academic performance, presumably as a consequence of extended time for chewing and recovering from its effects (Alemu et al., 2020; Meressa et al., 2009).

Despite the fact that many khat users want to reduce or stop their khat use, these attempts often fail: Duresso et al. (2018a) monitored an unaided quit attempt of 60 Ethiopian students who were moderate khat users using electronic diaries. Only 7% managed to achieve four weeks

of abstinence and most experienced significant withdrawal symptoms and cravings (Duresso et al., 2018b). Though the literature shows the range of problematic consequences resulting from khat use and the difficulties to stop it, there is insufficient research about psychological interventions (Odenwald & al'Absi, 2017) and a lack of programs specifically targeting students (Ahmed et al., 2020).

One type of intervention with a potential high applicability are Screening and Brief Interventions (Humeniuk et al., 2012). SBIs represent a well-established approach in reducing substance use behavior, typically encompassing one to five sessions, with robust empirical support for decreasing moderate alcohol use (O'Donnell et al., 2014) and to a smaller extent for other substance use (DiClemente et al., 2017; Saitz, 2014). SBIs usually incorporate a standardized screening for substance use, a structured feedback on screening outcomes and additional interventional elements (Saitz, 2014), often based on the FRAMES principles (Bien et al., 1993) and techniques of motivational interviewing (Miller & Rollnick, 2013).

The ASSIST (Alcohol, Smoking, and Substance Involvement Screening Test)-linked Brief Intervention developed by the WHO (Humeniuk et al., 2010) was positively evaluated in a large international study involving several types of substances (Humeniuk et al., 2012). Widman and colleagues (2017) developed an adapted version of the ASSIST-linked Brief Intervention for khat users and evaluated it in a controlled study (Widmann et al. 2022). They found a significantly larger decrease in khat-use time for the intervention group compared to the assessment control group; however, effect sizes were small. They also reported that the intervention was less effective among participants with comorbid psychopathology (Widmann et al., 2017). Considering this and the lack of evidence regarding khat-related interventions, the question arises, whether additional intervention components could enhance the effect of a brief intervention.

Increasing the Effectiveness of an SBI with Mindset Induction

In general, commitment and change motivation are well-known mechanisms in ceasing risky or adopting healthy behaviors (DiClemente et al., 2017). The mindset theory of action phases (Gollwitzer, 2012b) provides a theoretical framework for motivational and decisional processes related to behavior change. It proposes that an individual passes through different phases in goal pursuit, each with its tasks and challenges. Phase-specific cognitive procedures are activated to overcome these challenges (i.e., the activation of specific mindsets). Crucially, this activation can carry over to other unrelated tasks, a peculiarity that researchers have used to study the mindsets' characteristics and, more recently, to investigate how they interact with other interventions (Gollwitzer and Keller 2016).

In the *predecisional* stage, when contemplating the desirability and feasibility of a goal is needed, a deliberative mindset is activated. This mindset is associated with open-minded and impartial information processing and a realistic view of control and feasibility (e.g., (Brandstätter et al., 2015; Doerflinger & Gollwitzer, 2020; Fujita et al., 2007). In contrast, one transitions to the *preactional* stage after making a decision. In this phase, an implemental mindset takes over that is characterized by cognitive tuning towards planning the implementation of the goal (Keller et al., 2019). This goes along with more closed-mindedness (Büttner et al., 2014), more focus on pros than cons (Taylor & Gollwitzer, 1995), illusions of control (Gollwitzer & Kinney, 1989), and increased illusory optimism regarding one's performance (Puca, 2001) or encountering adverse events (Keller & Gollwitzer, 2017).

Regarding the increased open-mindedness of the deliberative mindset, one would expect that inducing a deliberative mindset before an SBI would increase the SBI's effectiveness. In a study testing this idea in the context of risky drinking among German college students, Büchele and colleagues (2020) combined deliberative versus implemental mindsets with the ASSIST-

linked Brief Intervention. The authors included students who exhibited risky drinking but motivation to change alcohol use was no pre-requirement for study participation. Contrary to expectations, participants in an implemental mindset during the SBI managed to reduce their alcohol consumption in the four weeks after the intervention compared to the four weeks before the intervention. Participants in a deliberative mindset during the SBI even increased their alcohol consumption (Büchele et al., 2020). So, the increased open-mindedness caused by the deliberative mindset appeared to be counter-productive in the case of risky drinking (Nenkov & Gollwitzer, 2012).

The Present Research

The present study aimed to investigate the effectiveness of the adapted version of the ASSIST-linked Brief Intervention in reducing khat consumption among university students in Jimma, Ethiopia, who had the explicit wish to reduce their khat consumption. First, we expected larger reductions in the amount and frequency of khat use in the experimental group after receiving the ASSIST-linked Brief Intervention compared to a control group. Second, we investigated the downstream consequences of experimentally induced mindsets on the outcome of the brief intervention. We expected that participants differ in their khat use after the intervention depending on the induced mindset (Gollwitzer, 2012a).

Methods

Design

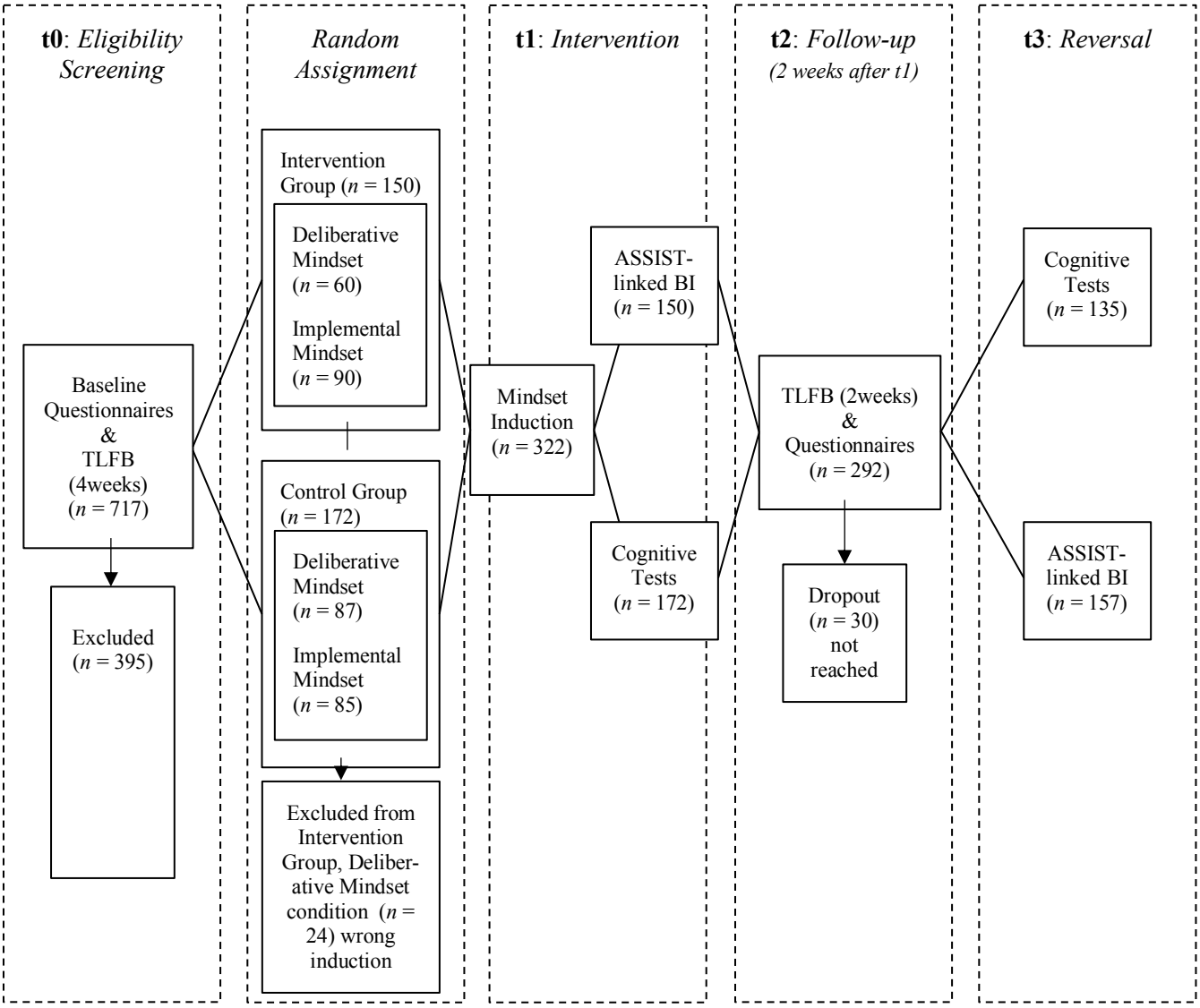
For this randomized controlled intervention study, a sample of khat using students from Jimma University who wished to cut down or stop their khat use was recruited and screened (see selection criteria below) (Hassen et al., 2021). In a second step, eligible individuals were invited for the treatment trial and randomly assigned (1) to the experimental group who received the

ASSIST-linked Brief Intervention (BI) or the control group (CG) who participated in cognitive tests (CT) and (2) to one of the two mindset conditions, the deliberative versus the implemental mindset. In total, the study comprised four appointments: Screening at t0, mindset induction and BI or CT at t1, a follow-up at t2 (two weeks after t1), and a reversal between the BI and CT groups at t3 (see Figure 1).

The study was pre-registered as a randomized controlled trial with the registry number NCT03730805. An originally planned control condition for the mindset factor (i.e., with no mindset induction) had to be omitted because of the delayed onset of the study (see next paragraph) as we expected difficulties to recruit the necessary number of participants in the remaining time. The same is the case for the planned observation period of four weeks before and after t1. We collected data for the four weeks before t1 but had to cut the follow-up period to two weeks to be able to conclude the study.

Figure 1

Study Design



Study Setting

The study was implemented at the Jimma University campus, a university with over 40,000 students located in the southwestern part of Ethiopia, known as a traditional khat growing region. Data collection was initially scheduled to coincide with the start of the university term in October 2018. However, due to rising inter-ethnic violence and a resulting governmental

decision to postpone the start of the term, the students, who mainly live in state-run accommodations, were not allowed to return to Jimma for some weeks and the project timeline had to be adapted. As a result, data collection took place from November to December 2018.

Recruitment, Procedure, and Participants

For recruitment, we distributed leaflets about the study's general purpose and selection criteria on the university campus. Interested participants with an initial motivation to reduce or cease their khat use could attend a short preparation workshop about the purpose and procedure of the study, including information about the BI. After giving their informed consent, 717 participants (98.7% male) completed the baseline screening (t0) comprising a set of self-report questionnaires. Of all participants, 322 were included in the trial (see criteria below) and attended t1. Based on the random assignment, first, the deliberative or the implemental mindset was induced, and then the participants either received the ASSIST-linked BI or completed the Raven Matrices test (Raven, 2003); this test was employed to the CG in order to achieve a comparable face-to-face time with mental health experts. Two weeks later, 292 participants were reached up at the t2 assessment to answer follow-up questionnaires. At t3, the BI group completed the Raven Matrices, while the CG received the BI for ethical reasons. Sample characteristics are described in Table 1 and flow of participants is shown in Figure 1.

Table 1

Socio-demographic characteristics and baseline variables of the study participants

	Intervention Group		Control Group		Total	*p*-value
	Deliberative	Implemental	Deliberative	Implemental		
Participants (%, *n*)	18.8% (55)	27.4% (80)	28.4% (83)	25.3% (74)	100% (292)	-
Socio-demographics						
Age (*M*, *SD*)	22.22 (1.51)	22.27 (1.63)	21.99 (1.56)	21.99 (1.63)	22.11 (1.58)	.640
Relationship status (% single, *n*)	61.8 % (34)	55.0% (44)	60.2% (50)	58.1% (43)	58.6% (171)	.754
Religion (% Islam, *n*)	30.9% (17)	32.5% (26)	32.5% (27)	28.4% (21)	31.2% (91)	.875
Study vear (*M*, *SD*)	5.49 (1.03)	5.49 (1.11)	5.33 (0.98)	5.50 (0.95)	5.45 (1.02)	.611
Khat use in 28 days before t0						
Khat use bundles (*M*, *SD*)	37.18 (46.97)	31.12 (32.64)	31.20 (31.69)	34.47 (44.52)	33.14 (38.56)	.877
Khat use days (*M*, *SD*)	13.76 (9.08)	14.36 (8.67)	15.36 (9.44)	15.92 (8.85)	14.93 (9.01)	.576
Clinical covariates						
Taking Steps (*M*, *SD*)	27.35 (7.83)	25.85 (7.78)	25.39 (7.58)	26.93 (7.16)	26.27 (7.58)	.400
SRQ 20 (*M*, *SD*)	6.42 (5.70)	5.79 (5.46)	6.40 (5.74)	5.80 (5.36)	6.08 (5.54)	.885

Note: SRQ 20 - Self-Report Questionnaire 20: Taking Steps refers to a subscale of the Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES)

Inclusion and Exclusion Criteria

The first level selection criteria were khat use in the last four weeks before study participation, an interest in psychological assistance services to reduce or cease khat use, and current student status. We only included students in the second year and above, as most students

start chewing khat during their first year of university (Abdeta, Tolessa, Adorjan, & Abera, 2017). We also excluded participants who did not provide full data (2 missing items per questionnaire were tolerated). The characteristics of this first stage sample are reported by Hassen et al. (2021).

During implementation of the study, a second step of selection for the clinical trial became necessary. Due to the very small number of female participants (< 10), we only included male participants in our analyses as khat use among women, despite its rapid increase, is still socially stigmatized and therefore underreported (Yitayih & van Os, 2021). Because of the unexpected high prevalence of severe mental health problems which impair the effect of brief interventions (see Widmann et al., 2017), further exclusion criteria had to be implemented before inclusion into the trial (and participants were accordingly referred to or informed about the student or psychiatric clinic): acute suicidality ($N = 53$), self-reported lifetime and current episodes of severe mental disorders (e.g., schizophrenia), severe alcohol use (AUDIT > 15) or any lifetime illicit substance use (22 cannabis, 10 heroin, 14 other opiates, 11 cocaine, 9 amphetamine, 5 hallucinogens, 9 inhalants, 3 methadone, 3 barbiturates, and 3 sedatives).

T0 and t2 assessments took place in classrooms in groups of up to 11 participants where they anonymously filled in self-report questionnaires on tablet computers using Qualtrics (www.qualtrics.com); instructions and technical assistance were provided by a study team member. To assure data protection, participants did not fill in names but instead an individual code. T1 and t3 sessions took place at the counselors' offices in a 1:1 interaction.

The study was approved by the Institutional Review Boards of Jimma University (Ethiopia) and the University of Konstanz (Germany); the trial registry number is NCT03730805. All participants received detailed information on the study purpose and procedure in their preferred

language (Amharic, Afaan Oromoo, or English) and were only included in the study after giving their informed consent. The study was funded by the University of Konstanz.

Instruments

All materials were provided in English, Afaan Oromoo, and Amharic, the commonly spoken languages for the region and university campus. This paper only describes the questionnaires relevant to the present research question in detail. Further details on the questionnaires part of the overarching research project plus the detailed translation procedure are described elsewhere (Hassen et al., 2021).

Assessing Khat Use: The Timeline Followback

We used an adapted version of the *Timeline Followback* (Sobell & Sobell, 1996) to assess the amount and frequency of khat use in the 28 days before t1 and the 14 days after t1. The TLFB is a reliable and valid retrospective calendar-based method, originally developed to measure alcohol use but also validated for other substances and in cross-cultural studies (Robinson et al., 2014; Sobell et al., 2001). Via self-report, participants estimate their daily khat use for the respective time frame by two measures: consumed standard bundles of khat and days of khat use. Standard units of khat bundles were presented together with descriptions and photos. To define the standard units, we conducted a local market survey as performed previously by Widman et al. (2014); further details in Hassen et al. (2021).

To make it easier for participants to recall their consumption, they first had the chance to fill in a personal calendar, marking significant events or routines (e.g., sports classes) across the 28 or 14 days of assessment before t1 and after t1, respectively. These events were then presented again when participants had to indicate the number of consumed units for each day. After the first week of data collection for t1, we added a check to the TLFB that participants

must give a response for each day of the assessment period. This led to a low number of missing values for the TLFB measure (85 out of 11298 possible values, 0.8%).

Motivation to change khat use: The SOCRATES

The Stages of Change Readiness and Treatment Eagerness Scale (Miller & Tonigan, 1996) comprises 19 items to assess readiness to change substance use in relation to the transtheoretical model of behavior change. Each item describes how someone might feel about their substance use and is answered on a 5-point-Likert-scale from "strongly disagree" to "strongly agree." Sum scores of corresponding items yield three scales: Recognition, Ambivalence, and Taking Steps (TS). For instance, high scores for TS indicate that a change in substance use and corresponding successes are already experienced. In contrast, low scores indicate that no change in substance use has recently been made. For translation and adaptation of the instrument see Hassen et al. (2021); the internal consistencies of the three language versions were good to acceptable. For our analyses, we only used TS as it is the best indicator for implementing actions related to reducing or ceasing khat use.

Mental health

We assessed current symptom load with the Self-Reporting Questionnaire (SRQ-20), which was developed by the WHO as a screening tool for mental disorders (Harding et al., 1980). The SRQ-20 consists of 20 questions about common mental health problems, answered in a dichotomous yes/no format. It has been used in numerous settings and an Amharic translation, validated in Ethiopia (Hanlon et al., 2008), and an Afaan Oromoo translation, developed in one of our previous studies (Adorjan et al., 2017), were available. Internal consistencies for the three language versions in our study were good to excellent (Hassen et al.,

2021). SRQ cut-offs often vary depending on culture; based on a study from Youngmann et al. (2008) a cut-off score of 8 or more was considered as sign for severe mental distress.

Interventions

Mindset Manipulation

To induce deliberative and implemental mindsets, we applied the standard experimental manipulation developed by Gollwitzer and colleagues (Gollwitzer & Keller, 2016) and described in detail by Keller et al. (2019). One crucial part of this procedure is that the deliberative and implemental mindsets are evoked by unrelated decision problems and carry over to ostensibly unrelated subsequent tasks, like, in our case, the khat-related intervention. Therefore, participants are asked to come up with a personal task that is unique to them.

In the deliberative mindset condition, participants name an unresolved personal problem, for which they had not yet made any decision regarding whether to make a change. The chosen problem should be in the format of "Should I do… or not?" After naming the problem, participants reflected on the positive and negative, immediate and long-term consequences of taking action and sticking to the status quo.

Participants in the implemental condition were asked to name a personal project for which they had already made a decision to take action but had taken no further steps so far. The chosen project should be in the format of "I intend to…!" Then, they listed five steps necessary to complete the project and specified when, where, and how they planned to implement each step.

ASSIST-Linked Brief Intervention

The ASSIST-linked BI combines the well-established ASSIST screening tool (Humeniuk et al., 2008; WHO, 2002), followed by a standardized brief intervention. The instrument

identifies use (current & lifetime) and associated substance use disorder symptoms of different substance types (tobacco products, alcohol, cannabis, cocaine, amphetamine-type stimulants, sedatives, hallucinogens, inhalants, opioids, and other drugs) and generates an individual risk score (low, moderate, or high) for each substance. The related BI contains ten standardized steps, that include personalized feedback on risk scores, a decisional balance exercise, advice and handing over of self-help materials. The WHO recommends the ASSIST-linked BI for intercultural use (Humeniuk et al., 2012).

As there were no translations to Amharic or Afaan Oromoo available for our use, we translated the ASSIST, the accompanying BI material, and a self-help booklet into Amharic and Afaan Oromoo based on the version reported by Widmann et al. (2017) which added khat to the main list of substances. Adopting from Widmann et al. (2017), khat risk scores were based on the same ranges used for alcohol (0-10, 11-26, 27+) rather than on the ranges for illegal substances, as khat use is legal and culturally integrated in Ethiopia. The ASSIST-linked BI was conducted by Ethiopian counsellors, psychiatric nurses, and psychologists from Jimma University student clinic and psychiatric clinic. All interviewers received an intensive 2-week training on conducting the ASSIST-linked BI, including on motivational interviewing skills, the study procedure and assessment tools, provided by an international group of licensed psychologists, psychotherapists, and researchers.

Statistical Procedures

As preliminary analyses, we compared the four group conditions regarding socio-demographic characteristics, readiness to change, mental health variables, and khat use with the Kruskal-Wallis test using SPSS version 29.

We analyzed the change of participants' khat consumption in the 28 days before and the 14 days after the brief intervention. We used 14 days as reference period and calculated an average of 2 * 14 days before t0 and compared it with the 14 days before t2. Based on the TLFB we created two dependent variables: frequency of khat use, i.e. whether participants consumed any khat on a specific day, and amount of khat use, i.e. the number of bundles consumed per day.

We fitted (generalized) linear mixed-effects models to the data in our main analyses, utilizing the lme4 package (Bates et al., 2015) for R (R Development Core Team, 2008). We use models with the maximal random effects structure (Barr et al., 2013), meaning that we specify random intercepts for participants but also random slopes for the within-participant variable. This way of analyzing the data has important advantages when it comes to statistical power as individual observations can be analyzed instead of having to rely on averages over multiple observations. Further, missing values in either TLFB assessment (pre- or post-intervention) are less of an issue compared to analyses using aggregated scores for the number of khat bundles consumed or the number of days on which khat was consumed.

Results

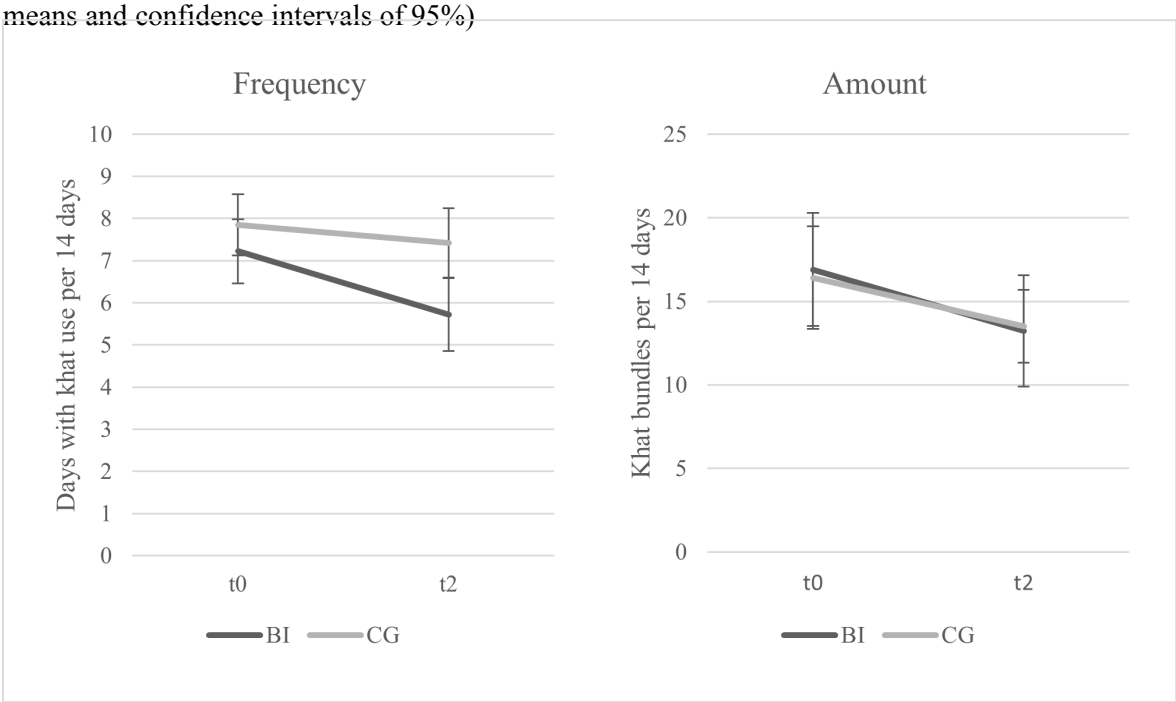
Descriptive analyses

On average, students consumed around 33.14 (*SD* = 38.56) khat bundles on around 14.93 (*SD* = 9.01) days in the month before the intervention. As described in Table 1, we detected no baseline differences between the four groups regarding socio-demographic variables, Taking Steps (SOCRATES) and SRQ-20 scores, or khat use, indicating a successful randomization.

We report khat use frequency and amount for BI and and control groups in the two assessments in Figure 2.

Figure 2

*Frequency and amount of khat use per 14 days before and after the intervention (*We report means and confidence intervals of 95%)



Testing intervention effects

For the analysis of the khat use frequency (probability of consuming khat on a specific day), we first fitted generalized linear mixed-effects models regressing the probability to have consumed khat (frequency) on whether participants were in the intervention or control group, whether they were in the implemental or deliberative mindset condition, and a time factor that encompasses whether consumption data was from before or after t1 with allowing for random variation in slopes for the latter as well as random intercepts for each participant. Moreover, we controlled for symptom load and change motivation by using the SRQ-20 score and the Taking Steps subscale of the SOCRATES, respectively. These analyses revealed no significant main

effects of the mindset induction, nor any 2-way or 3-way interactions with the mindset induction. Neither did the analyses for the number of consumed khat bundles (amount) on a given day. Adding the 2-way and 3-way interactions never improved model fit, all *p*s ≥ .162. Therefore, we dropped the factor mindset induction and its interactions from the further analyses reported in the manuscript, but they can be found in the Appendix.

Frequency of khat use

Analyzing the frequency data without considering the participants' mindset revealed main effects for symptom load, $b = 0.07$, $z = 2.96$, $p = .003$, and change motivation, $b = -0.05$, $z = -2.93$, $p = .003$, meaning that the likelihood to have consumed on a day was significantly increased for participants with higher symptom load but reduced for participants with higher change motivation. There was no significant main effect of the intervention ($b = -0.36$, $z = -1.33$, $p = .185$) which would have indicated a difference in baseline likelihood of consumption. Similarly, there was no significant main effect of time ($b = -0.25$, $z = -1.17$, $p = .243$) which would have indicated that the likelihood to consume differed in the control condition between before and after t1. However, the 2-way interaction between intervention and time was significant in the full model, $b = -0.65$, $z = -2.06$, $p = .040$. This indicates that the intervention group's likelihood to consume differed between before and after t1. Consistently, adding the 2-way interaction significantly increased explanatory power, $\chi(1) = 4.05$, $p = .044$. In contrast, further adding the two- and three-way interactions between time, the intervention, and symptom load or change motivation, respectively, did not increase explanatory power, all $\chi(3)$s ≤ 4.94, *p*s ≥ .176.

Because of the significant 2-way interaction between intervention and time on the frequency variable, we analyzed the control and intervention groups separately. In the control group, no significant effects emerged, all *p*s ≥ .051. In the intervention group, there was a strong negative

effect of time, $b = -0.89$, $z = -3.94$, $p < .001$. Again, symptom load was positively related, $b = 0.07$, $z = 2.18$, $p = .029$, and change motivation negatively related, $b = -0.06$, $z = -2.85$, $p = .004$, to the likelihood of consuming khat on a given day. Further adding the two-way interactions between time and symptom load or change motivation, respectively, did not increase explanatory power in the intervention and control groups, all $\chi(1)$s ≤ 2.53, ps $\geq .111$.

Amount of khat use

For the analysis of bundles before and after the intervention (amount), we fitted similar linear mixed-effects models regressing the number of consumed bundles on a given day on the same predictors (i.e., whether participants were in the intervention or control group and a time factor that encompasses whether consumption data was from before or after t1) with allowing for random variation in slopes and intercepts for each participant. Again, we controlled for symptom load and change motivation. This analysis revealed significant main effects of change motivation, $b = -0.02$, $t(292.3) = -2.60$, $p = .010$, symptom load, $b = 0.02$, $t(292.4) = 2.18$, $p = .030$, and time, meaning that participants consumed fewer bundles after t1 than before, $b = -0.20$, $t(291.0) = -2.04$, $p = .042$. The main effect of the intervention or its 2-way interaction with time were not significant, $|b|$s ≤ 0.06, ps $\geq .659$, as was adding the 2-way interaction, $\chi(1) = 0.20$, $p = .659$ to the model fit. Similarly, further adding the possible two- and three-way interactions with either symptom load or change motivation did also not increase the explanatory power of the models, all $\chi(3)$s ≤ 3.94, ps $\geq .268$.

We also analyzed the amount variable for the control and intervention groups separately. In the control group, we observed negative main effects of time, $b = -0.20$, $t(157.2) = -2.10$, $p = .038$, and symptom load, $b = 0.03$, $t(157.1) = 2.28$, $p = .024$, but not change motivation, $b = -0.01$, $t(156.8) = -1.27$, $p = .206$. In the intervention group, an effect of time, $b = -0.26$, $t(134.4) = -2.41$, $p = .017$, was accompanied by a significant main effect of change motivation,

$b = -0.03$, $t(135.6) = -2.53$, $p = .013$. In this analysis, the effect of symptom load was not significant, $b = 0.02$, $t(135.1) = 0.85$, $p = .399$. Further adding the two-way interactions between time and symptom load or change motivation, respectively, did not increase explanatory power in the intervention and control groups, all $\chi(1)$s ≤ 1.57, ps $\geq .210$.

Taken together, while we find some decrease in the number of consumed khat bundles from before t1 to after t1, this effect is not specific to the intervention group but also emerges in the control group, meaning that all participants consume fewer bundles of khat after t1 compared to before.

Discussion

This study's main objective was to investigate the effectiveness of the ASSIST-linked BI to reduce khat use among Ethiopian students and further test the effects of induced mindsets on the outcome of the BI. First, we found a reduction in the frequency of khat use favoring the intervention group versus the control group. We observed a general decrease in consumed khat bundles in both groups after t1, with a slightly stronger effect in the intervention group than the control group. Still, the effects of the BI on khat use were relatively small: In the two weeks after the intervention, the brief intervention group consumed 3.67 bundles and 1.50 days less on average, whereas the control group consumed 2.90 bundles and 0.43 days less. In contrast to these small BI effects we found no effect of additional mindset induction. In sum, our hypotheses can only be partially confirmed. The results point out the positive potential of BIs, but considering the small effects, various influential factors need to be addressed. This matches recent reviews on Screening and Brief Intervention (SBI) for illicit substance use (DiClemente et al., 2017; Saitz, 2014), which not only reflect the small effect sizes and the even smaller effects when it comes to other drugs than alcohol but also discuss possible additional factors determining the success of SBIs.

Our data reveals two relevant co-variates: We observed psychopathological symptom load and change motivation as significant predictors of khat consumption. Khat use frequency and amount were lower among participants with fewer mental problems and more change motivation. This aligns with results from a randomized controlled study by Widmann et al. (2017), who found the ASSIST-linked BI to be less effective among khat users with comorbid depression and PTSD. Perhaps due to our recruitment strategy of explicitly offering psychological advice, our sample had a surprisingly high rate of comorbid mental health problems (Hassen et al., 2021). Recalling the results from Duresso et al. (2018a), we additionally assume that many participants probably experienced severe withdrawal and craving symptoms (e.g., enhanced distress, emotional reactivity, nervousness), which could impede the khat reduction even more.

Additionally, the quantity of prior khat use could represent a further relevant aspect: There was a huge variety of consumption patterns in our sample, from occasional to heavy khat use; we might have even oversampled heavy users due to our recruitment strategy, as students with heavy khat use are more likely to experience adverse effects and, therefore, might be more interested in receiving psychological advice. Following the recommendations in the ASSIST's manual, BIs were neither designed for clients with low nor severe substance use and substance use disorders. The ASSIST-linked BI's effects were found among clients with moderate substance use problems (Humeniuk et al., 2010). Nevertheless, other authors report that heavier khat users were more successful in maintaining abstinence than participants with lower khat use (Duresso et al., 2018b). The authors posited a possible relation between higher khat use and higher commitment to change substance consumption but pointed out the need for further research. Overall, the amount of the consumed substance seems to play a substantial role in the

intervention's effectiveness, but further research is needed. Thus, the too broad inclusion of all degrees of khat use severity might have reduced the effect of our intervention.

Moreover, our results showed significant reductions of khat amount in both the intervention and control groups at follow-up. One explanation could be that taking part in an intervention study, even when being in the control group, that included the assessment of one's khat use with the TLFB calendar as well as the self-report questionnaires regarding related problems, could have encouraged a reflective deliberative process about one's khat use and motivated behavior change similar to the intervention. This might have lessened the difference between intervention and control condition. Another follow-up assessment, sometime later, may provide additional helpful answers to this question as well as investigating the sustainability of the instigated behavior change. Overall, our results show the expected effects though to a smaller extent. The data was more favorable in the BI condition, which speaks for the potential benefits of SBIs to reduce khat use.

Concerning the influence of mindset induction on the efficacy of BI, we found no considerable effects regarding a deliberative mindset induction before the ASSIST-linked BI when compared to an implemental mindset induction. However, it is still important to discuss several implications resulting from the two mindset conditions. A deliberative mindset is associated with increased open-mindedness, less defensiveness, and less illusory optimism regarding risk perceptions (relative to an implemental mindset). The original hypotheses of Büchele and colleagues (2020) state that participants in a deliberative mindset should have showed more openness and a more realistic awareness for their risk, which in turn should have led to a more effective BI and a larger reduction of their substance use. Nevertheless, neither our nor the results from Büchele and colleagues (2020) could confirm this hypothesis, which the latter authors attributed to the decision state of the participants: Nenkov and Gollwitzer

(2012) found differential effects caused by asking participants to engage in a renewed deliberation of a decision; repeated deliberation might increase commitment when participants are already decided but it might even lower it when participants are still undecided. In the study of Büchele and colleagues (2020), eligibility was not limited to students motivated to change alcohol use, so participants in a deliberative mindset (i.e., in a predecisional phase) could have been still undecided about their consumption. A subsequent deliberation of the pros and cons, as is part of the ASSIST-linked BI, might have prolonged the decision to change. Alternatively, participants in an implemental mindset (i.e., in a postdecisional phase) might have been eager to "jump to a decision" to reduce their alcohol consumption, i.e. the renewed deliberation might have increased their commitment to this path of action (Büchele et al., 2020). In contrast, in the current investigation we only included participants interested in reducing or even ceasing their khat use. As our findings cannot confirm the results of Büchele et al. (2020), we assume that participants in our study might have already made the decision to change their khat use and therefore the assigned deliberation might have activated such post-decisional defensiveness in both mindsets groups (Nenkov & Gollwitzer, 2012) and enhanced their commitment.

The lack of a control condition regarding the mindset factor renders it impossible to reach a definite answer. However, some support for this possibility comes from the observation that participants with measured higher change motivation (i.e., in a postdecisional state) were more likely to exhibit lower khat use after the BI. Still, on the other hand, we found no interaction between change motivation and mindset condition. Moreover, we found surprisingly low change motivation scores despite our explicit recruitment strategy targeting people who are willing to reduce or cease their khat use. However, it is to note that there are some concerns regarding the chosen instrument for change motivation, given that the SOCRATES is situated within the framework of the transtheoretical model of change (Hassen et al., 2021). This model

has been rarely applied to the Ethiopian culture or to khat consumption and there is currently little research on the validation of the Amharic and Afaan Oromoo adaption of the SOCRATES nor do norms exist for the Ethiopian population. Therefore, any interpretation should be made with caution.

Limitations

Due to the mentioned rising inter-ethnic violence and related political transitions before and during data collection, we had to make some short-time changes to the study design (e.g., shortening the duration of the assessment following T1), which caused some methodological challenges. When replicating this study, a longer follow-up period would be better as well as implementing a control condition where no mindset is induced.

Furthermore, we relied on self-report and did not include an objective verification of the khat use (e.g., urine analyses). Therefore, participants might have reported false khat use rates, possibly due to social desirability, which have been enhanced by the missing blindness of the study staff for the allocation to intervention and control group. But the tablet-based assessment of khat use seemed to have promoted honest answers as visible regarding the unexpected high rates of admitting other substance use and mental health problems (Hassen et al., 2021).

We must take into account that the validity of the ASSIST and ASSIST-linked BI adapted for khat needs further examination. There are different arguments about whether to set the risk score levels for khat comparable to alcohol, as it is culturally and socially similarly integrated, or comparable to drugs (Odenwald et al., 2010). Therefore, the adequate interpretation of khat use in the ASSIST-linked BI cannot be fully guaranteed. Our results justify the investment in further studies on a khat-version of the ASSIST-linked BI.

Conclusion

In the present study, the observed high rates of khat use and comorbid mental problems clearly showed the need for offering services to help students reduce their khat consumption. Khat use decreased in both groups, but more markedly in the intervention group. Participants with less psychopathological symptoms and more change motivation reported lower khat use but these factors had no measurable influence on the effect of the intervention. Although interactions with the included mindsets did not reach significance, this topic requires more theory driven research. More research about effective interventions and the mechanisms behind them is necessary to increase the success rates for those seeking to reduce or cease khat use.

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Appendix

Testing Mindset Intervention Effects

For the analysis of the probability of consuming khat on a specific day, we fitted generalized linear mixed-effects models regressing the probability to have consumed khat on whether participants were in the intervention or control group, whether they were in the implemental or deliberative mindset condition, and a time factor that encompasses whether consumption data was from before or after T1 with allowing for random variation in slopes for the latter as well as random intercepts for each participant. Moreover, we controlled for symptom load and change motivation by using the SRQ score and the score of the TS subscale of the SOCRATES, respectively. This analysis revealed main effects for symptom load, $b = 0.06$, $z = 2.41$, $p = .016$, and change motivation, $b = -0.05$, $z = -2.64$, $p = .008$, meaning that the likelihood to have consumed on a day was significantly increased for participants with higher symptom load but reduced for participants with higher change motivation. No other main effect was significant, and neither was the 3-way interaction between our experimental factors. However, the 2-way interaction between intervention and time was approaching significance in the full model, $b = -0.82$, $z = -1.70$, $p = .089$. Consistently, neither adding all three 2-way interactions nor the 3-way interaction (i.e., analyzing the full model) significantly increase explanatory power, χs ≤ 3.17, ps $\geq .367$.

To keep it similar to the analyses reported in the manuscript, we moved on to analyze the control and intervention groups separately. In the control group, no significant effects emerged, all ps $\geq .194$. In the intervention group, there was a strong negative effect of time, $b = -1.15$, $z = -3.30$, $p < .001$, but no significant effect of the mindset manipulation, $b = 0.13$, $z = 0.32$, $p = .748$, or an increase in explanatory power when adding the interaction between the two, $\chi(1) = 1.28$, $p = .258$. Again, symptom load was positively related, $b = 0.06$, $z = 1.93$, $p = .053$,

and change motivation negatively related, $b = -0.07$, $z = -2.89$, $p = .004$, to the likelihood of consuming khat on a given day.

For the analysis of bundles before and after the intervention, we fitted similar linear mixed-effects models regressing the number of consumed bundles on a given day on the same predictors (i.e., whether participants were in the intervention or control group, whether they were in the implemental or deliberative mindset condition, and a time factor that encompasses whether consumption data was from before or after t1) with allowing for random variation in slopes and intercepts for each participant. Again, we controlled for symptom load and change motivation. This first analysis only revealed a main effect of change motivation, $b = -0.02$, $t(268.3) = -2.50$, $p = .013$. Furthermore, symptom load, $b = 0.02$, $t(268.4) = 1.70$, $p = .090$, and time, meaning that participants consumed fewer bundles after t1 than before, $b = -0.26$, $t(267.9) = -1.89$, $p = .059$, were near the conventional levels of significance. All other main effects were not significant, $|b|$s ≤ 0.26, ps $\geq .290$, as were the comparisons between the model with only main effects and these with two-way and three-way interactions between the three factors, χs ≤ 2.09, ps $\geq .352$.

Next, we looked at the control and intervention groups separately. In the control group, we find a negative trend of time, $b = -0.26$, $t(142.7) = -1.88$, $p = .063$, but no significant effect of the mindset manipulation, $b = 0.22$, $t(141.8) = 0.98$, $p = .331$, or an increase in explanatory power when adding the interaction between the two, $\chi(1) = 0.02$, $p = .898$. Only symptom load was a significant predictor in the control group, $b = 0.03$, $t(142.0) = 2.08$, $p = .039$. In the intervention group, a stronger effect of time, $b = -0.42$, $t(124.5) = -2.58$, $p = .011$, was again accompanied by no significant effect of the mindset manipulation, $b = -0.26$, $t(126.9) = -1.06$, $p = .294$, and no significant increase in explanatory power when adding the interaction between the two, $\chi(1) = 1.96$, $p = .162$. Consistently, the interaction between the two in the full model

was not significant, $b = 0.30$, $t(125.1) = 1.40$, $p = .163$. Change motivation was also a significant predictor in the full model, $b = -0.03$, $t(126.6) = -2.55$, $p = .012$. Taken together, while we find some decrease in the number of consumed khat bundles from before t1 to after t1, this effect is not specific to the intervention group but also emerges in the control group; meaning that participants are consuming fewer bundles of khat after t1 compared to before. However, it seems that the decrease in the number of bundles is stronger in the intervention group than the control group.