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Effects of a Patient-Centered Intervention to Reduce Alcohol Use Among Youth With Chronic Medical Conditions

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A B S T R A C T

Purpose: Alcohol poses unique risks for youth with chronic medical conditions (YCMC) yet many drink. Preventive interventions targeting YCMC are scarce.
Methods: YCMC with type 1 diabetes, juvenile idiopathic arthritis, systemic lupus erythematosus, or inflammatory bowel disease were recruited and randomized to trial the effects of a self-administered condition-tailored psychoeducational intervention on frequency in days of past 3-month alcohol use, alcohol-related risk perceptions, and knowledge. Changes in outcomes over time were measured and compared by treatment arm using multivariate mixed effects models.
Results: Among N = 418 participants (average age 16.0 years, 52.2% female, 84.7% white, 90.7% non-Hispanic), 24.2% reported past-year alcohol use at baseline. Alcohol-related knowledge increased overall and was greater for the intervention group (adjusted improvement in knowledge score +7.70, 95% confidence interval [CI] 2.92–12.48). By 6-month follow-up, the percentage of youth reporting any alcohol use is risky/dangerous increased among intervention arm participants from 41.5% to 45.4% at baseline and decreased from 38.9% to 37.4% among controls (adjusted intervention effect odds ratio 1.79, 95% confidence interval 1.02–3.13). Overall, frequency of drinking increased over time from 3.72 to 4.52 days on average, with no differences by treatment group. Among female drinkers, the predicted mean frequency of drinking days declined in the intervention group (4.11–3.33) and increased among controls (2.82–4.55) (adjusted intervention effect rate ratio .50, 95% confidence interval .25–.99).
Conclusions: Exposure to a chronic illness–tailored psychoeducational intervention targeting alcohol use increased knowledge and perceived risk and, among females, reduced alcohol use. Promising results merit future work to optimize the model for both males and females.

IMPLICATIONS AND CONTRIBUTION

Adolescents with a chronic illness who were exposed to a self-administered, condition-tailored psychoeducational intervention reported increases in alcohol-related knowledge and perceived risk. Females in the intervention group decreased their average number of drinking days, while females in the control group saw an increase. There is potential to optimize this model.

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Approximately one-quarter adolescents in the U.S. and some 11% globally grow up with a chronic medical condition [1,2]. To stay healthy, youth with chronic medical conditions (YCMC) require ongoing medical care, take medicines, and obtain periodic laboratory tests. YCMC also must modulate behaviors and avoid health-compromising activities by controlling their diet, sleep, and substance use, while endeavoring to participate in activities and relationships central to mental health and development [3,4]. Challenging for all youth, these holistic self-care behaviors are acutely important for YCMC; however, in busy clinical settings, challenges and problems with them may be missed [5].

For YCMC, health risk behaviors can contribute to disease exacerbations and complications, placing even greater stress on youth, their families, and healthcare systems [6]. Alcohol use is a top contributor to preventable morbidity and mortality worldwide among adolescents [6,7] and despite their medical vulnerability, YCMC drink alcohol at levels commensurate with their healthy peers [8]. By young adulthood, YCMC experience disproportionate rates of heavy and problem drinking [9,10], behaviors that pose additional safety risks from simultaneous exposure to prescription medications with alcohol use contraindications. Either to avoid mixing alcohol with medications, or because of lapsed judgment around self-care and treatment adherence when under the influence of alcohol, YCMC who drink alcohol are nearly twice as likely to frequently miss or skip their medications as those who do not [9].

Screening, Brief Intervention, and Referral to Treatment (SBIRT) is recommended by the American Academy of Pediatrics to identify and reduce substance use among all youth, and given the heightened vulnerability of YCMC intensified prevention is logical for them [11]. Medically vulnerable youth are sensitive to potential harmful effects of alcohol on treatment safety and efficacy [12]. They are also interested in learning about the specific impacts of alcohol use on their disease and its treatment, with females and males differing somewhat in concerns regarding the salience of risks for treatment nonadherence, and concern for attunement to physiologic cues about disease activity when under the influence [13]. When choosing to limit or abstain from using alcohol, YCMC act out of concern to avoid disease-related harms and remain symptom free [14]. Taken together, findings suggest the potential for promoting health-protecting behaviors regarding alcohol use to YCMC, and the potential of brief interventions tailored to their unique concerns and circumstances.

Despite mounting evidence about prevalence, risks, and problems related to alcohol use by YCMC, there are no evidence-based preventive interventions targeting reduced alcohol use by them. Currently, routine visits in subspecialty care do not include screening or guidance regarding alcohol use and time to address behavioral health concerns is highly constrained. We developed a psychoeducational intervention to test a model for targeted prevention of alcohol use among medically vulnerable youth. The intervention drew on theories of health behavior change that recognize the primacy for adopting health protecting and risk reducing behaviors of messages that impact perceived risk from a health threat that is deemed personal and credible [15,16], and on the SBIRT framework for substance use screening and response [17,18]. This first test of a YCMC-focused alcohol use prevention model employed an online assessment coupled with a brief, self-administered psychoeducational intervention. Measures and intervention materials drew from epidemiological and qualitative research with YCMC. We hypothesized that compared to adolescents who were *not* exposed to an alcohol use prevention intervention, adolescents who received the disease tailored self-administered intervention would gain knowledge about the effects of using alcohol on their chronic illness, increase their assessment of the riskiness of using alcohol, and decrease the frequency of alcohol use behaviors.

Methods

Using a randomized trial design, we delivered the novel Take Good Care (TGC) psychoeducational intervention to a convenience sample of YCMC recruited from May 2017 to September 2019 during routine visits to their subspecialty provider [13]. The intervention was developed under an iterative patient-centered design process with input from key stakeholder group members including YCMC and subspecialty providers routinely treating them, pediatricians, and behavioral scientists. For the trial, we tested the effects of viewing the intervention on YCMC drinking behaviors (primary dependent variable), impacts on knowledge regarding the effects of alcohol on their disease and its management, and YCMC perceptions about the riskiness of drinking (putative intermediary variables). We also explored gender-based subgroup effects, given the potential that males and females might respond differently to the intervention [19,20]. All participants completed baseline and 6-month follow-up surveys; participants in the intervention arm also reported about knowledge and perceived risk of alcohol use immediately after viewing the intervention. Data were collected via the REDCap electronic data capture tool hosted at Boston Children's Hospital (BCH) [21,22]. The BCH Institutional Review Board reviewed and approved the study under youth assent and a waiver of parental consent.

Setting and sample

Adolescents aged 14–18 years seeking routine care in the Rheumatology, Endocrinology, or Gastroenterology clinics at BCH were enrolled. Eligibility criteria were a clinical diagnosis of type 1 diabetes (T1D), juvenile idiopathic arthritis (JIA) or systemic lupus erythematosus (SLE), inflammatory bowel disease (IBD) (i.e., diagnosed with ulcerative colitis or Crohn's disease), ability to read English, and manipulate a tablet computer. Exclusion criteria were inability to provide assent, English comprehension skills below middle school reading level, determined by their inability to consent, and pregnancy at baseline. We employed a stratified randomization scheme to ensure that equal percentages of males/females and older/younger adolescents were enrolled in the intervention and control groups.

Intervention

The TGC intervention comprised a deck of 28–32 slides, addressing topics related to alcohol use identified as salient to YCMC in prior research [13]. Images were rendered in a rich adolescent-relevant visual style (Figure 1) by an artist embedded with the research team and annotated with quotes taken directly from formative research coupled with user-friendly, expert reviewed explanations of content. The intervention was self-administered on a tablet with a polarizing screen for privacy in the clinic waiting room and the configuration allowed participants to advance manually or via auto-play, with an average review time of 4 minutes. Disease-specific versions of the same

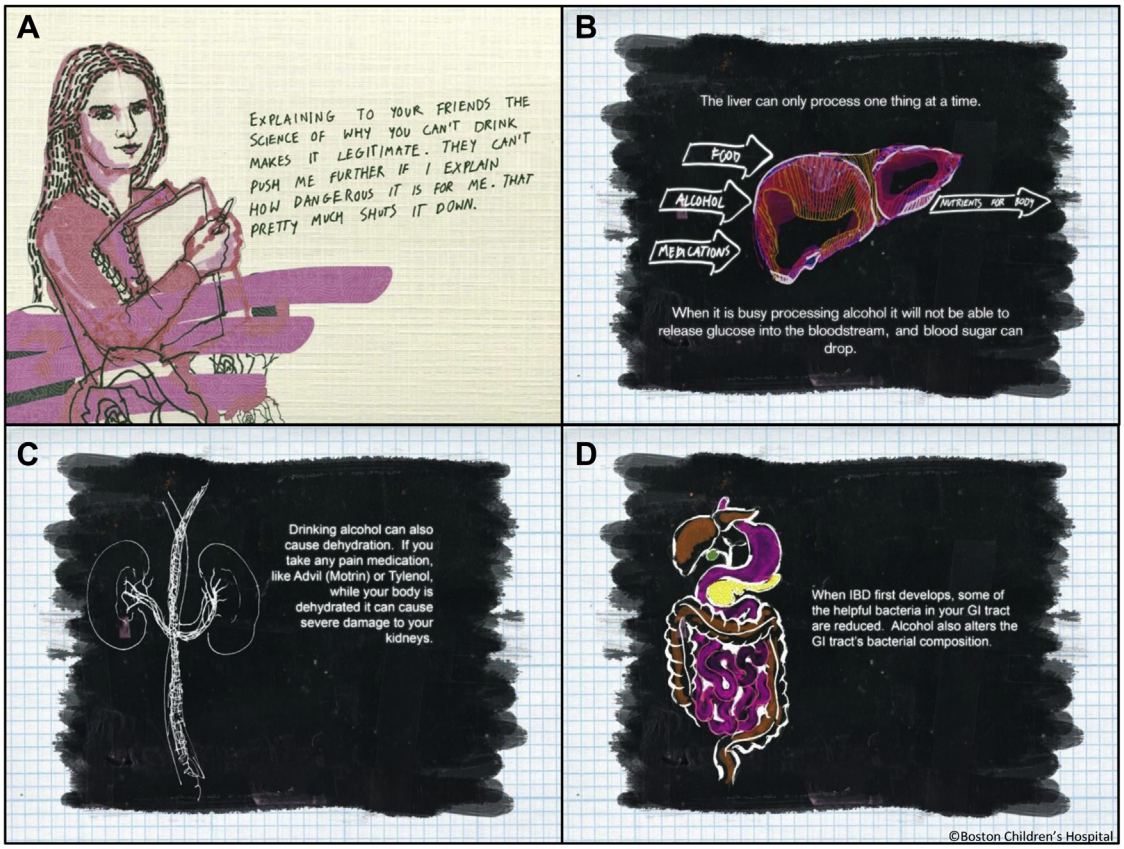

Figure 1. (A) An example of the common social story of alcohol use for youth with chronic medical conditions included in each disease tailored deck; (B-D) explain alcohol's effects on organ systems in the body relevant to type 1 diabetes, juvenile idiopathic arthritis/system lupus erythematosus, and inflammatory bowel disease respectively.

intervention were developed and delivered, each tailored to the specific health effects of using alcohol on disease processes and treatment for T1D, JIA/SLE, and IBD, respectively. Content of the intervention was designed to be emotionally resonant regarding the riskiness of alcohol use for YCMC with attention to the social developmental context of adolescence ("the social story"), and factual and specific regarding alcohol's effects on the body, disease processes, and self-management ("the medical science").

Measures

Sociodemographic characteristics. Age in years, gender (male, female, other), race (American Indian/Alaska Native, Asian, African American, Pacific Islander, White), ethnicity (Hispanic/Latino), number of parents in the house, and highest level of education attained by a parent were self-reported. If gender was indicated other or missing, the gender recorded in the patient's chart was used.

Health status. Chronic illness experience was assessed using the 5-question Problem Areas in Diabetes scale [23] to assess feelings (i.e., feeling scared, depressed), worry about the future, concern that a condition is taking up too much mental and physical energy, and coping with complications on a 5-point Likert scale ("not a problem, minor problem, moderate problem, somewhat serious problem, and serious problem"), which was adapted for use with JIA/SLE and IBD patients. Any score $\geq$8 indicated a positive screen. Depressive symptoms were assessed via the Patient Health Questionnaire-2 [24]; anxiety was screened via the Generalized Anxiety Disorder scale [25]. For both mental health measures, scores $\geq$3 indicated a positive screen. Past-year self-rated health was reported on a 5-point scale (1-Excellent to 5-Poor) [26]. Past-year experience of a diagnosis-specific health problem was self-reported as experience of a severe hyper- or hypoglycemic event in the past year for participant with T1D and experience of a disease flare for participants with JIA/SLE or IBD.

Substance use. Participants self-reported frequency of alcohol use days in the past three months ("In the last three months, how many days did you have a drink containing alcohol?") [27]. Self-report of past-year alcohol, cannabis, and e-cigarette use was also collected, as was experience of binge drinking in the past 3 months for drinkers, defined using established age/sex cutoffs [28]. Past-year frequency of experiencing alcohol-related harms (i.e., blackouts, injury, vomiting, emergency room visits, secret use, and sexual contact) and/or cannabis-related harms (i.e., hallucinations, anxious/paranoid feeling, secret use, and sexual contact) were self-reported. Both measures were dichotomized to any/no harms. Intermediary measures of alcohol use included **perceived riskiness** of consuming different quantities of alcohol

("How many drinks on one occasion would you consider risky or dangerous drinking for yourself?" any, >1, >2, >3, >4, >5 or do not consider alcohol risky or dangerous); the ordinal measure of **perceived risk** was dichotomized as **risk intolerance** for participants who endorsed "any" versus other. Knowledge about alcohol's effects on each chronic illness was assessed via 7–8 true/false questions tailored to each specific disease (see Appendix Table A, for summary of questions). A **knowledge score** variable was defined as the percentage of questions answered correctly out of 100.

Data analyses

All N = 418 adolescents randomized into the study who completed the baseline and 6-month follow-up without missing primary outcomes were included in the analytic sample (Figure 2) comprising teens from endocrinology (n = 192, 45.9%), rheumatology (n = 109, 26.1%), and gastroenterology (n = 117, 28.0%). Disease/clinic group differences in demographic and substance use characteristics at baseline were evaluated using bivariate tests (chi-squared, Fisher's exact, *t*-test, analysis of

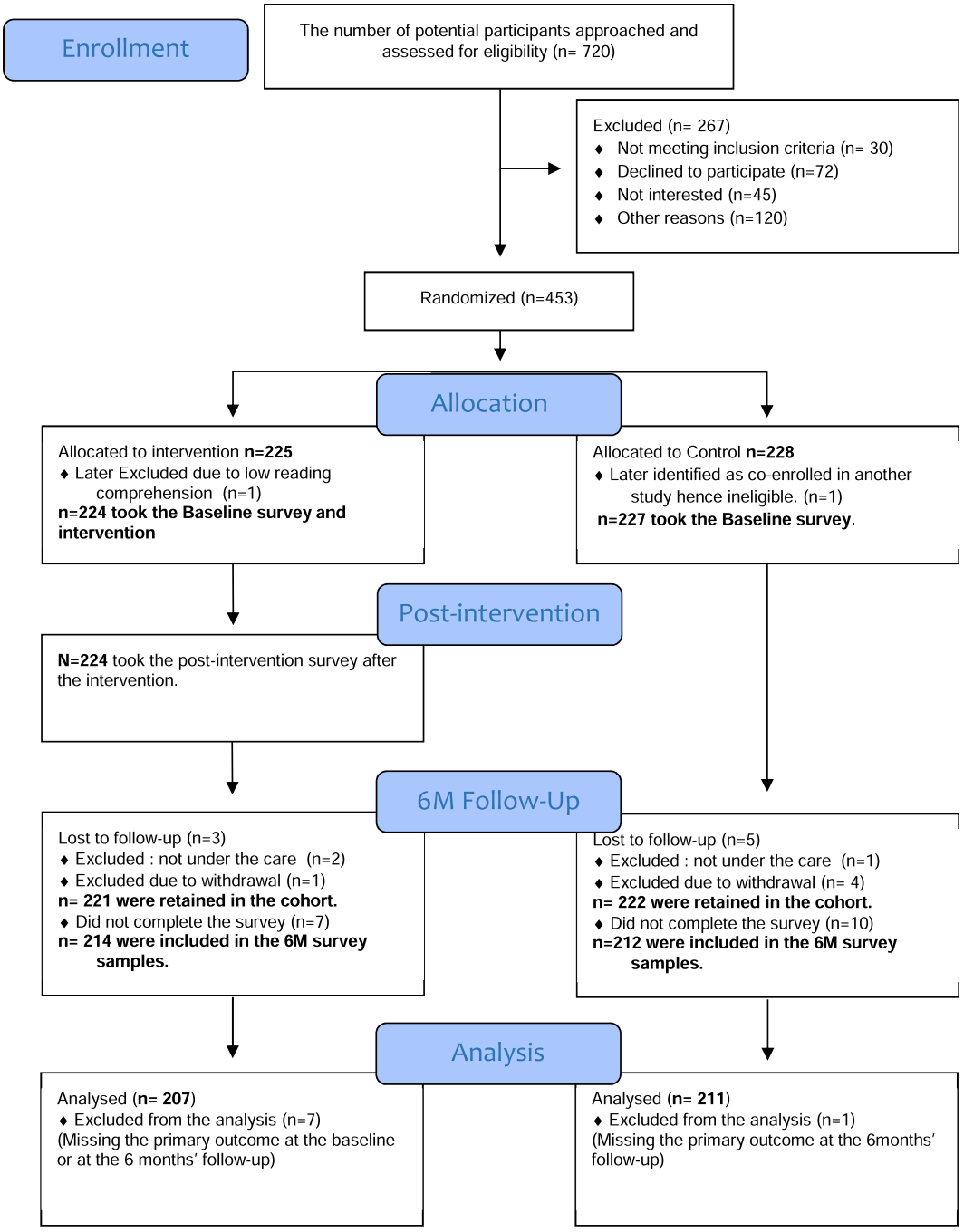

Figure 2. CONSORT flow diagram for enrollment.

variance, or Kruskal-Wallis), as were differences in outcomes between treatment and control groups at baseline and follow-up. Multivariate mixed effects models were used to assess adjusted intervention effects, with individual random effects to account for repeated measures (i.e., baseline vs. 6-month follow-up); adjusted predictive margins and total intervention effects were calculated to illustrate the interactive effect of the treatment versus control arm over time. All models controlled for age, gender, parent education, race/ethnicity, anxiety, and depression. Model distribution varied by outcome: Gaussian models were used for knowledge score, logistic models were used for risk intolerance, and negative binomial models were used for past 3-month alcohol use days (among past-year drinkers only). To examine the potential for differential intervention impact by gender, we performed gender-stratified analyses for all outcomes; as there were few (<5) Hispanic/non-white participants per strata for the alcohol use outcome, we elected to address potential confounding by restricting these stratified analyses to non-Hispanic white participants. All analyses were performed using SAS 9.4 (Cary, NC). Statistical significance was considered at $p < .05$.

Results

Sociodemographic and clinical characteristics of participants

Among all participants (N = 418), nearly half (45.9%) were recruited from the diabetes program, and the remainder divided between rheumatology (26.1%) and gastroenterology (28.0%). Half (49.5%) of all participants were randomized to the intervention arm (Table 1). The average participant age was 16.0 years and there were nearly equal percentages of female and male participants (Table 1). The proportion of participants' parents who completed at least a college degree was higher in the intervention than control group (82.1% vs. 73.0%, $p = .025$) (Appendix Table B), otherwise the treatment groups did not differ regarding sociodemographic factors.

Alcohol use behaviors

Overall, past-year alcohol use was reported by 24.2% of participants with no differences across diseases/clinics (Table 1). Past-year alcohol use was associated with older age ($p < .001$), past-year cannabis and e-cigarette use ($p < .001$), higher average knowledge about alcohol's effects on a chronic illness ($p = .013$), and greater risk tolerance for alcohol consumption ($p < .001$) (Table 1). Among youth reporting past-year alcohol use, 84.2% reported use in the past 3 months, of whom 43.5% reported binge drinking. On average, participants reporting past 3-month alcohol use drank 3.7 days in that period. Among past-year alcohol users, 54.5% and 72.9% reported experiencing alcohol- or cannabis-related harms, respectively (Table 1). Cannabis use was reported by more participants in the intervention than the control group (19.8% vs. 12.3%, $p = .037$) (Appendix Table B).

At follow-up, 73.3% of participants who drank in the past year also reported using alcohol in the last 3 months, 74.5% and 71.7% of intervention and control participants respectively ($p = .751$; Table 2). The average number of days consuming alcohol in the past 3 months reported by participants who used alcohol was 4.52. On average, among participants reporting past-year alcohol use, the intervention group reported fewer drinking days in the past 3 months than the control group (4.29 vs. 4.80) but intervention effects were not significant in adjusted analyses (Table 2).

Average number of drinking days in the past 3 months, differed for males and females as a function of exposure to the intervention (Figure 3C, Appendix Table D). In stratified analyses, the predicted mean drinking days of past-year drinkers among females declined from 4.11 at baseline to 3.33 at follow-up in the intervention arm while drinking days increased from 2.82 at baseline to 4.55 at follow-up among the control group (intervention effect rate ratio .50, 95% confidence interval [CI] .25–.99, $p = .046$). In contrast, the average number of days using alcohol in the past 3 months among males increased from 1.19 at baseline to 2.01 at follow-up among the intervention group and decreased from 2.27 at baseline to 1.91 at follow-up among the control group (intervention effect rate ratio 2.01, 95% CI .96–4.22, $p = .064$).

Alcohol-related knowledge and risk tolerance

The average percent correct baseline knowledge score was 64.9% for all participants. Knowledge scores were higher among participants reporting past-year alcohol use (69.9% vs. 63.3%, $p = .013$) (Table 1), and among youth with IBD (scores for T1D, JIA/SLE, and IBD respectively 62.6%, 62.8%, and 70.7%; $p = .016$) (Appendix Table C). There were no differences in knowledge at baseline between the intervention and control groups. At baseline, a large minority (40.2%) of participants agreed with the statement that any alcohol use is risky or dangerous for them (i.e., risk intolerance), with fewer participants who drank reporting risk intolerance than those who did not drink (8.9% vs. 50.2%, $p < .001$) (Table 1). Immediately after viewing the intervention materials, exposed participants reported higher levels of knowledge regarding alcohol's effects on their disease than before viewing the intervention materials (82.75% correct vs. 64.84%), and greater risk intolerance (51.2% vs. 41.5%) (Table 2).

Average knowledge score increased to 73.05% among all participants at follow-up and to 75.90% among participants who consumed alcohol in the past year. Knowledge of alcohol's effects on their disease increased from 64.84% to 76.86% among the intervention group, and from 64.98% to 69.30% among the control group. The increase in knowledge scores from baseline to follow-up was greater for the intervention than control groups (intervention effect β: +7.70 change in score, 95% CI 2.92–12.48, $p = .002$) in adjusted analyses. The percentage of participants reporting risk intolerance at follow-up was 41.4% among all participants and 13.9% among those who reported drinking alcohol in the past year. The percentage of the intervention group reporting risk intolerance increased from 41.5% to 45.4% and decreased from 38.9% to 37.4% in the control group (intervention effects odds ratio [OR] 1.79, 95% CI 1.02–3.13, $p = .043$) in adjusted analyses (Table 2).

In stratified analyses, the predicted mean alcohol-related knowledge among females in the intervention group increased from 64.81% to 78.95% and from 62.09% to 68.44% in the control group (intervention effect β: +7.79, 95% CI 1.57–14.00, $p = .014$). Among males, the predicted mean alcohol-related knowledge increased in the intervention group from 51.21% to 60.74%, and from 55.52% to 57.68% (intervention effect β: +7.38, 95% CI .001–14.75, $p = .050$) (Figure 3A, Appendix, Table D). In female intervention group participants, the predicted probability of reporting risk intolerance increased from 33.43% to 42.56% and from 25.79% to 30.26% in the control group (intervention effect OR 1.18, 95% CI .55–2.55, $p = .670$). In males, the predicted

Table 1
Sample characteristics overall and by past-year alcohol use

	Total		Past-year alcohol use				*p* value
			Yes		No		
	n	%	n	%	n	%	
Total N, %	418	100%	101	24.2%	317	75.8%	
Randomized group							
Control group	211	50.5%	46	45.5%	165	52.1%	.255
Intervention group	207	49.5%	55	54.5%	152	47.9%	
Sociodemographic characteristics							<.001
Age (mean, SD)	16.0	1.4	17.1	1.1	15.7	1.4	
Gender							.796
Male	195	46.7%	44	43.6%	151	47.6%	
Female	218	52.2%	56	55.4%	162	51.1%	
Other/missing	5	1.2%	1	1.0%	4	1.3%	
Race							.082
White	354	84.7%	94	93.1%	260	82.0%	
Black	17	4.1%	3	3.0%	14	4.4%	
Asian	8	1.9%	1	1.0%	7	2.2%	
Other race	37	8.9%	3	3.0%	34	10.7%	
Missing/prefer not to answer	2	.5%	0	.0%	2	.6%	
Ethnicity							.415
Hispanic or Latino	36	8.6%	6	5.9%	30	9.5%	
Non-Hispanic, non-Latino	379	90.7%	95	94.1%	284	89.6%	
Prefer not to answer	3	.7%	0	.0%	3	.9%	
Household composition							.434
Two-parent household	354	84.7%	88	87.1%	266	83.9%	
Other	64	15.3%	13	12.9%	51	16.1%	
Parent college education							.310
College or higher	324	77.5%	82	81.2%	242	76.3%	
Less than college	94	22.5%	19	18.8%	75	23.7%	
Health characteristics							
Emotional distress (PAID score ≥8)	36	8.6%	10	9.9%	26	8.2%	.596
Depression (PHQ ≥3)	23	5.5%	8	7.9%	15	4.7%	.221
Anxiety (GAD ≥3)	41	9.8%	13	12.9%	28	8.8%	.235
Clinic							.441
Endocrinology	192	45.9%	41	40.6%	151	47.6%	
Rheumatology	109	26.1%	30	29.7%	79	24.9%	
Gastroenterology	117	28.0%	30	29.7%	87	27.4%	
Self-rated health, past year							.613
Excellent	62	14.8%	11	10.9%	51	16.1%	
Very good	193	46.2%	48	47.5%	145	45.7%	
Good	108	25.8%	29	28.7%	79	24.9%	
Fair	51	12.2%	13	12.9%	38	12.0%	
Poor	4	1.0%	0	.0%	4	1.3%	
Endocrinology							
Severe hyperglycemia past year	18	9.4%	4	9.8%	14	9.3%	1.000
Severe hypoglycemia past year	10	5.2%	2	4.9%	8	5.3%	1.000
Rheumatology							
Disease flare past year	62	56.9%	20	66.7%	42	53.2%	.204
Gastroenterology							
Disease flare past year	52	44.4%	14	46.7%	38	43.7%	1.000
Substance use							
Past-year cannabis use	67	16.0%	48	47.5%	19	6.0%	<.001
Past-year e-cigarette use	54	12.9%	39	38.6%	15	4.7%	<.001
Past 3-month alcohol use, among past-year users			85	84.2%			
Past 3-month alcohol days, among past-year users (mean, SD)			3.7	4.0			
Binge drink[a] past 3 months, among past 3-month users			37	43.5%			
Substance use harms							
Any alcohol-related harms, past year (among past-year alcohol users)			55	54.5%			
Any cannabis-related harms, past year (among past-year cannabis users)	47	70.1%	35	72.9%	12	63.2%	.431
Alcohol knowledge							
Alcohol knowledge, a scaled score out of 100 (mean, SD)	64.9	25.9	69.9	21.3	63.3	27.0	.013
Alcohol risk intolerance (no. of drinks per occasion risky)							<.001
Any number of drinks per occasion is risky	168	40.2%	9	8.9%	159	50.2%	
>1 drink per occasion is risky	43	10.3%	4	4.0%	39	12.3%	
>2 drink per occasion is risky	75	17.9%	17	16.8%	58	18.3%	
>3 drink per occasion is risky	56	13.4%	24	23.8%	32	10.1%	
>4 drink per occasion is risky	32	7.7%	19	18.8%	13	4.1%	
>5 drink per occasion is risky/alcohol not risky	44	10.5%	28	27.7%	16	5.0%	

Column percentages are shown.
GAD = Generalized Anxiety Disorder scale; PAID = Problem Areas in Diabetes; PHQ = Patient Health Questionnaire.
[a] Binge drink questions were asked among the past 3-month alcohol users, or the past-year alcohol users, who missed past 3-month alcohol use questions. The criteria for binge drink were defined as follows: females 14–17 years old having ≥3 drinks containing alcohol on one occasion; females 18 years old or males/other genders 14–15 years old having ≥4 drinks containing alcohol on one occasion; and males/other genders 16–18 years old having ≥5 drinks containing alcohol on one occasion.

Table 2
Alcohol use outcomes over time, by intervention and control group

	Total		Intervention group		Control group		*p* value[a]	Marginal predictive values[b]				Intervention effects[c]		
								Intervention group		Control group				*p* value[d]
Knowledge[e]	Mean	SD	Mean	SD	Mean	SD		Mean	95% CI	Mean	95% CI	Mean	95% CI	
Baseline	64.91	25.89	64.84	26.24	64.98	25.61	.955	59.69	54.14–65.25	60.47	54.93–66.00			
Postintervention	82.75	22.93	82.75	22.93										
6-month follow-up	73.05	24.95	76.86	23.64	69.30	25.68	.002	71.72	66.25–77.18	64.79	59.35–70.24	7.70	2.92–12.48	.002
Knowledge of past-year alcohol users	Mean	SD	Mean	SD	Mean	SD		Mean	95% CI	Mean	95% CI	Mean difference	95% CI	
Baseline	69.89	21.28	70.52	20.08	69.14	22.84	.747	63.82	54.89–72.76	62.61	52.63–72.58			
Postintervention	85.71	16.64	85.71	16.64										
6-month follow-up	75.90	21.29	77.37	19.93	74.15	22.90	.451	70.67	61.69–79.65	67.61	57.59–77.63	1.84	−7.91 to 11.59	.708
Alcohol risk intolerance[f]	n	%	n	%	n	%		Prob	95% CI	Prob	95% CI	OR	95% CI	
Baseline	168	40.2	86	41.5	82	38.9	.233	33.07	19.49–50.22	36.34	21.89–53.77			
Postintervention[g]	106	51.2	106	51.2										
6-month follow-up	173	41.4	94	45.4	79	37.4	.050	46.16	29.66–63.54	35.66	21.40–53.01	1.79	1.02–3.13	.043
Alcohol risk intolerance past-year alcohol users[h]	n	%	n	%	n	%		Prob	95% CI	Prob	95% CI	OR	95% CI	
Baseline	9	8.9	5	9.1	4	8.7	.900	4.08	1.19–13.06	2.53	.62–9.71			
Postintervention[i]	10	18.2	10	18.2										
6-month follow-up	14	13.9	9	16.4	5	10.9	.111	6.40	1.99–18.70	2.44	.60–9.37	1.67	.56–4.97	.355
Past 3-month alcohol use[j] (past-year users only)	n	%	n	%	n	%		Prob	95% CI	Prob	95% CI	OR	95% CI	
Baseline	85	84.2	45	81.8	40	87.0	.481	80.67	49.20–94.73	89.48	59.546–98.01			
6-month follow-up	74	73.3	41	74.5	33	71.7	.751	69.39	36.46–89.96	67.22	31.01–90.34	2.25	.39–12.89	.358
Past 3 months, the number of alcohol days[k] (past-year users only)	Mean	SD	Mean	SD	Mean	SD		Mean	95% CI	Mean	95% CI	Rate ratio	95% CI	
Baseline	3.72	4.04	3.62	4.08	3.85	4.03	.322	2.29	1.34–3.90	2.62	1.47–4.69			
6-month follow-up	4.52	4.60	4.29	4.44	4.80	4.81	.707	2.80	1.65–4.74	3.04	1.69–5.47	1.05	.63–1.77	.842

[a] *p*-values compare the intervention versus control arms within a single time point.
[b] Predicted population margins were computed based on the regression models.
[c] The estimates represent the difference in the change over time for the intervention versus the control arm, respectively. This indicates if effect of the intervention differed by arm.
[d] *p*-values compare the intervention effect between intervention versus control arms over time (control group as a reference group).
[e] Knowledge scaled score indicates the percentage of questions answered correctly out of 100. Intervention effect on the score was modeled with mixed effect models assuming a normal distribution. Beta coefficients were shown as the intervention effect over time comparing the two arms.
[f] Probability of having higher risk intolerance categories was modeled using a cumulative logit link with multinomial distributions. Intervention effects were described as adjusted odds ratios comparing the two arms over time instead of the beta coefficients. Level 0: any number of drinks per occasion is risky; Level 1: >1 drink per occasion is risky; Level 2: >2 drink per occasion is risky; Level 3: >3 drink per occasion is risky; Level 4: >4 drink per occasion is risky; and Level 5: >5 drink per occasion is risky/alcohol not risky.
[g] Postintervention denominator N = 207.
[h] Denominator N = 101.
[i] Denominator N = 55.
[j] Past 3-month alcohol use was modeled with a binomial distribution using a logit link. Adjusted odds ratios comparing the two arms over time are shown instead of beta coefficients.
[k] The number of days using alcohol during the past 3 months (range 0–90 days) was modeled with a negative binomial distribution using a log link. Adjusted rate ratios comparing the two arms over time were shown as the intervention effect instead of beta coefficients.

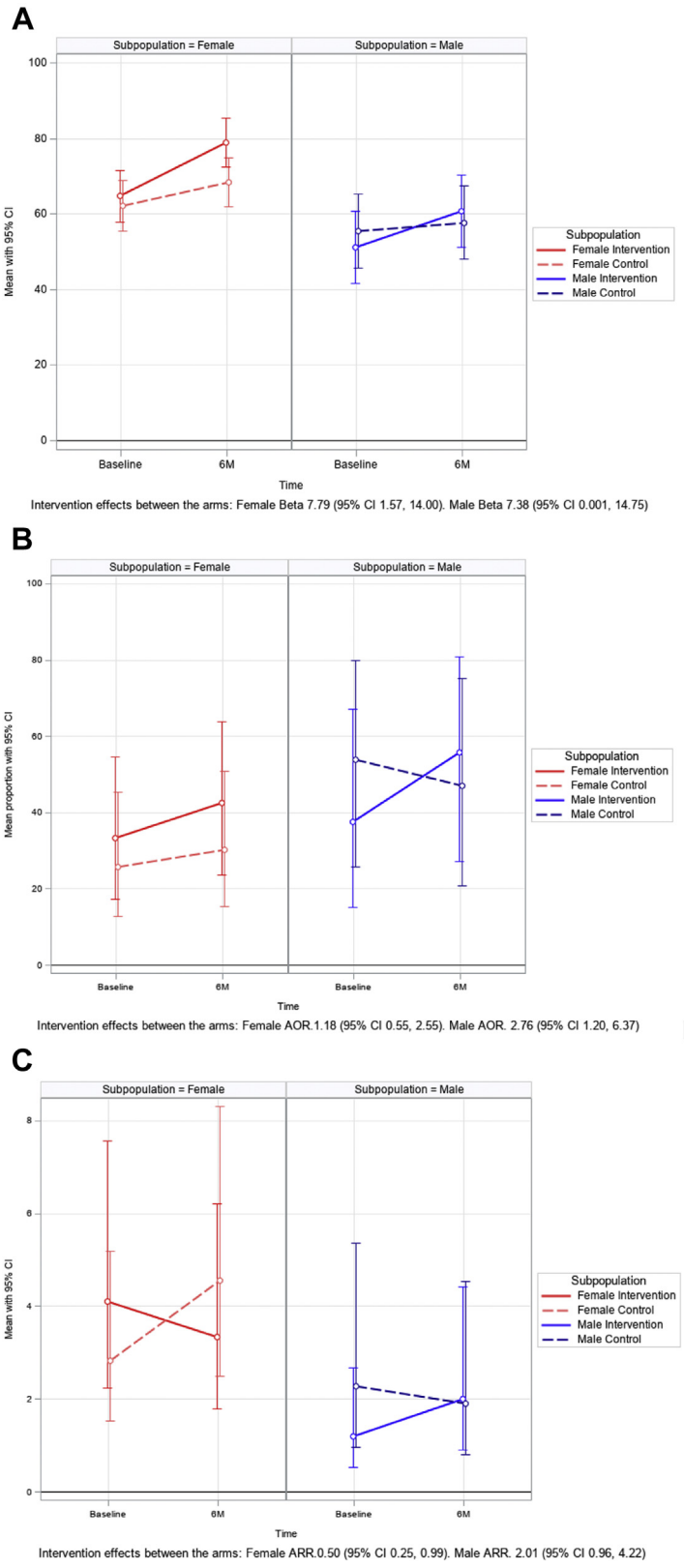

Figure 3. Panels illustrate gender stratified results of intervention effects on (A) predicted mean alcohol-related knowledge; (B) predicted probability of reporting alcohol-related risk intolerance; and, (C) predicted frequency of drinking days.

probability of reporting of risk intolerance increased from 37.58% to 55.66% among the intervention group and decreased in the control group from 54.04% to 47.01% (intervention effect OR 2.76, 95% CI 1.20–6.37, $p = .017$) (Figure 3B, Appendix, Table D).

Discussion

In this first test of an alcohol use preventive intervention targeting adolescents with chronic medical conditions, we observed positive impacts of a novel psychoeducational intervention on alcohol use–related knowledge, perceived risk, and, for female drinkers, frequency of alcohol use. Findings build on a growing body of work that identifies the prevalence and problems associated with alcohol use by medically vulnerable youth, and their responsiveness to concerns regarding maintaining their health and avoiding disease exacerbations, toxicities, and complications. Participants reported high prevalence levels of alcohol as well as cannabis use (the latter was not a focus of the intervention), and, among YCMC who used alcohol, high prevalence levels of harms related to alcohol as well as cannabis, underscoring the need for preventive intervention. The large percentage of adolescents growing up with a chronic illness coupled with the potential for ameliorating preventable harms among them, suggest that taking a disease-tailored approach to alcohol use prevention may yield high public health impact. Such an approach fits into the SBIRT model; the electronic brief intervention is scalable and can be widely disseminated.

Findings revealed reductions over time in the frequency of alcohol use among female but not male drinkers, and strong impacts on knowledge and risk perception in the planned directions for *all* intervention arm participants. Large favorable impacts on secondary outcomes observed immediately after viewing the intervention attenuated somewhat by the 6-month follow-up, but positive changes in the intervention group were still greater than those observed in the control group. This is significant given the low dose of the intervention, which was brief and self-administered. Fostering an enduring internalized awareness of the importance of limiting alcohol use for their chronic illness may be helpful for medically vulnerable adolescents who are faced with the task of maintaining effective lifelong disease management practices and health protecting behaviors.

As noted, females showed a consistent pattern of treatment response for both primary and secondary outcomes, while males showed favorable intervention impacts on secondary outcomes only (Figure 3A–C, Appendix Table D). Gender differences in intervention effects are not entirely surprising as females have been shown to respond more readily than males to some psychoeducational interventions, and may be less committed drinkers [31,32]. Prior qualitative work found that medically vulnerable males and females had somewhat different safety concerns about alcohol use [13]. In this trial, the ability to detect significant declines in drinking days among the restricted samples included white/non-Hispanics only, a step taken to reduce sample heterogeneity, limit variance, and preserve power. Future work with a larger more heterogeneous sample is needed to better understand the impacts and reach the intervention across a diverse set of conditions and populations. Given gender differences, it will be important to consider how the design of the intervention materials might be improved to better reach males whose knowledge and sense of perceived risk but not alcohol use behaviors were favorably impacted.

The intervention was particularly effective in changing knowledge and attitudes, in line with the "low dose" prevention approach of the model. Future work might test whether boosting the intervention with reinforcing materials at a subsequent date (e.g., via text messaging), or using it to inform a clinical conversation during the visit, will increase the salience and "stickiness" of the intervention's effects on all outcomes over time including among youth who may have already begun using alcohol.

Findings extend work from a pilot trial that tested the effects of a college student focused version of the TGC intervention [29,30]. The college student trial tested the acceptability and near term (two week) impacts on alcohol use and binge drinking of two competing versions of the TGC intervention in an uncontrolled trial. That study delivered to college students with T1D the TGC intervention with pre-recorded audio-video narration by either a diabetes peer educator or a pediatric endocrinologist (versions delivered randomly), to understand the value of different narrative frames. High levels of acceptability to the intervention in both forms were found, along with some indication that provider framed content may be more credible hence impactful. Findings also showed sharp declines in binge drinking among participants regardless of exposure to peer or provider narrated versions.

Limitations

Positive results from this first trial of a novel psychoeducational intervention to reduce alcohol use among medically vulnerable adolescents should be viewed considering the study's limitations. We recruited adolescents from three chronic illness areas at a single institution and results are not generalizable. Adolescents with more serious levels of alcohol use could have opted not to participate in the trial or may not have come to the clinic at all. Survey self-reports are subject to recall and reporting biases, known limitations for prevention trials. Knowledge and perceived risk measures were developed through formative research with multistakeholder input; however, they are not validated scales. Sample size limited the investigation of the intervention's effects among some subgroups.

Conclusion

Alcohol use is a serious problem among youth with a chronic medical condition. Intensifying the SBIRT model for this group via exposure to a chronic-illness tailored psychoeducational intervention targeting alcohol use, increased knowledge, perceived risk, and among females, reduced the frequency of alcohol use. Promising results merit future work to optimize the model, individualizing for both males and females.

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Supplementary Data

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