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Changes in alcohol consumption among Belgian adults participating in the internet-based one-month-abstinence campaign 'Tournée Minérale'

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Abstract

Background and objective Temporary abstinence campaigns (TAC) are a promising approach to reduce alcohol consumption. This study examined changes in (at-risk) alcohol consumption and determinants of alcohol consumption among Belgian adults participating in the Tournée Minérale Campaign (TMC, Belgian TAC). In addition, moderating effects of age, sex, education level, successfully refraining from alcohol during TMC, risk drinking, drinking levels and binge drinking were investigated.

Methods TMC is a fully automated mass media prevention campaign challenging Belgian adults to refrain from alcohol during the month February. This study includes a baseline, post- (four weeks after TMC) and follow-up (six months after TMC) test using online recruitment and an online questionnaire. Participants were self-selected by signing up on the TMC website. Repeated measures ANCOVAs were used to examine changes over time in alcohol consumption (log transformed due to skewness) and determinants among TMC participants ($n = 8{,}730$, 48.4 ± 12.9 years old, 37.4% males) who filled in all three measurements. Moderation effects were assessed for age, sex, education level, successfully refraining from alcohol during TMC, risk drinking, drinking levels and binge drinking at baseline. McNemar tests were used to examine the change in prevalence of risk drinking and binge drinking.

Results TMC participants showed a significant decrease in weekly alcohol consumption (mean exp(x)-1) and CI) from baseline (6.2 [6.4,6.7]) to post (4.2 [4.1,4.3], $F = 22.0$, $p < .001$ d = -2.4 [-2.4,-2.3]) and from baseline to follow-up (5.1 [4.9,5.2], $F = 24.2$, $p < .001$, d = -1.5 [-1.5,-1.4]), and an increase from post to follow-up ($F = 21.1$, $p < .001$). In the short term (from baseline to post), the decreases were stronger among older, male and lower educated TMC participants, those successfully refraining during TMC, higher risk drinkers and binge drinkers. In the medium term (from baseline to follow-up), changes in alcohol consumption were moderated by education (stronger among lower educated) and risk drinking (increase in lower risk drinkers and decrease in higher risk drinkers). Participants' baseline drinking level moderated changes in alcohol consumption. Both short and medium term increases in alcohol consumption were observed among those with a low drinking level (those who drank 0 to < 4 glasses at baseline), while short and medium term decreases were observed among those with higher drinking levels, i.e. those with moderate (≥ 4 to ≤ 10 glasses), high (> 10 to ≤ 17 glasses) and highest (> 17 glasses) drinking level at baseline. A reduction

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in the proportion of risk drinkers and binge drinkers and changes in determinants of alcohol consumption (e.g. attitudes towards drinking less alcohol and habit of drinking alcohol) were observed among TMC participants.

Conclusions TMC participants reported favourable changes in (the underlying determinants of) alcohol consumption in the short and medium term. Higher level drinkers appear to be especially attracted to participate in TMC and to experience the strongest decreases in alcohol consumption. However, without comparison with a control group of non-participants or comparison points, we cannot simply attribute the changes over time to participation in TMC. Future research with a stronger study design is needed to rule out possible bias (e.g., selection bias, seasonal effects or regression to the mean) and to examine mechanisms and longer term effects of TACs.

Keywords Intervention, Alcohol use, Determinants, Mass media campaign, Adult

Text box 1. Contributions to the literature

- Participants of the one-month-abstinence campaign 'Tournée Minérale' reported favourable changes in (the underlying determinants of) alcohol consumption in the short and medium term.
- The changes in consumption among the one-month-abstinence campaign 'Tournée Minérale' participants appeared to be stronger among lower compared to higher educated participants.
- Promisingly, the changes among one-month-abstinence campaign 'Tournée Minérale' participants appeared to especially be in higher level drinkers.

Introduction

In 2016, worldwide 43% of the population older than 15 years consumed alcohol in the last year, with an average of 15.1 L of pure alcohol per consumer [50, 70]. In Belgium this prevalence was even higher with 77% of the inhabitants drinking alcohol in the last year, with an average of 15.9 L per person [69]. Moreover, one in seven Belgians (14%) drank more than 100 g pure alcohol a week, which is the upper limit of the Belgian guidelines for alcohol consumption (10 standard glasses a week; one standard glass contains 10 g pure alcohol). Almost one third of Belgian adults (32.2%) have engaged in binge drinking on at least one occasion in the past 30 days (drinking large amounts of alcohol within a certain time: 40 g (females) or 60 g (males) pure alcohol in two hours (e.g. four or six standard glasses respectively)) [32, 69]. Various harms, both personal (e.g. cancer) and social (e.g. economic costs), have been linked to (at-risk) alcohol consumption [8, 53, 62, 70]. For example, in Belgium alcohol consumption is related to 903 million direct and 643 million indirect costs yearly (i.e., 0.4% of the Belgian gross domestic product) [8, 53, 62, 67, 70] and is associated with 3.8% of all deaths [29].

To reduce (at-risk) alcohol consumption and related harms, public health interventions based on behavioural theories and targeting determinants of alcohol consumption are necessary [11, 33, 34]. A promising public health intervention that can provide short and middle term harm reduction benefits, might be a temporary abstinence campaign (TAC) [17]. To date, there is a limited number of TAC effect evaluation studies and they often show methodological shortcomings (e.g. no baseline measurement or small sample size) and include only a few relevant determinants of alcohol consumption. Participants in Dry January, a TAC in the UK, reported a decrease in alcohol consumption and an increase in drink refusal self-efficacy (i.e. the extent to which a person can say no to alcohol) six months after participation, while there were no changes observed among the general population of adult drinkers [19, 20]. Participants in the 'Febfast' campaign, an Australian TAC, reported a lower alcohol consumption and a greater awareness of the risks of at-risk alcohol consumption four months after the campaign compared to non-participants. Additionally, four months after the campaign, participants were less likely to believe that drinking alcohol has health benefits and more likely to agree that alcohol is a serious issue for their community, but less likely to refuse alcohol when offered [38]. Although a control group was included in this study, there was no baseline measurement and, because of the retrospective study design, outcomes depended on participant recall. Participants in the 'IkPas'-action, a TAC in The Netherlands, reported a lower alcohol consumption and a greater awareness of their own alcohol intake six months after the campaign [5]. This study did not include a control group and no underlying determinants of alcohol consumption were assessed. A fourth small US study ($n=50$) found a short-term increase in alcohol consumption among college students after a TAC of 10 days, but no underlying determinants of alcohol consumption were studied [7]. Despite the use of a control group and baseline and post intervention measures, the findings of this study cannot be generalized to the general population due to the small sample size and the specific study group (i.e. college students). The 'Buddhist Dry Lent' abstinence campaign (Thailand) and the 'Hello Sunday Morning' (Australian) targeted a longer abstinence period (ranging from three to twelve months). A short-term positive change on alcohol abstinence was found for the intervention communities

compared to the non-intervention communities three months after completing the 'Buddhist Dry Lent' abstinence campaign [40], but no longer term effects were found. An observational study on 'Hello Sunday Morning' [41] reported a decrease in alcohol consumption but did not include a control group. No changes in determinants were assessed in both studies.

A recent review [17] emphasizes the need for research on TACs as there is a general paucity of studies on this kind of campaigns. Furthermore, while alcohol consumption has been shown to differ according to age (use depending on age group), sex (higher use in males), and education level (higher use in higher educated people) [27, 28, 53], the potential moderation effects of these personal characteristics have not been examined in depth in previous TAC studies. Only the TAC 'IkPas' [5] showed stronger changes in alcohol consumption in younger versus older females, but found no changes in consumption according to age in males. Other research shows that the effect of a computer-delivered brief intervention on alcohol use was greater among younger participants compared to older participants [27]. Research on the moderation role of sex in alcohol reducing interventions is inconclusive. Some evidence suggests that females tend to respond more favourably to alcohol interventions than males [35, 36, 44], while others report no moderation of sex on the effects of alcohol reducing interventions [3]. A meta-analysis [52] showed that the effects of alcohol reducing interventions were stronger in higher educated than lower educated adults while a more recent study reported that individuals with lower levels of education may be more receptive to brief alcohol interventions [60].

There are several psychological theories that explain alcohol-related behaviour [12]. According to the theory of planned behaviour [1, 13], intention to drink alcohol is shaped by three key factors: attitude, subjective norm, and perceived behavioural control [13]. Further research supports the addition of habits from the dual-process theory alongside the determinants of the theory of planned behaviour to more comprehensively assess alcohol consumption [26, 37, 46]. Additionally, perceived benefits of alcohol consumption seem to be important indicators of drinking behaviour [23, 51]. Finaly, drinking behaviours can be triggered by certain (social) cues or social influences, as explained by the social-contextual framework [15].

To summarize, current studies on TAC's are limited due to methodological shortcomings (e.g. no baseline measurement or small sample size), not including different drinking patterns, the lack of including determinants of alcohol consumption and possible moderation effects. Therefore, this study examined changes in (at-risk) alcohol consumption, determinants (i.e. attitude, perceived benefits, habit, subjective norm, self-efficacy and social influence) and moderating effects (age, sex, education level, successfully refraining from alcohol during TMC, risk drinking, drinking levels and binge drinking) on these changes among Belgian adults participating in TMC (Belgian TAC). Some of the current limitations in the existing literature are addressed by including a baseline measurement, examining different drinking patterns, considering several determinants of alcohol consumption and potential moderators.

Methods

The CONSORT EHEALTH [25] and CHERRIES checklist [24] were used to describe and report the intervention and online survey design (Supplementary Files 1 and 2).

Intervention

TMC was first developed and funded in 2017 by "de druglijn", a government subsidized service for all substance use questions, and the national Foundation against Cancer. TMC challenged adults to refrain from alcohol during the month February. The aim was to raise awareness of alcohol consumption and raise money for research on cancer. TMC was not intended for people with an alcohol use disorder, for whom a TAC alone may not be sufficient and may be dangerous (e.g. risk of seizures from unmonitored alcohol withdrawal) [66]. TMC campaign materials communicated about helplines for alcohol (addiction). From December 2016 till February 2017, Belgian adults were encouraged by a nationwide, large-scale promotional campaign (e.g. press release, TV spots, advertisements, banners, posters and social media) to participate in TMC and to register on the campaign website [16]. People could participate for free and could visit the campaign website and social media channels whenever they liked. The website has since been updated and the first version has not been archived.

Intervention components were distributed to Belgian adults via social media and for those who had registered on the TMC website via the website and email. Intervention components included information about health benefits of not drinking, a proposal for various non-alcoholic alternatives, an alcohol calculator (which computes weight loss and money savings based on the number of glasses of alcohol consumed), exemplary testimonies from other participants, motivational messages to keep up the abstinence challenge, and the opportunity to share participation and progress online (e.g. by sharing a 'sober badge'). An acyclic behaviour change diagram (Supplementary File 3) shows the underlying behaviour change techniques (theory-based methods), practical applications and targeted determinants of TMC. The underlying behaviour change techniques [22] and targeted

determinants of each intervention component were identified by the authors. An overview of all intervention components and distribution channels can be found in Table 1. Participants did not receive specific messages on binge drinking.

Study design

This observational study among TMC participants includes a baseline, post- (four weeks after the end of TMC) and follow-up test (six months after TMC). The measurements (i.e. online surveys) took place from January 25 until February 10, 2017 (baseline), from March 30 until April 18, 2017 (post) and from September 26 until October 6, 2017 (follow-up) respectively. The study was approved by the ethical committee of the Ghent University Hospital (2017/0069).

Participants

All participants who registered on the TMC website were contacted through e-mail (specified when registering). The study invitation disclosed an affiliation with the researchers' university (Ghent University, Belgium), which may have influenced the number of volunteers and their responses to the questions. All participants ($\geq$ 18 years) who understood the purpose and content of the study and were no abstainers (defined as those who did not drink alcohol in the past year) were eligible to participate. Internet literacy was an implicit eligibility criterion for participation in this study, as individuals without such literacy were unable to take part. Those willing to participate in the follow-up measurements could voluntarily provide their contact details to be included. A reminder was sent twice to those who had not yet completed the questionnaire.

A total of 123,842 people registered on the website, of which 48,349 people completed the baseline questionnaire (39% response rate). Some participants were excluded from the study: 87 participants were excluded because they were younger than 18 years old, 57 because they gave an incorrect birthdate (e.g. '1680' or '2017'), and 743 because they were abstainers (defined as not having drunk alcohol in the past year). This resulted in a sample of 47,462 adult participants at baseline. The post-test was completed by 15,610 participants (32.9% response rate compared to baseline, 12.6% compared to those who registered on the website) and the follow-up test was completed by 13,979 (29.5% response rate compared to baseline, 11.3% compared to those who registered on the website) participants. Figure 1 shows the total number of participants who filled in all three measurements (i.e. 8,730 participants) and, hence, were included in the analyses.

Survey design

Participants were invited to complete an open online questionnaire. The data was collected using a template on the SurveyMonkey platform, which allowed for easy navigation between questions (e.g. back button). Survey items were not randomized. There were one to four questionnaire items per page. Questionnaires consisted of approximately 14 pages (baseline), 40 pages (post) and 20 pages (follow-up). The introduction clearly described the purpose and length of the questionnaire, provided information on informed consent (i.e. that their participation is completely without obligation and their data will be treated strictly confidential and processed anonymously), and included a statement that the researchers had no affiliation with the intervention developers. No incentives were offered for filling in the questionnaires and there was no exclusion based on time spent to fill in the questionnaire. The completeness of the questionnaire was facilitated by mandatory completion for the majority of questions before continuing. It was technically not possible to assess the view rate or recruitment rate of the survey. The questionnaires could be filled in for approximately 14 days (the exact dates are given in Fig. 1). Participants' data was linked across the three surveys using their unique email address, which was requested at the end of each time point when completing the questionnaire. Duplicates entries of email addresses were removed based on completeness rate. Participants who did not provide their email address (e.g. by leaving the questionnaire early) could not be included in the analyses for all three measures. To protect participants' privacy, the email addresses were removed before the analyses were conducted.

Measures

Personal characteristics (contextual and moderator)

Following characteristics were assessed at baseline and dichotomized to include as moderators: age (based on mean age, younger participants: 18–48 years old or older participants: 49 years or older), sex (male or female), and education level (lower educated (non to secondary education) or higher educated (college or university)). Work status (employed or not employed) and perceived general health [32, 68] were assessed for descriptive purposes. General health ranging from very bad (1) to very good (5) and categorized as low (1–3) or high (4 and 5) general health). Participantswere asked at post-measurement how strict they participated. As the goal of TMC was to totally refrain from alcohol during one month, the degree of success was recoded to 'successful' (answer: 'I did not drink any alcohol at all') and 'unsuccessful' (answer: 'I drank less alcohol' or 'I participated but did not succeed').

Table 1 Overview of components of the campaign Tournée Minérale, underlying behaviour change techniques, targeted determinants and channel(s)

Practical application	Channel(s)	Behaviour change technique [22]	Targeted psychosocial determinant(s)
Participants were challenged to refrain from alcohol for one month	Website Social Media TV-spot	Goal setting, Persuasive communication, Repeated exposure	Habit, Self-efficacy
Participants could register on TMC website (as individual or in group) and share the participation online	Website Social Media	Implementation intentions, Mobilizing social networks, Public commitment	Habit, Self-efficacy, Social support
An overview of possible health benefits of not drinking alcohol (feeling fitter, having a better skin, sleeping better, losing weight, saving money and not having a hangover) were shared	Website E-mail Social media	Arguments, Belief selection, Early commitment, Persuasive communication, Repeated exposure	Attitude, Knowledge, Perceived benefits
An overview of alternatives for alcoholic beverages (such as Mocktails) were shared	Website E-mail Social media	Belief selection, Counter-conditioning	Attitude, Knowledge, Perceived benefits, Perceived barriers, Self-efficacy
Participants could calculate how much weight they could lose and money they could save with refraining from alcohol with the 'Alcohol calculator'	Website Social media	Belief selection, Feedback, Personalize risk	Attitude, Awareness, Knowledge, Perceived benefits, Risk perception
Good practice stories (other people telling how to break drinking habits) and information about habitual drinking were shared	Website E-mail Social Media	Consciousness raising, Information about others approval, Modeling, Planning coping responses	Awareness, Risk perception, Self-efficacy, Social support
Participants could weekly claim an online sober 'badge' for completing the abstinence challenge (four badges in total)	Social Media E-mail	Provide contingent rewards, Reinforcement	Attitude, Self-efficacy
Social events (e.g., parties) could indicate that they support TMC	Social media	Facilitation	Self-efficacy, Social norm, Social support
Wristband and pins of TMC were distributed	Intermediaries	Facilitation	Self-efficacy, Social influence, Social support
Participants weekly received motivational messages to complete the abstinence challenge	Email Social media	Providing cues, Repeated exposure	Attitude, Self-efficacy

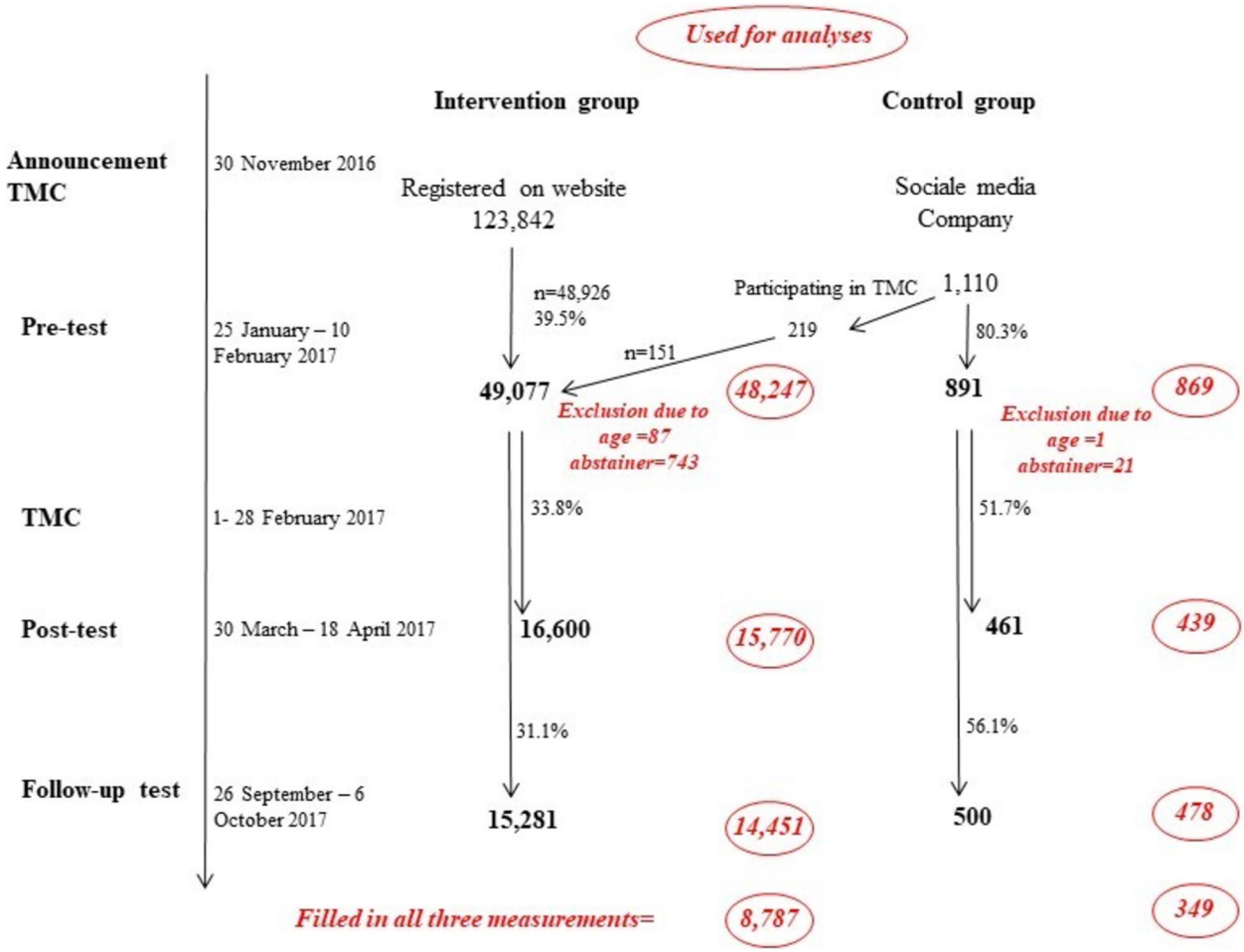

Fig. 1 Overview of participant recruitment

Alcohol consumption (primary outcome)

To measure frequency of alcohol consumption, people were asked on how many days they drank alcohol during the past 14 days. Since the baseline measurement was performed at the end of January 2017, consumption during the past 14 days was assessed to avoid the unusual high alcohol intakes during New Year receptions. To measure quantity of alcohol consumption, people were asked how many standard glasses they drank on average on a day they drank alcohol. Response options were 1, 2, 3–4, 5–6, 7–8, 9–11, 12–15, 16–18, 19–24 and 25 or more glasses. These options were recoded to its average. For the last category the difference with the midpoint of the previous category was added to 25 (i.e. 25 + ((25–21.5)/2)) = 26.75) [71]. Weekly alcohol consumption, was obtained by multiplying the frequency and quantity of alcohol consumption divided by two [45].

Risk drinking, drinking levels and binge drinking (secondary outcomes and moderator)

Risk drinking was defined based on the Belgian alcohol guideline [65]. Weekly alcohol consumption was dichotomized to distinguish between higher risk drinking (more than 10 standard glasses per week) and lower risk drinking (up to 10 standard glasses per week). Based on the median weekly alcohol consumption among lower and higher risk drinkers, four groups for drinking levels were defined: low drinking level (those drinking less than 4 glasses per week at baseline), moderate drinking level (those drinking between 4 and 10 or less glasses per week at baseline), high drinking level (those drinking more than 10 and 17 or less glasses per week at baseline) and highest drinking level (those drinking more than 17 glasses at baseline).

Binge drinking, only measured at baseline and follow-up, was assessed by asking how often in the last six months a person drank four (for females)/ six (for males) or more glasses of alcohol within a two-hour period. This question is based on the NIAAA standard on binge drinking adjusted to a Belgian standard portion of alcohol [47] (i.e. 10 g; binge drinking is defined as drinking 40 g (females) or 60 g (males) of pure alcohol within two hours). Nine frequency categories were provided, ranging from 'never' to 'daily'. Binge drinking was dichotomized into non-binge drinkers and binge drinkers. Both risk drinking and binge drinking were included as secondary outcome as well as moderator in analyses with weekly alcohol consumption.

Psychosocial determinants of alcohol consumption (secondary outcomes)

As TMC tried to influence specific determinants, a tailor-made questionnaire was developed (Supplementary File 4). Questions were drafted based on the most important targeted determinants in TMC identified by the authors and based on questions used in a previous TAC study [6], namely: attitude, perceived benefits, habit, subjective norm and social influence. The Theory of Planned Behaviour was used to define the determinants [56]. For example, according to Ajzen [1], attitude refers to a person's evaluation of the advantages and disadvantages of performing the behaviour. The self-efficacy towards refraining from alcohol was assessed with an eleven-item measure based on the drink-refusal self-efficacy and is defined as a person's confidence in performing a set of behaviours [73]. All determinants were assessed on a five-point Likert scale from 'completely disagree' to 'completely agree', except self-efficacy which was scaled from 'completely not confident' to 'confident'. Factor analyses identified two factors for social influence towards drinking less: supportive social influence and non-supportive social influence (i.e. perceived environmental encouragement or criticism on alcohol use) and three factor for self-efficacy towards refraining from alcohol: social self-efficacy (e.g. when someone offers you an alcoholic drink), emotional self-efficacy (e.g. when you are worried) and opportunistic self-efficacy (e.g. when watching TV). Internal consistency was checked for all determinants (Cronbach α between 0.70–0.95). Average scores were calculated for each determinant. Higher scores on attitude towards drinking less alcohol, perceived benefits of drinking less alcohol, subjective norm of drinking less, self-efficacy towards refraining from alcohol or supportive social influence toward drinking less can be hypothesized to be favourable for reducing alcohol use. Higher scores on the habit of drinking alcohol, subjective norm of drinking more and non-supportive social influence towards drinking less can be hypothesized to be non-favourable for reducing alcohol use.

Statistical analyses

Statistical analyses were performed using SPSS statistics software package version 25 with statistical significance $\alpha < 0.05$. Effect sizes of the results are presented as Partial Eta Squared and can be interpreted as small ($\eta^2 = 0.01$), medium ($\eta^2 = 0.06$) or large ($\eta^2 = 0.14$) [10]. All variables were normally distributed except for weekly alcohol consumption. A natural log transformation of weekly alcohol consumption was performed ($\ln(x+1)$). For interpretation purposes the log transformed consumption was back transformed (i.e. $\exp(x)-1$) such that mean alcohol consumption could be interpreted across time points (i.e. by given the back transformed adjusted means and confidence intervals). The main analyses were performed on the complete cases. Therefore, a drop-out analysis (tested with Pearson chi-square test for categorical and independent t-test for continuous variables) was done between those completing all three measurements and those completing one or two measurements. Descriptive statistics were used to describe the characteristics of the analytic sample (i.e. the complete cases) as well as those of the general Belgian adult population.

Repeated measures ANCOVAs were used to examine changes over time in alcohol consumption and determinants with age, sex and educational level included as covariates. In case of a significant time effect, post hoc analyses (LSD) were done to see which measurements differed from each other. To examine moderation effects of age, sex, education, successfully refraining from alcohol during TMC, risk drinking, drinking levels and binge drinking, repeated measures two-way ANCOVAs were used including alcohol (dependent variable), time (within subject variable), moderator (between subject variables) and covariates. First, the overall time*moderator interaction effect was examined and in case of a statistically significant overall interaction effect, the specific interaction effects (i.e., baseline-post*age, baseline-FU*age and post-FU*age) were examined. Next overall time effects within moderator subgroups were examined and in case of a statistically significant time effect, post hoc analyses (LSD: least significant difference) were performed and reported with back transformed $d = \exp(x)\text{-}\exp(y)$ and confidence interval based on the Delta Method [14] i.e., $[d\text{-}((\exp(d)*SE)*1.96), d + ((\exp(d)*SE)*1.96)$. The results of the post hoc analyses are presented in

the results section of this paper, the specific interaction effects, the overall time effects within moderator subgroups and the overall time*moderator interaction effect are presented in Supplementary Files. The same stepwise method was used for the moderation analyses for the four drinking levels (i.e., subgroups were compared: low vs. moderate, low vs. high, low vs. highest, moderate vs. high, moderate vs. highest and high vs. highest). Assumptions of the ANOVA were checked by examining linearity of the residuals, homogeneity of variance and normality of the standardized residuals (Supplementary File 5). The linearity of the residuals and normality of the standardized residuals were within norms. The Mauchly Test of Sphericity showed a Greenhouse-Geiser of 0.968 and a Huynh–Feldt of 0.968; therefore the results are interpreted according to the Huynh–Feldt F and *p*-value of the within-subjects effects. To examine the change in prevalence of risk drinking and binge drinking, McNemar tests (with asymptotic *p*-values) were used.

Results

Drop-out analysis and descriptive statistics

Compared to non-completers (those who completed only one or two measurements) ($n=38,732$), those completing all three measurements ($n=8,730$) were older and more likely to be male, higher educated, unemployed, report better general health and not be a binge drinker (Table 2). Of those who completed all three measurements, 7,659 out of 8,616 (88.9%; missing: $n=114$) refrained successfully from alcohol during TMC. On post and follow-up measurements ($n=8,730$), the percentage of individuals reporting an average of 0 glasses per week during the last 14 days was 8.9% and 7.5% respectively, compared to 6.8% at baseline.

Changes in alcohol consumption among TMC participants and moderating effects

TMC participants showed a significant decrease in weekly alcohol consumption (Table 3) from baseline (6.5 [6.4,6.7]) to post (4.2 [4.1,4.3], $F=22.0$, $p<0.001$ d = −2.4> [−2.4,−2.3]) and from baseline to follow-up (5.1 [4.9,5.2],

Table 2 Comparison between completers ($n=8,730$) and non-completers ($n=37,047$) according to baseline characteristics, and characteristics of the general Belgian adult population

Baseline characteristics	Completers $n=8,730$	Non-completers $n=38,732$	Comparison between groups		General population[b]
	M ± SD[a] or % (missing)	M ± SD or % (missing)	t or chi[b]	p	M ± SD or %
Age	48.4 ± 12.9 (0)	43.5 ± 12.9 (0)	−31.5	< .001	40.84
% males	38.0% (136)	36.7% (2,927)	4.8	.029	49.2%
% high education level	70.4% (0)	65.5% (0)	76.6	< .001	36.1%
% employed	76.8% (0)	81.8% (0)	115.4	< .001	70.6%
% high general health[c]	80.0% (11)	78.5% (47)	9.7	.002	77.0%
Weekly alcohol consumption	11.0 ± 13.9 (0)	10.8 ± 13.9 (1)	−1.2	.248	9.4
% higher risk drinkers	35.6% (0)	34.9% (1)	1.4	.231	14.0%
% binge drinkers	59.2% (121)	65.2% (817)	110.4	< .001	46.7%

Completers: those who filled in all three measurements, non-completers: those who filled in one or two measurement(s)

[a] *M* mean, *SD* standard deviation

[b] Belgian adults (of 18 years or older) based on Gisle et al. [32], StatBel [57], StatBel [58, 59], Van der Heyden [65]

[c] General health was assessed using a scale from 1 to 5 and categorized as low (1-3) or high (4 and 5) general health

Table 3 Weekly alcohol consumption over time among TMC participants ($n=8,730$)

Weekly alcohol consumption[a]		Time effect for pre-post, pre-FU and post-FU[c]				
	Adj M [95%CI][b]		F	p	PE[b]	d [95% CI]
Pre	6.52 [6.37,6.67]	Pre-post	152.2	< .001	.017	−2.36 [−2.38,−2.33]
Post	4.16 [4.06,4.26]	Pre-FU	64.1	< .001	.007	−1.46 [−1.48,−1.44]
FU	5.06 [4.94,5.18]	Post-FU	21.1	< .001	.002	.90 [.88,.91]

FU Follow-up, PE^2 partial eta squared, *Adj M* adjusted means, *CI* confidence interval, Huynh–Feldt F and *p*-value

[a] Back transformed exp(x)−1

[b] Co-variates: age, sex and educational level

[c] LSD post hoc analyses with back transformed d = exp(x)-exp(y) and CI [d-((exp(d)*SE)*1.96),d + ((exp(d)*SE)*1.96)

Table 4 Weekly alcohol consumption over time among TMC participants according to several moderators ($n=8,730$)

Moderator	Weekly alcohol consumption[a]			Post hoc analyses[b] time effects in subgroups		
	Baseline	Post	Follow-up	Baseline-post	Baseline-FU	Post-FU
	Adj M [95%CI]	Adj M [95%CI]	Adj M [95%CI]	d [95%]	d [95%]	d [95%]
Younger $n=4,107$	5.40 [5.22,5.58]	3.72 [3.59,3.85]	4.20 [4.05,4.34]	−1.68 [−1.72,−1.65]	−1.20 [−1.23,−1.17]	.48 [.46,.50]
Older $n=4,623$	7.68 [7.44,7.94]	4.59 [4.44,4.74]	5.94 [5.76,6.14]	−3.09 [−3.13,−3.05>]	−1.73 [−1.77,−1.70]	1.35 [1.34,1.37]
Males $n=3,266$	8.98 [8.62,9.35]	5.43 [5.21,5.65]	6.85 [6.85,7.12]	−3.55 [−3.61,−3.50]	−2.14 [−2.18,−2.09]	1.42 [1.39,1.44]
Females $n=5,328$	5.32 [5.17,5.47]	3.51 [3.41,3.61]	4.17 [4.05,4.29]	−1.81 [−1.84,−1.78]	−1.14 [−1.17,−1.12]	.66 [.65,.68]
Lower educated $n=2,588$	7.15 [6.82,7.49]	4.19 [4.00,4.39]	5.28 [5.04,5.53]	−2.96 [−3.02,−2.90]	−1.87 [−1.92,−1.81]	1.09 [1.07,1.12]
Higher educated $n=6,142$	6.26 [6.10,6.44]	4.14 [4.04,4.26]	4.97 [4.83,5.10]	−2.12 [−2.15,−2.09]	−1.30 [−1.32,−1.27]	.82 [.80,.84]
Successful $n=7,659$	6.36 [6.20,6.53]	4.00 [3.90,4.10]	4.91 [4.78,5.03]	−2.36 [−2.39,−2.33]	−1.45 [−1.48,−1.43]	.90 [.89,.92]
Not successful $n=957$	7.78 [7.28,8.29]	5.59 [5.26,5.95]	6.32 [5.91,6.75]	−2.18 [−2.25,−2.12]	−1.45 [−1.52,−1.39	.73 [.69,.77]
Lower risk $n=5,626$	3.28 [3.21,3.37]	2.76 [2.69,2.84]	3.31 [3.22,3.40]	-.52 [-.55,-.50]	.03 [.00,.05]	.55 [.53,.56]
Higher risk $n=3,104$	19.72 [19.37,20.07]	8.12 [7.85,8.42]	10.20 [9.86,10.56]	−11.59 [−11.66,−11.52]	−9.52 [−9.57,.9.46]	2.08 [2.05,2.10]
Not bingen $n=3,512$	4.51 [4.35,4.66]	2.91 [2.81,3.01]	3.43 [3.31,3.56]	−1.60 [−1.63,−1.56]	−1.07 [−1.10,−1.04]	.52 [.51,.54]
Bingen $n=5,097$	8.77 [8.52,9.03]	5.34 [5.19,5.50]	6.58 [6.39,6.77]	−3.43 [−3.47,−3.39]	−2.18 [−2.22,−2.15]	1.24 [1.22,1.26]

Younger: 18–48 years old, older: ≥ 49 years old

Co-variates: age, sex and educational level

FU Follow-up, PE^2 partial eta squared, *Adj M* adjusted means, *CI* confidence interval

[a] Back transformed exp(x)−1

[b] LSD post hoc analyses with back transformed d = exp(x)-exp(y) and CI [d-((exp(d)*SE)*1.96),d + ((exp(d)*SE)*1.96). Interaction-effects can be found in Supplementary File 6

$F=24.2$, $p<0.001$, d = −1.5 [−1.5,−1.4]), and a significant increase from post to follow-up ($F=21.1$, $p<0.001$, d = 0.90 [0.88,0.92]).

All moderators showed a significant interaction-effect with time, indicating that changes over the three time points differed according to these moderators (Table 4 and Supplementary File 6). From *baseline to post*, changes in weekly alcohol consumption were moderated by age ($F=36.9$, $p<0.001$), sex ($F=17.9$, $p<0.001$), education ($F=14.5$, $p<0.001$), successfully refraining during TMC ($F=8.1$, $p=0.004$), risk drinking ($F=1,344.4$, $p<0.001$) and binge drinking ($F=23.8$, $p<0.001$). The decrease in alcohol consumption from baseline to post was stronger among older, male and lower educated TMC participants in comparison to their counterparts. TMC participants who successfully refrained from alcohol during TMC had a significant decrease in alcohol consumption from baseline to post, while no significant change over time was observed among TMC participants who did not successfully refrain from alcohol during TMC. The higher risk drinkers showed a significant decrease in alcohol consumption from baseline to post while there was no significant change among lower risk drinkers. The decrease in alcohol consumption from baseline to post was stronger among binge drinkers than non-binge drinkers.

From *baseline to follow-up*, changes in weekly alcohol consumption were only moderated by education ($F=7.4$, $p=0.007$) and risk drinking ($F=1,089.4$, $p<0.001$). The decrease in alcohol consumption from baseline to follow-up was stronger among lower compared to higher educated TMC participants. From baseline to follow-up, lower risk drinkers showed a small but significant increase in weekly alcohol consumption, whereas higher risk drinkers showed a significant decrease in consumption.

From *post to follow-up*, all moderators, except education ($F=1.2$, $p=0.264$), showed significant interaction effects with time. The increase in alcohol consumption from post to follow-up was more pronounced among older compared to younger TMC participants, among male compared to female TMC participants and among binge drinkers compared to non-binge drinkers. No significant change in alcohol consumption from post to follow-up was observed for those not successfully refraining from alcohol during TMC, while those successfully refraining showed a significant increase. Higher risk drinkers showed no significant changes in alcohol consumption from post to follow-up, while lower risk drinkers showed a significant increase.

Moderation by drinking levels at baseline

TMC participants' drinking levels at baseline moderated changes in alcohol consumption ($F=475,7$ $p<0.001$) (Table 5). When comparing drinking level groups two by two (low vs. moderate, low vs. high, low vs. highest, moderate vs. high, moderate vs. highest and high vs. highest drinking levels) all interaction effects with time were significant from baseline to post and from baseline to follow-up. As shown in Supplementary File 7 and Table 5, from baseline to post and from baseline to follow-up, a significant increase in alcohol consumption was observed among TMC participants in the lowest drinking level group, while a significant decrease in alcohol consumption was observed among the moderate drinking level, the high drinking level and the highest drinking level groups. No significant interaction effects with time were observed from post to follow-up, except for the comparison between moderate and highest drinking level groups. A significant increase from post to follow-up was observed among TMC participants in the moderate drinking level group, while no significant change was observed in the highest drinking level group ($F=0.9$, $p=0.353$).

TMC participants' at risk drinking and binge drinking over time

There was a significant decrease in the proportion of higher risk drinkers between baseline (35.6%) and post (19.7%) ($Chi^2=918.7$, $p<0.001$), baseline and follow-up (26.8%) ($Chi^2=305.1$, $p<0.001$) and post and follow-up ($Chi^2=238.7$, $p<0.001$). There was also a significant decrease in the proportion of binge drinkers between baseline (59.2%) and follow-up (43.7%) ($Chi^2=791.9$, $p<0.001$).

Changes in determinants of alcohol consumption among TMC participants

Changes in determinants anticipated to be favourable for reducing alcohol consumption are seen in both short (baseline to post) and medium (baseline to follow-up) term by the significant small increase in attitude towards drinking less alcohol and the decrease in habit of drinking alcohol (Table 6). On the other hand, TMC participants also showed a significant short and medium term decrease in perceived benefits of drinking less, subjective norm of drinking less and supportive social influence toward drinking less.

Discussion

The current study evaluated changes in (at-risk) alcohol consumption and its determinants in both the short term (i.e., immediately after TMC) and medium term (i.e., six months after TMC) among TMC participants. In the short and medium term, TMC participants reported a decrease in weekly alcohol consumption

Table 5 Weekly alcohol consumption over time among TMC participants according to drinking levels at baseline ($n=8,730$)

Drinking level	Weekly alcohol consumption[a]			Post hoc analyses[b] time effects in subgroups		
	Baseline	Post	Follow-up	Baseline-post	Baseline-FU	Post-FU
	Adj M [95%CI]	Adj M [95%CI]	Adj M [95%CI]	d [95%]	d [95%]	d [95%]
Low ($n=3,305$)	1.27 [1.22,1.31]	1.68 [1.60,1.75]	2.06 [1.97,2.15]	.40 [.39,.44]	.79 [.77,.82]	.38 [.36,.41]
Moderate ($n=2,591$)	6.41 [6.34,6.48]	4.04 [3.92,4.16]	4.78 [4.64,4.92]	−2.37 [−2.41,−2.34]	−1.63 [−1.66,−1.60]	.74 [.72,.76]
High ($n=1,406$)	12.80 [12.72,12.90]	6.18 [5.90,6.46]	7.50 [7.18,7.83]	−6.63 [−6.70,−6.55]	−5.31 [−5.24,−5.37]	NA
Highest ($n=1,698$)	28.05 [27.49,28.63]	10.15 [9.66,10.66]	13.11 [12.48,13.75]	−17.90 [−18.03,−17.78]	−14.94 [−15.03,−14.84]	NA

Drinking levels = low: 0 to < 4 glasses, moderate: ≥ 4 to ≤ 10 glasses, high: > 10 to ≤ 17 glasses, highest: > 17 glasses

Co-variates: age, sex and educational level

FU Follow-up, PE^2 partial eta squared, *Adj M* adjusted means, *CI* confidence interval, *NA* not applicable (no significant effects)

[a] Back transformed exp(x)−1

[b] LSD post hoc analyses with back transformed d = exp(x)-exp(y) and CI [d-((exp(d)*SE)*1.96), d + ((exp(d)*SE)*1.96). Interaction-effects can be found in Supplementary File 7

Table 6 Determinants of alcohol consumption over time for TMC participants ($n = 8,730$)

	Determinants at pre, post and follow-up[a]		Time effect for pre, post and follow-up			Time effect for pre-post, pre-follow-up and post-follow-up[c]				
		Adj M [95% CI][b]	F	p	PE[b]		F	p	PE[b]	d [95% CI]
Attitude towards drinking less alcohol	Pre	4.68 [4.67,4.70]	5.2	.005	.001	Pre-Post	5.2	.023	.001	.04 [.03,.06]
	Post	4.73[4.71,4.74]				Pre-FU	9.6	.002	.001	.02 [.01,.04]
	FU	4.71[4.69,4.72]				Post-FU	1.0	.323	.000	NA
Perceived benefits of drinking less alcohol	Pre	3.38 [3.36,3.39]	57.0	< .001	.007	Pre-Post	101.4	< .001	.012	-.46 [-.48,-.44]
	Post	2.92 [2.90,2.94]				Pre-FU	8.6	.003	.001	-.02 [-.04,-.01]
	FU	3.35 [3.33,3.37]				Post-FU	57.8	< .001	.007	.44 [.42,.45]
Habit of drinking alcohol	Pre	2.70 [2.67,2.72]	73.1	< .001	.008	Pre-Post	81.2	< .001	.009	-.33 [-.36,-.31]
	Post	2.36 [2.34,2.38]				Pre-FU	123.9	< .001	.014	-.55 [-.57,-.52]
	FU	2.15 [2.13,2.17]				Post-FU	6.2	.013	.001	-.21 [-.23,-.19]
Subjective norm of drinking less	Pre	2.12 [2.09,2.14]	33.7	< .001	.004	Pre-Post	36.1	< .001	.004	-.19 [-.22,-.17]
	Post	1.92 [1.90,1.95]				Pre-FU	59.3	< .001	.007	-.22 [-.24,-.19]
	FU	1.90 [1.88,1.93]				Post-FU	4.3	.038	.001	-.02 [-.04,-.00]
Subjective norm of drinking more	Pre	1.54 [1.52,1.56]	2.5	.081	.000	Pre-Post	NA	NA	NA	NA
	Post	1.55 [1.53,1.57]				Pre-FU	NA	NA	NA	NA
	FU	1.48 [1.46,1.49]				Post-FU	NA	NA	NA	NA
Emotional self-efficacy towards refraining from alcohol	Pre	4.30 [4.28,4.31]	1.3	.269	.000	Pre-Post	NA	NA	NA	NA
	Post	4.39 [4.37,4.41]				Pre-FU	NA	NA	NA	NA
	FU	4.35 [4.33,4.37]				Post-FU	NA	NA	NA	NA
Opportunistic self-efficacy towards refraining from alcohol	Pre	4.67 [4.66,4.68]	2.8	.061	.000	Pre-Post	NA	NA	NA	NA
	Post	4.66 [4.65,4.67]				Pre-FU	NA	NA	NA	NA
	FU	4.70 [4.69,4.71]				Post-FU	NA	NA	NA	NA
Social self-efficacy towards refraining from alcohol	Pre	4.31 [4.29,4.32]	.5	.596	.000	Pre-Post	NA	NA	NA	NA
	Post	4.39 [4.37,4.40]				Pre-FU	NA	NA	NA	NA
	FU	4.35 [4.33,4.37]				Post-FU	NA	NA	NA	NA
Supportive social influence towards drinking less	Pre	1.90 [1.88,1.92]	20.4	< .001	.002	Pre-Post	24.4	< .001	.003	-.10 [-.12,-.08]
	Post	1.80 [1.78,1.82]				Pre-FU	36.0	< .001	.004	-.12 [-.14,-.10]
	FU	1.78 [1.76,1.80]				Post-FU	1.2	.277	.000	NA
Non-supportive social influence towards drinking less	Pre	1.75 [1.73,1.77]	3.7	.024	.000	Pre-Post	.9	.348	.000	NA
	Post	1.71 [1.69,1.73]				Pre-FU	2.9	.087	.000	NA
	FU	1.64 [1.63,1.66]				Post-FU	7.6	.006	.001	-.07 [-.08,-.05]

FU Follow-up, *Adj M* adjusted mean, *CI* confidence interval, PE^2 partial eta squared, *NA* not applicable (no significant effects)

[a] On a scale from zero to five

[b] Co-variates: age, sex and educational level

[c] LSD post hoc analyses

and in the proportion of risk drinking and binge drinking. In the short term, the decrease in weekly alcohol consumption was stronger among older, male and lower educated TMC participants, those successfully refraining during TMC, higher risk drinkers and binge drinkers. In the medium term, changes in alcohol consumption among TMC participants were moderated by education and at risk drinking, with stronger decreases among those with lower education. Additionally, these was an increase in consumption in lower risk drinkers and decrease in higher risk drinkers. Participants' baseline drinking level also moderated changes in alcohol consumption in both short and medium term. An increase in alcohol consumption was observed among those with a low drinking level, while other groups (i.e., moderate, high and highest drinking levels) showed a decrease in consumption over time. Changes over time in determinants favouring reduction in alcohol consumption were observed. Both in short and medium term, there was an increase in positive attitudes towards drinking less alcohol and a decrease in the habit of drinking alcohol. Nonetheless, there was also

a decrease in the short and medium term in perceived benefits of drinking less alcohol, subjective norm of drinking less alcohol and supportive social influence towards drinking less.

Alcohol consumption

The decrease in alcohol consumption over time in TMC participants was comparable to changes in alcohol consumption in previous TAC studies [6, 19]. In the current study, weekly alcohol consumption decreased from 7 at baseline to 4 glasses/week at post and was still decreased at follow-up (5 glasses/week) (adjusted means for weekly alcohol consumption). However, since this study did not include a control group or comparison points, this decrease in alcohol consumption could be due to other factors than the TMC intervention itself. For example, there could be a seasonal influence on alcohol consumption. Conflicting results are found in studies on the seasonal influence on alcohol consumption [21, 30, 42]. Data from a large cohort study with young Swiss men [30] showed increases in alcohol consumption during the summer, at the end of the year and on (the evening before) public holidays. A large population-based study in Norway ($n=50,814$) [42] found that the highest level of alcohol consumption was reported during the summer season, but the highest number of individuals who reported alcohol consumption in the last four weeks was found in the month January. According to the study of de Vocht et al. [21] ($n=38,372$ participants), alcohol consumption in England is fairly stable across the year and alcohol consumption is somewhat lower in the summer months. Other TAC evaluations [19, 41, 55] also found a decrease in alcohol consumption among participants with data collected at different time points throughout the year and conducted in other countries (e.g. Australia, Thailand or UK) than Belgium. Additionally, this study also had a non-random loss to follow-up (e.g., those not successfully refraining from alcohol during TMC might be the ones who did not complete post and/or follow-up measurements). Also, there was a low response rate (e.g. 30% response), which is not uncommon in alcohol research [62]. Our findings may be overly optimistic if those who were unsuccessful in refraining from drinking during TMC did not participate in our study or dropped out. Future research should examine which factors are associated with drop-out in TAC studies and try to have a higher response rate across measurements to have a more representative sample of TAC participants. Nonetheless, it is challenging to find a proper control group. Some attempts were made in other TAC research [19, 40], but there were still differences between intervention and control group participants in baseline characteristics which the researchers tried to resolve by using covariates [19]. Participants of the TAC 'Buddhist Dry Lent' drank less alcohol three months after participating compared to a control group [40]. Participants of the TAC 'Dry January' showed favourable changes in AUDIT-C scores among participants compared to non-participants, indicating a medium reduction in alcohol consumption especially in those who successfully completed the challenge [19]. Future TAC research should use a stronger research design, for example a time series design [9] or a difference in difference design [72], is needed to make statements on the intervention effects of TMC and to rule out regression to the mean.

Risk and binge drinking

A reduction in risk drinking and binge drinking was observed among TMC participants. Additionally, the decrease in alcohol consumption over time among TMC participants was stronger in the more at-risk drinkers (i.e., higher risk drinkers, high drinking levels groups and binge drinkers). This observation and the fact that TMC appeals to these more at-risk drinkers, is in line with previous TAC-studies [5, 38]. However, to ensure that TACs effectively achieve harm reduction goals, future research should investigate whether the reduction in (at-risk) alcohol consumption is directly associated with the intervention (i.e. including a control group or comparison points). Additionally, it is essential to determine if this reduction is sustained in the long term (more than six months after a TAC) and not biased by regression-to-the-mean or repeated participation in a TAC, such as TMC, which has been organized annually since 2017.

Moderation of age, sex and education

Results showed a stronger decrease in alcohol consumption among older compared to younger participants (short term), among males compared to females (short term), and among lower compared to higher educated participants (short and medium term). These differences could be on the one hand explained by the higher baseline alcohol consumption among older, male and less educated participants leaving more room for a decrease and TACs being especially effective for those with high levels of alcohol consumption. On the other hand, regression to the mean or seasonal variations in alcohol consumption (as mentioned above) could be different depending on these moderators. Other research [3] report no moderation of sex in alcohol reducing interventions. The evaluation of the TAC 'IkPas' [5] showed that changes in alcohol consumption were stronger in younger versus older females, but found no differences in changes in alcohol consumption according to age in males. A study of a brief computer-delivered intervention [27] reported greater effect on alcohol use among

younger than older participants. It is possible that TMC appealed more towards older Belgian adults. For example, TMC materials included an elderly lady and a range of age groups in the campaign images. To our knowledge, no previous TAC studies have examined the moderating effects of education. However, a meta-analysis [52] showed that the effects of alcohol reducing interventions in general were stronger in higher educated than lower educated adults. A possible explanation for the contradiction with our findings may be that satisfaction with different intervention components might be different in subgroups of the population. For example, campaign materials of some TAC may appeal more to younger people, while materials of other TAC may appeal more to older adults. A future process evaluation could provide insights into whether satisfaction with the TMC materials differed across demographic groups and whether this has influenced changes over time in alcohol consumption. Successfully refraining from alcohol during TMC only was significantly associated with short term changes in weekly alcohol consumption among TMC participants (i.e., a decrease among successful and no changes in weekly alcohol consumption among not successful TMC participants). In the medium term, in both participants successfully refraining from alcohol during TMC and those who were not successful, a decrease in consumption was observed. Although other TAC research did found an association on successful completing the challenge and reduction in alcohol consumption in the medium term [19, 41], this study cannot confirm these claims.

Determinants of alcohol consumption

Theoretically, it is expected that changes in alcohol consumption (potentially elicited by participation in TMC) are explained by changes in the underlying determinants of alcohol consumption. Participants in TMC showed a significant short and medium term increase in attitude towards drinking less alcohol and a decrease in the habit of drinking alcohol. Both changes are in line with theoretical expectations based on the theories behind the behaviour change techniques (BCT) used in TMC to change the determinants of alcohol consumption. For example, the Theories of Learning [74] underpins the BCT 'repeated exposure' which targets attitudes, while the Theories of Automatic, Impulsive and Habitual Behaviour [2] inform the BCT 'public commitment' which targets habit. An overview of BCTs used in TMC is given in Table 2 and further details on the theories behind these BCTs can be found in Eldredge et al. [22]. By refraining from alcohol during one month, participants had to establish new habits. A behaviour can be changed by breaking the habit in which the behaviour was practiced in the past [49]. After participation, participants drank less without thinking about it. The current study also found a decrease in subjective norm of drinking less; meaning that after the intervention participants perceived less pressure from their social environment to drink less alcohol. Several studies showed the importance of peer perception on alcohol use [61, 64] and the impact of the 'drinking culture' on an individual's alcohol consumption [4, 48]. Belgium is known for its drinking culture (e.g. legal drinking age of 16 years) [31]. The change in perception could be a consequence of the change in the drinking behaviour (i.e. less pressure to drink less). As participants' alcohol consumption was decreased after the intervention and fewer participants were still drinking too much, they may perceive less pressure from their social environment to drink less. It is also possible that TMC had an influence on the drinking culture in Belgium and that TMC was able to change the objective social norm regarding alcohol consumption. Further research is needed on the influence of TACs on social drinking norms. The lower consumption of participants may also explain the decrease in supportive social influence: participants reported being less encouraged to drink less. The decrease in social support might therefore also be a result of their reduced drinking behavior change rather than a direct effect of TMC.

Participants in TMC did not feel more confident to refrain from alcohol (i.e. self-efficacy) in a variety of situations after participation, which was against theoretical expectations from the Self-regulation Theory supporting the BCT 'Goal-setting' which was used in TMC to target self-efficacy [43]. The TAC evaluation study of 'Dry January' [19] reported a significant increase in drink-refusal self-efficacy scores in the intervention group compared to the control group. It is noticeable that the scores of self-efficacy towards refraining from alcohol in our study are high at baseline, while in general participants drank quite a lot (a high self-efficacy does not necessarily lead to moderate alcohol consumption). A seven-point scale could possibly have resulted in a wider spread of the self-efficacy scores.

The current study also found that participants experienced fewer benefits of drinking less alcohol immediately after the campaign than they anticipated before the start of TMC. Comparable intervention effects were found in the TAC 'IkPas'-study [5] where participants indicated that, besides saving money, they perceived few 'quick wins' resulting from participating. Although other research [18] did observe weight loss among Dry January-participants, more substantial benefits of not drinking alcohol such as improved skin or weight loss may not be visible after one month. According to the Theories of learning [74], because participants did not

directly experience these benefits, it is not surprising that perceived benefits of drinking less alcohol scored lower after TMC; participants may have anticipated unrealistic short-term effects. Six months after TMC, participants' perceived benefits of drinking less alcohol increased again. Future research should investigate the impact of highlighting benefits of drinking less alcohol in campaign materials. Future research should also use mediation analyses to examine whether the observed changes in alcohol consumption can be explained by changes in determinants. Finaly, future TAC research should examine whether the BCTS behind the campaign materials are sufficient to drive changes in (determinant of) adults alcohol consumption. It would also be valuable to assess if the use of other BCTs might be more effective, and if so, identify which specific approaches could enhance the campaign's impact.

Despite we can only draw limited conclusions from the current study on intervention effects (i.e., due to the lack of a control group or comparison points as mentioned above), TMC may have had some favourable influences. For example, by changing the population-wide social norm surrounding alcohol consumption or the (availability of) non-alcoholic beverages. Future research should be conducted to substantiate this hypothesis.

Limitations and strengths

Some methodological limitations (besides the lack of a control group) should be taken into account when interpreting the results of this study. Although weekly alcohol consumption in the intervention group was similar to the general Belgian population, there were more higher risk drinkers. While the prevalence of risk drinkers in the general Belgian adult population has been steadily decreasing between 2001 and 2018 [32], the observed decreases among TMC participants are unlikely to be solely explained by this time trend, but might also be explained by regression to the mean. Similar research [19] found a higher alcohol consumption among people who participate in a TAC compared to a control group suggesting that heavier drinkers are drawn to campaigns such as TMC. There were also some other limitations. Participants were self-selected resulting in a non-representative sample of the Belgian population. In addition, TMC participants included in this dissertation were limited to those who registered on the TMC website, which restricts the generalizability of the results to all Belgian adults who participated in TMC. Additionally, as analyses were done on participants who completed all three measurements, our analysis assumed missingness to be completely at random, while non-random missingness is likely (e.g., it is possible that those not successfully refraining from alcohol during TMC were the ones who dropped-out). If participants who experienced less benefits from participating in TMC and therefore experienced no reduction in their alcohol consumption, were more likely to drop-out, our results will have overestimated reductions in alcohol consumption among TMC participants. In addition, using only complete cases may have led to loss of precision [54]. Although TMC was not aimed at people with addiction but at the more 'general drinkers', addiction was not an exclusion criterion for this study. Another limitation is the reliance on self-report of alcohol consumption over the last two weeks (instead of the usual last six months), but any biases related to this shorter time frame would have affected all participants equally and are therefore no source of bias in the analyses. It should be noted that since some participants completed the baseline measures while they had already started their abstinence challenge (questionnaire closed on February 10), they were asked to report their alcohol consumption before starting their abstinence. This may have introduced some recall bias. Next, the tailor-made questionnaire assessing determinants was not pilot-tested. Additionally, not all targeted determinants were assessed, such as knowledge. The identified behaviour change techniques are comparable to the most frequently used techniques in web-based interventions [39]. In addition, future research should investigate whether exposure to campaign materials has an impact on changes over time in (determinants of) alcohol consumption. Finally, no long-term changes could be studied as there was only a follow-up measurement six months after TMC. Despite these limitations, this study has several strengths. This study included three points of data collection (baseline, post, follow-up), multiple aspects of alcohol consumption (including high-risk drinking), various determinants and moderators.

Conclusion and practical implications

To conclude, TMC participants reported favourable changes in (the underlying determinants of) alcohol consumption in the short and medium term. Higher level drinkers appear to be especially attracted to participate in TMC and to experience the strongest decreases in alcohol consumption. However, without comparison with a control group of non-participants or comparison points, we cannot simply attribute the changes over time to participation in TMC. Future research with a stronger study design is needed to rule out possible bias (e.g., selection bias, seasonal effects or regression to the mean) and to examine mechanisms (e.g., examining the underlying behaviour change techniques of TACs) and longer term (more than six months after participation) effects of TACs. Future campaign developers could better tailor TAC materials

to specific subgroups, such as younger participants, to achieve similar reductions in alcohol consumption as in other subgroups, such older participants. Future campaigns could also benefit from promoting longer-term strategies, like encouraging adults to participate in a TAC annually, to sustain lower consumption levels. In addition, TACs could aim to attract a broader range of drinkers, as they currently mostly attract heavy drinkers. For example, campaigns could include materials that highlight reasons for participation even for moderate drinkers who may fell less compelled to join. Finally, future campaigns should avoid overemphasizing the short-term benefits of abstaining, which can create unrealistic expectations. Practical recommendations for improving the TMC campaign, based on the process evaluation of TMC, are available in a separate publication [63].

Abbreviations

BCT Behaviour Change Technique
TAC Temporary Abstinence Campaign
TMC Tournée Minérale campaign

Supplementary Information

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Supplementary Material 1

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Authors' contributions

AT carried out the data curation, formal analysis, investigation, methodology, project administration, software, and visualization, and led the original draft writing. JVC led the conceptualization, formal analysis, funding acquisition, investigation, supervision, and review and editing of the manuscript, and supported project administration and software development. JVD supported the conceptualization, project administration, and supervision, and contributed to the review and editing of the manuscript. GN supported the review and editing of the manuscript. BD led the conceptualization, formal analysis, funding acquisition, and supervision, and contributed to the review and editing of the manuscript. All authors have read and approved the final manuscript.

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Data availability

The data sets generated during and/or analyzed during this study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the ethical committee of the Ghent University Hospital (2017/0069) and is in compliance with the ethical standards of the Declaration of Helsinki.
Informed consent was obtained from all individual participants included in the study.

Competing interests

The authors declare no competing interests.

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