Changes over time in young adults' harmful alcohol consumption: A cross-temporal meta-analysis using the AUDIT

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Abstract

Background: Recent studies suggest that young adult participation in, and volume of, alcohol consumption has decreased. However, the evidence on trends in harmful alcohol consumption in this age group is limited. The current paper aims to examine changes over time in harmful alcohol consumption using a robust, widely employed measure.

Methods: The literature was systematically searched for articles reporting on Alcohol Use Disorders Identification Test (AUDIT) scores in young adults aged 18-24 years. The key data extracted were year of measurement and mean AUDIT score (proportion above clinical cut-off was not relevant for these analyses). Cross-temporal meta-analysis was applied to the extracted data.

Results: A decrease was found in young adults' AUDIT scores measured between 1989 and 2015 (b=-0.13, β=-0.38, p=0.015, 95% CI=-0.24, -0.03), representing a 0.63 standard deviation change over this period. Variance did not change over this time, suggesting scores decreased equally over the distribution.

Conclusions: Results indicate that harmful alcohol consumption in young adults may have declined between 1989 and 2015. Despite the continued problems posed by dependence and short and long-term harms, these promising findings offer hope that the considerable alcohol-related disease burden in this age group may be reduced. Ongoing data collection is required to evaluate whether these declines in young adulthood persist into later life, and future research should explore the reasons for declining harmful alcohol consumption in young adults.

Keywords: alcohol consumption; alcohol-related harm; young adult; meta-analysis; trends

1. Introduction

Alcohol use is one of the leading contributors to the burden of disease worldwide, and for those aged 15 to 49 years it is the largest risk factor for death and disability (Griswold et al., 2018), with harmful patterns of alcohol consumption established early in the life course. However, epidemiological research indicates that alcohol consumption has been decreasing in Western countries. From 1990 to 2017, volume of consumption per capita for adults significantly decreased in Australasia and Western Europe, and showed a downward trend in Central and Eastern Europe (Manthey et al., 2019). While drinking participation rates increased in North America between 1990 and 2017, per capita alcohol consumption remained stable, indicating that those who do consume alcohol are consuming less (Manthey et al., 2019).

Although young adults – generally defined as 18-24 years – tend to have the lowest alcohol abstinence rates in absolute terms (Livingston et al., 2016), age-period-cohort analyses in countries such as Australia (Livingston et al., 2016), Great Britain (Meng et al., 2014), Sweden (Kraus et al., 2015) and Russia (Radaev and Roshchina, 2019) have begun to show decreased drinking participation among more recent cohorts of young adults. In Australia, past-year abstinence among those aged 18-24 years rose from 11% in 2004 to 19% in 2016 (Australian Institute of Health Welfare, 2017), and in this same age group in England, current abstinence increased from 15% in 2005 to 24% in 2015 (Ng Fat et al., 2018). Similarly, in the US, the proportion of college entrants who drank wine or beer at least occasionally decreased consistently between 1985 and 2016 (Twenge and Park, 2019). Lifetime, annual, and past 30-day consumption also declined for both college-enrolled and non-student young adults (19-28 years) in the US from 1987 to 2015 (Johnston et al., 2016).

Volume of consumption, too, appears to have declined in this age group. For example in Australia, young adults born in the early-to-mid 1990s reported markedly lower annual consumption than young adults born twenty years prior (Livingston and Vashishtha, 2019), and drinkers in more recent cohorts in Great Britain are also consuming less (although not significantly so for women; Meng et al., 2014).

However, a limitation of the extant research is that measures of consumption focusing on participation/abstinence rates and volume of intake fail to capture changes in harmful alcohol consumption. While these data do exist, harmful alcohol consumption is loosely defined and conceptualised across studies, with indicators of change often derived from narrow and disparate measures. This is also reflected in the use of varying terminology in the literature (Roche, 2009)

Harmful alcohol consumption has been conceptualised by some as ‘risky’ or ‘hazardous’ drinking, which could refer to short or long-term engagement in heavy, frequent or binge drinking, or else to exceeding volume and frequency thresholds that align with a specific level of risk for alcohol-related injury and disease. Alternatively, others have conceptualised harmful alcohol consumption as actual alcohol-related harms, such as acute and chronic harms to mental and physical health, social consequences of drinking, meeting criteria for alcohol dependence or abuse, or population-level outcomes like hospital presentations or alcohol-related road traffic accidents.

Further, the way data has been collected and analysed has changed over time, including between-wave alterations to survey methodologies (Livingston and Vashishtha, 2019), as well as changes to whether an injury or presentation is recorded as alcohol-related (Livingston, 2008). Moreover, the popularity of survey instruments and procedures for deriving population-level data vary within and across countries. Instruments may vary when incorporating country-specific definitions of standard drinks or risky drinking thresholds (Livingston and Vashishtha, 2019), and often differ in the period of preceding time to which a given measure’s questions about alcohol consumption refer, which may impact responses (World Health Organization, 2000).

These issues make data aggregation and comparison problematic, and it is perhaps for this reason that trends in this area are unclear. For example, a recent study of a US sample (aged 18-29 years) found increases in the prevalence of past-year high-risk drinking (exceeding daily drinking limits at least weekly) and of DSM-IV alcohol abuse or dependence (Grant et al., 2017). A 2011 systematic review of studies from multiple countries also found increases in alcohol-related problems among younger birth cohorts (for most studies this meant meeting criteria for abuse or dependence; Keyes et al., 2011).

On the other hand, Livingston and Vashishtha (2019) found that various survey-based measures of risky drinking had declined in many high-income Western countries for young adults over the last 10 to 15 years. The authors, however, stressed caution in interpreting the data on aggregate because of the heterogeneity of measures used, which include heavy episodic drinking, single occasion risky drinking, long-term risky drinking, and drinking above country-specific acute or chronic guidelines.

There is a clear need for analyses of more stable, uniform measures of harmful consumption. This research question is especially important, as identifying trends in alcohol consumption is a crucial first step in elucidating temporal or cohort-specific influences that drive drinking behaviour (Keyes et al., 2011; Slade et al., 2016), and understanding changes in harmful alcohol consumption is key to informing prevention, treatment and public health policy (Keyes et al., 2011; Livingston et al., 2016). This is particularly true for young people, where evidence suggests patterns of consumption in youth are predictive of alcohol-related problems in adulthood (McCambridge et al., 2011).

Data from a variety of samples measured consistently over time against one common metric is required for a robust analysis of trends in young adults' harmful alcohol consumption. The 10-item Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993) provides a promising target for analysis of changes over time. The AUDIT was developed as a screener for hazardous and harmful consumption, which means it detects consumption consistent with being at risk for physical/psychological harms as well as consumption that has already resulted in such harms. While this means the AUDIT reflects a broad conception of harmful alcohol consumption, key here is that it is a uniform, stable instrument that allows for comparison across samples and over time – obviating the need to compare narrow, disparate findings dependent on time and place of measurement.

The AUDIT is designed to identify less severe or less established harmful consumption (Saunders et al., 1993), meaning it is particularly well suited to young adults, who may not yet display the severe dependence or harms that other instruments or population-level data aim to capture. The AUDIT demonstrates strong psychometric properties, is well-established and, importantly for the purposes of this research, is widely utilised in the literature (Reinert and Allen, 2007).

The present study will examine changes over time in harmful alcohol consumption, as measured by the AUDIT. To do so, a systematic search of the literature will be conducted to identify studies that have administered the AUDIT, and cross-temporal meta-analysis (CTMA) will be applied to the extracted data. CTMA (Twenge, 1997a, b) is used to compare scores on a given instrument for different generations taken at the same age/age range, thus capturing both cohort and time period variance (together comprising "generational change"; Campbell et al., 2015).

Unlike standard meta-analytic techniques which compare effect sizes, CTMA examines how the mean score on a specific metric has changed over time; regressing mean scores on year of data collection. As such, in contrast to its application as a screening instrument where cut-off scores are the value of interest, the present study – focused on broader generational change – will utilise AUDIT means. CTMA enables the calculation of an overall effect size representing the magnitude of change over time. Other benefits of CTMA are that it eschews retrospective reporting (Twenge et al., 2010) and allows for weighting by sample size and variance. These weightings allow larger samples, which are more likely to reflect the population, to have a greater contribution.

The aim of this research is to assess changes over time in the degree to which young adults have been engaging in harmful alcohol consumption, using up-to-date data derived from a systematic search for all available research.

2. Methods

2.1. Literature search and study inclusion

The literature was searched for all published studies using the AUDIT or AUDIT-C scales for adolescents and/or young adults. For the purposes of comparison, we also sought to apply these same methods to examine trends in adolescent harmful alcohol consumption, as well as changes in alcohol intake itself via the three-item AUDIT Alcohol Consumption Questions (AUDIT-C; Bush et al., 1998). The AUDIT-C consists of the first three items of the AUDIT and measures average quantity, frequency and heavy episodic drinking.

Systematic searches of the Medline, EMBASE and PsycInfo databases were performed in July 2017. The search strategy involved combining terms related to alcohol use and AUDIT or AUDIT-C scales (see Table S1 for Medline search terms). The search was limited to research papers and English language publications. Search terms related to age were not employed to ensure that articles containing data on young people were not incorrectly excluded.

2.2. Inclusion and exclusion criteria

Papers were included if they contained data that: 1) allowed for AUDIT or AUDIT-C means and standard deviations to be extracted or calculated; 2) were specific to those aged 12-17 years or 18-24 years (or parts thereof); 3) included at least 10 participants; 4) contained both males and females; 5) did not exclude abstainers; 6) was gathered from an unselected group/general population (i.e., no specific or clinical populations except for age-based or school or college students); 7) was reported as part of an original research paper and not reported elsewhere previously; 8) was not part of a thesis or dissertation; 9) was reported in English. For the purposes of this study, college or university samples with age ranges that included mature age students were retained, given most individuals in these samples belonged to the young adult range of interest. In other cases, samples where the age range exceeded the relevant age category by more than one year were excluded (e.g., 10-16 years).

2.3. Data screening

After duplicates were removed, combined records numbered 2,584. The titles and abstracts of these were screened for relevance by one of the study authors (RV). A total of 511 full text articles were then retrieved and examined against the inclusion criteria by three of the study authors (RV, KP and LM).

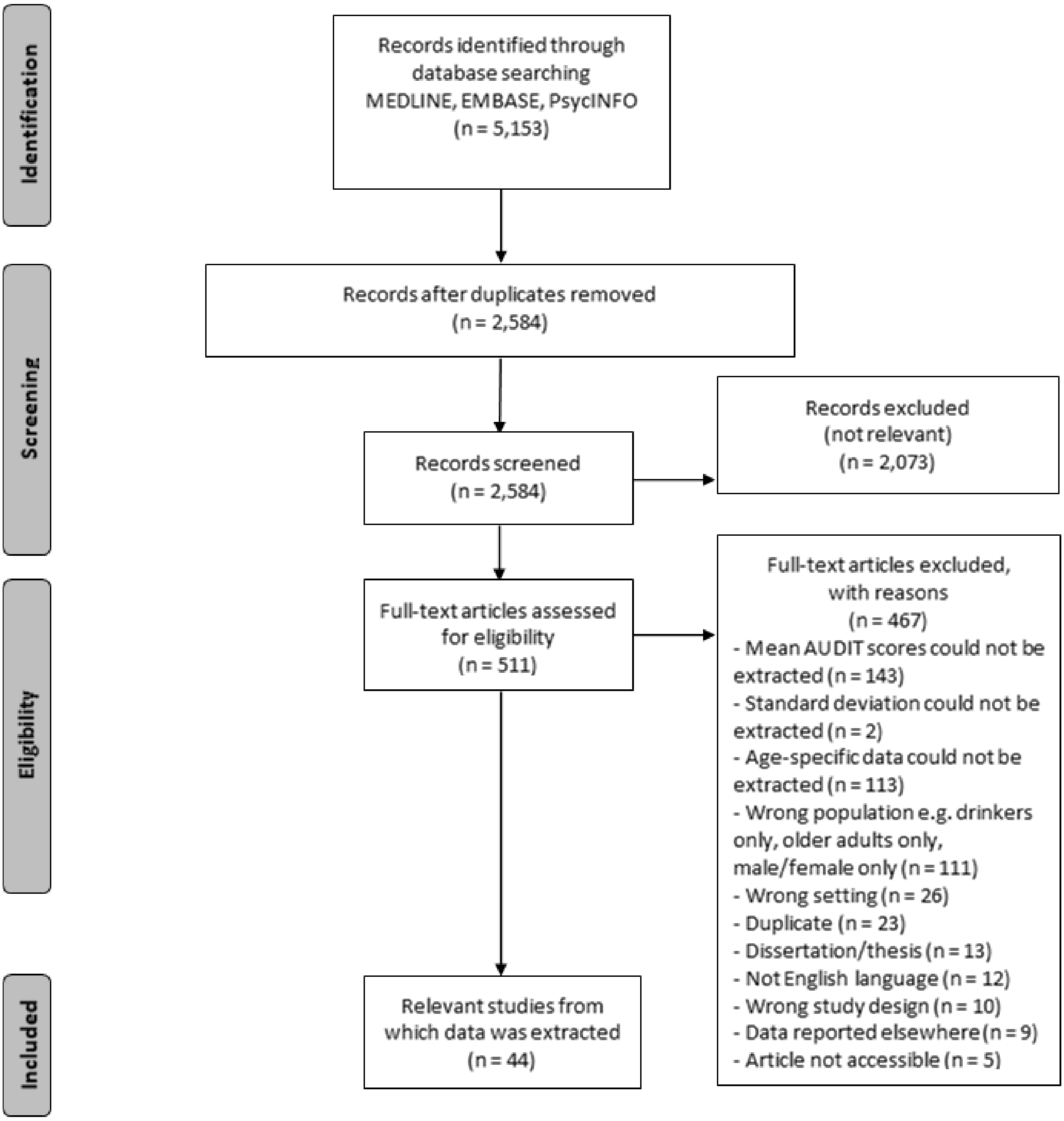

Identification
Screening
Eligibility
Included
Records identified through database searching MEDLINE, EMBASE, PsycINFO (n = 5,153)
Records after duplicates removed (n = 2,584)
Records screened (n = 2,584)
Records excluded (not relevant) (n = 2,073)
Full-text articles assessed for eligibility (n = 511)
Full-text articles excluded, with reasons (n = 467)
- Mean AUDIT scores could not be extracted (n = 143)
- Standard deviation could not be extracted (n = 2)
- Age-specific data could not be extracted (n = 113)
- Wrong population e.g. drinkers only, older adults only, male/female only (n = 111)
- Wrong setting (n = 26)
- Duplicate (n = 23)
- Dissertation/thesis (n = 13)
- Not English language (n = 12)
- Wrong study design (n = 10)
- Data reported elsewhere (n = 9)
- Article not accessible (n = 5)
Relevant studies from which data was extracted (n = 44)

Figure 1. *Preferred reporting items for systematic reviews and meta-analyses (PRISMA) diagram of search and study selection.*

2.4. Data extraction

To perform the CTMA, the mean AUDIT/AUDIT-C score, standard deviation, and year of data collection were extracted using a standardised data extraction form. Consistent with previous analyses, year of data collection was coded as two years prior to publication date if not otherwise specified (Twenge, 2000). Where multiple measurements of the same sample were taken, only the baseline/first measurements were extracted (there was only one such study). If multiple independent samples were reported in the same paper, each were extracted separately (reflected in Table 1 with ‘a’/’b’). Where means or standard deviations were reported for subgroups only (e.g., for males and females separately), overall means and standard deviations were calculated.

2.5. Final sample

The systematic literature search returned 44 studies providing data that met the inclusion criteria (see Figure 1). Two papers contained two independent sets of relevant data, yielding a total of 46 individual samples (37 young adult, 19 adolescent). Seven of these samples provided AUDIT-C data, 36 provided AUDIT data, and three provided both. This resulted in 39 AUDIT samples in total (32 young adult, seven adolescent), and 10 AUDIT-C samples in total (eight young adult, two adolescent). While analyses were planned for both adolescent and young adult groups, as well as for both AUDIT and AUDIT-C means (four regressions in total), the search did not return adequate adolescent samples for either measure nor enough young adult AUDIT-C data. As such, studies that provided AUDIT-C data only were removed, as were the adolescent AUDIT samples. This left 32 young adult AUDIT samples collected between 1989 and 2015, comprising 25,191 individuals (see Table 1 for full details).

Table 1

Information for studies included in the cross-temporal meta-analysis (n=32).

Study first author (year)	Year data collected	Sample type	Country	*N*	Mean	SD	*w*
Fleming (1991)	1989	U	United States	989	9	5.8	29.40
Clements (1998)	1996	U	United States	306	3.9	3.8	21.19
Lennings (1998)	1996	U	Australia	183	7.5	5.9	5.26
Kypri (2002)	2000	U	New Zealand	1480	8.92	6.82	31.82
Stahlbrandt (2007)	2000	U	Sweden	556	9.8	5	22.24
Andersson (2007)	2003	U	Sweden	2032	7.29	4.65	93.98
Kills Small (2007)	2005	U	United States	88	9.24	6.18	2.30
O'Brien (2010)	2005	U	Australia	1028	10.13	6.59	23.67
Blomeyer (2013)	2006	CS	Germany	268	4.55	4.26	14.77
Zverev (2008)	2006	U	Malawi	787	8.30	8.10	12.00
Hallett (2012)	2007	U	Australia	7237	7.40	6.43	175.04
Young (2008) a	2007	U	South Africa	2049	8.94	7.20	39.53
Balodis (2010)	2008	U	Canada	90	7.66	5.42	3.06
Young (2010)	2008	U	South Africa	318	8.23	6.57	7.37
Young (2008) b	2008	U	South Africa	1119	8.84	6.90	23.50
Moreno (2012)	2009	U	United States	224	5.80	4.90	9.33
Olthius (2011)	2009	U	United States	1555	6.10	5.90	44.67
Prat (2011)	2009	U	Spain	517	4.53	3.80	35.80
Claros (2010)	2010	U	United States	199	4.67	4.38	10.37
Ridout (2012)	2010	U	Australia	158	9.43	6.05	4.32
Kreusch (2013)	2011	U	Belgium	61	8.93	5.37	2.16
MacKillop (2013)	2011	U	United States	354	6.57	5.23	12.94
Young (2013)	2011	U	United States	200	5.33	5.05	7.84
Choi (2015)	2013	U	South Korea	448	13.34	7.99	7.02
Snipes (2015)	2013	U	United States	751	4.83	5.39	25.85
Whitney (2015)	2013	U	United States	62	8.55	6.11	1.66
Baranger (2016)	2014	U	United States	727	4.85	3.76	51.42
Lindgren (2016) a	2014	U	United States	360	5.22	4.89	15.06
Lindgren (2016) b	2014	U	United States	450	5.37	4.76	19.86
Marczinski (2016)	2014	U	United States	146	6.19	4.61	6.87
Brunelle (2017)	2015	U	Canada	175	7.30	5.11	6.70
Pereira-Morales (2017)	2015	U	Colombia	274	4.70	4.30	14.82

Notes: U = university sample; CS = cohort study (specifically, the Mannheim Study of Children at Risk); *w* = inverse of the sample variance.

2.6. Cross-temporal meta-analysis (CTMA)

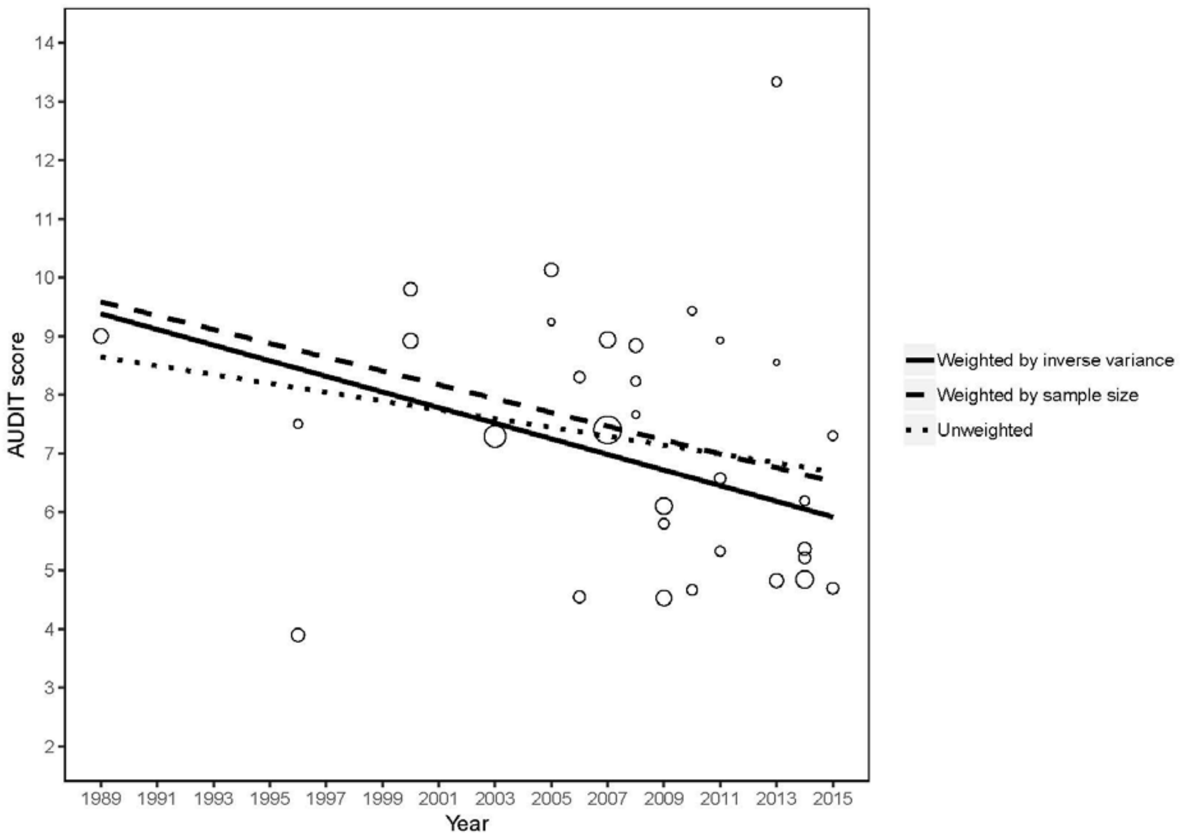
Consistent with previous CTMAs, we calculated simple correlations between mean AUDIT scores and year of data collection, as well as bivariate regressions weighted by sample size and the inverse of the sample variance (*w*) (Mackenzie et al., 2014; Twenge and Campbell, 2001; Twenge et al., 2004). The variance was calculated by multiplying the within-study standard deviation by 1/n of that study, and this number was then inverted to produce *w*. Sensitivity analyses were also performed where the data was winsorized so that mean AUDIT outliers beyond the 5th and 95th percentiles were brought up/down to these limits.

To determine the size of the effect, a magnitude of change score/cross-temporal effect size (*d*) was calculated. Using the regression equation weighted by *w*, AUDIT scores for the earliest and latest years were computed, and subtracting the former from the latter, a difference score was produced. This difference score was then divided by the average standard deviation for all studies (i.e., the mean of study standard deviations and not an overall standard deviation based on sample means, avoiding the ecological fallacy; Twenge et al., 2004), yielding the effect size. Analyses were conducted with R (version 3.5.1) using the packages DescTools (Signorell et al., 2019; to perform winzorisation) and QuantPsyc (Fletcher, 2012; to obtain standardised betas), the script for which is available in the supplementary material. The package ggplot2 (Wickham, 2016) was used to generate the figure.

3. Results

3.1. Mean scores and year

There was a negative correlation between mean AUDIT score and year of data collection (r=-0.21, p=0.239, 95% CI=-0.52, 0.15). Bivariate linear regressions displayed a stronger relationship when weighted by sample size (b=-0.12, β=-0.34, p=0.042, 95% CI=-0.23, -0.00) and by inverse variance (b=-0.13, β=-0.38, p=0.015, 95% CI=-0.24, -0.03), indicating that young adults' harmful alcohol consumption decreased between 1989 and 2015 (Figure 2). Adding a quadratic term (year*year) to evaluate the non-linear relationship between harmful alcohol consumption and time did not improve the model [weighted by inverse variance; F(1,29)=2.18, p=0.150]. Sensitivity analyses using winsorized data did not result in a change of size nor direction of effect for the unweighted correlation (r=-0.31, p=0.080, 95% CI=-0.60, -0.04) or linear regressions (weighted by sample size: b=-0.14, β =-0.44, p=.007, 95% CI=-0.23, -0.04; weighted by inverse variance: b=-0.14, β =-0.47, p=.004, 95% CI=-0.24, -0.05). Sample standard deviations did not change over this period (r=-0.13, p=0.48, 95% CI=-0.46, 0.23).



14
13
12
11
10
9
8
7
6
5
4
3
2
AUDIT score
1989
1991
1993
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1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
Year
Weighted by inverse variance
Weighted by sample size
Unweighted

Figure 2. *Mean AUDIT scores for young adults between 1989-2015. Larger data points reflect larger inverse variance for the sample.*

3.2. Magnitude of change

The magnitude of change (*d*) was calculated using the regression equation weighted by inverse variance (unstandardized beta=-0.13, intercept=274.40). This produced an estimated AUDIT score for the year 1989 of 9.38 and for 2015 of 5.92. The difference score (-3.46) divided by the average standard deviation yielded an effect size of -0.63, representing a 0.63 standard deviation decrease in young adults' AUDIT scores over the 26-year period. This is a medium-to-large effect size according to Cohen's guidelines (Cohen, 2013).

3.3. Restricting analyses to US samples

As the country contributing the most samples, analyses were also performed separately for US studies (14 samples; 6411 individuals). As in the main analyses, the unweighted correlation displayed a negative relationship (r=-0.33, p=0.255, 95% CI=-0.73, 0.25), growing stronger when weighted by sample size (b=-0.13, β=-0.56, p=0.003, 95% CI=-0.20, -0.05) and inverse variance (b=-0.10, β=-0.45, p=0.027, 95% CI=-0.19, -0.01) in bivariate regressions (see Figure S1). Visual inspection of the plotted data points did not suggest the presence of outliers, so winsorization was not performed. Adding a quadratic term did not improve the model [weighted by inverse variance; $F(1,11) = 1.51$, p=.245]. Again, as for the full sample, sample standard deviations did not change over this period (r=-.12, p=.689, 95% CI=-0.61, 0.44).

Using an unstandardized beta of -.10, an intercept of 206.63, and the year range 1989-2014, the magnitude of change was estimated to be -.49, representing a .49 standard deviation decrease in US young adults' alcohol use over the 25-year period. This is a medium effect size according to Cohen's guidelines (Cohen, 2013).

4. Discussion

To the best of the authors' knowledge, this study provides the first analysis of changes over time in young adults' harmful alcohol consumption as captured by a stable, widely employed instrument, and based on a systematic search for all available data. Harmful consumption in this age group, as measured by the AUDIT, appears to have decreased from 1989 to 2015. Sample standard deviations did not change significantly over time, suggesting that harms decreased equally over the distribution (Twenge et al., 2010).

Our findings are consistent with previously reported declines in drinking participation and volume of consumption in this age group. Together, this is preliminary evidence that, in addition to abstaining more and drinking in smaller volume, young adults are engaging in less harmful alcohol consumption. These encouraging findings offer hope that the considerable alcohol-related disease burden in this age group may be alleviated. Future assessment of harmful alcohol consumption is needed to determine whether subsequent cohorts of young adults continue this trend.

Ongoing data collection is also required to evaluate whether lower harmful consumption in young adulthood persists into later life. However, given that existing research already suggests youth alcohol consumption is associated with later drinking behaviour and health, the present findings may herald improved outcomes extending into adulthood for more recent cohorts of young adults.

That said, it should be noted that the present findings largely reflect trends in immediate or short-term consequences of drinking. As such, while the kind of alcohol consumption that presents a risk to functioning and health in the short term may have declined, it is possible that the harms that accumulate more slowly and present later in life, such as physical health conditions to which alcohol contributes, will still accrue.

While the present study sheds no light on *why* harmful alcohol consumption in young adults may be declining, reasons proffered by other researchers for decreasing consumption in young people more generally include delays in initiation to consumption, a greater understanding of the harms caused by alcohol, increased digital socialising, and health promotion efforts/prevention programs (Ng Fat et al., 2018; Pennay et al., 2015). Changes in availability and pricing policy may also contribute to consumption trends but are less applicable to the present research given the policy variation across included countries. Future research should examine the factors driving decreases in harmful alcohol consumption in young adults.

The strength of this study lies in the novel approach employed to address this research question. Analysis of a robust measure of harmful alcohol consumption means the present findings make an important contribution to the existing literature, which thus far has been limited by the use of disparate, unstable measures of specific outcomes that are difficult to compare. Applying the CTMA method allowed for analysis of a common metric over time, with the additional advantages of enabling the incorporation of sample size and variance, and the production of an overall estimate of the magnitude of change over time.

Despite these methodological merits and the important implications of this study, several limitations should be noted. While the robust nature of the AUDIT was a strength, its breadth obscures whether declines have occurred across the AUDIT's three dimensions of volume/frequency of consumption, dependence, and adverse consequences. That is, it is possible that AUDIT score trends could be masking more specific, diverging trends – which may partially explain the inconsistent findings to date in this area. Importantly though, the inclusion of questions reflecting these three dimensions was deemed optimal for constructing a general purpose tool to detect risk for, and actual, alcohol-related harms (Saunders et al., 1993).

The AUDIT has been used widely in the decades since its development, providing this study with samples spanning 26 years and 12 countries. However, as previous CTMA studies have found (Twenge, 2001), many papers that would have otherwise provided data meeting inclusion criteria failed to report means, instead reporting on the proportion of participants meeting diagnostic cut-offs. This resulted in a small sample size for the present study, and also meant it was not possible to examine changes in AUDIT-C scores, or corresponding trends in adolescents.

Contributing the most samples of any individual country, subgroup analyses were performed for the US samples, producing similar results to the main analyses. Apart from this analysis, the number of samples prevented thorough examination of geographic exposures. While the included countries were overwhelmingly high-income Western ones, the present study would have benefited from such analyses, as the same kinds of temporally variant environmental factors assumed to drive consumption trends also vary across countries. However, it is important to note that the sample size (and year spread) was appropriate for the analysis that was employed, being comparable to previous CTMAs (Donnelly and Twenge, 2017; Wegman et al., 2018).

Additionally, given relatively few samples from earlier years of the 1989-2015 range, analyses relied disproportionally on later data points. And while the AUDIT's strength lies in it being a stable, uniform measure, potential response biases may mean that apparent changes in the nature of consumption over time to some extent reflect changes in the reporting of alcohol consumption instead (Keyes et al., 2011), in addition to secular changes in drink sizes and strengths.

The data were also overwhelmingly collected in university samples, so it is possible that the present findings do not extend to non-student young adults. One series of US surveys sampling both student and non-student young adults did find decreases in both groups from 1980 to 2015 on various measures of alcohol consumption, but trends were more closely synchronised for some measures of consumption (e.g. annual prevalence) than others (e.g. past 30-day daily use; Johnston et al., 2016).

Finally, despite CTMA's strengths, it cannot separate the effects of cohort and time period (Rudolph et al., 2018). That is, our results indicate AUDIT scores have decreased in young adults, but to what extent this is due to cohort-specific factors or to broader temporal exposures is unclear. CTMA has also been criticised for systematically misestimating effect sizes, and for assuming that cohort changes are necessarily evident in changes in group means over time (Rudolph et al., 2018).

5. Conclusions

Alcohol consumption in young people is a pressing public health issue, leading to high rates of dependence, short- and long-term harms, and considerable disease burden. While still an area of significant concern, the present findings indicate that harmful alcohol consumption, as measured by the AUDIT, appears to have decreased for young adults from 1989 to 2015. This offers hope for a reduced alcohol-related disease burden in this age group, and the potential for improved drinking and health outcomes as these cohorts age.

References

Andersson, C., Johnsson, K.O., Berglund, M., Ojehagen, A., 2007. Alcohol involvement in Swedish University freshmen related to gender, age, serious relationship and family history of alcohol problems. Alcohol & Alcoholism 42(5), 448-455.

Australian Institute of Health Welfare, 2017. National Drug Strategy Household Survey 2016: Key Findings: Online data tables. Drug Statistics series no. 31. Cat. no. PHE 214. AIHW, Canberra.

Balodis, I.M., Lockwood, K.P., Magrys, S.A., Olmstead, M.C., 2010. Preference conditioning in healthy individuals: correlates with hazardous drinking. Alcoholism: Clinical & Experimental Research 34(6), 1006-1012.

Baranger, D.A.A., Ifrah, C., Prather, A.A., Carey, C.E., Corral-Frias, N.S., Conley, E.D., Hariri, A.R., Bogdan, R., 2016. PER1 rs3027172 genotype interacts with early life stress to predict problematic alcohol use, but not reward-related ventral striatum activity. Frontiers in Psychology 7, 464.

Blomeyer, D., Buchmann, A.F., Lascorz, J., Zimmermann, U.S., Esser, G., Desrivieres, S., Schmidt, M.H., Banaschewski, T., Schumann, G., Laucht, M., 2013. Association of PER2 genotype and stressful life events with alcohol drinking in young adults. PLoS ONE 8(3), e59136.

Brunelle, C., Hopley, A.A.B., 2017. The role of drinking norms and social networking sites on alcohol consumption in university students. Journal of Substance Use 22(6), 574-580.

Bush, K., Kivlahan, D.R., McDonell, M.B., Fihn, S.D., Bradley, K.A., 1998. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Archives of internal medicine 158(16), 1789-1795.

Campbell, W.K., Campbell, S.M., Siedor, L.E., Twenge, J.M., 2015. Generational differences are real and useful. Industrial and Organizational Psychology 8(3), 324-331.

Choi, S.W., Kim, D.J., Choi, J.S., Ahn, H., Choi, E.J., Song, W.Y., Kim, S., Youn, H., 2015. Comparison of risk and protective factors associated with smartphone addiction and Internet addiction. Journal of Behavioral Addictions 4(4), 308-314.

Claros, E., 2010. The relationship between emotional intelligence and abuse of alcohol, marijuana, and tobacco among college students. Dissertation Abstracts International: Section B: The Sciences and Engineering 71(5-B).

Clements, R., 1998. A critical evaluation of several alcohol screening instruments using the CIDI-SAM as a criterion measure. Alcoholism: Clinical & Experimental Research 22(5), 985-993.

Cohen, J., 2013. Statistical power analysis for the behavioral sciences. Routledge.

Donnelly, K., Twenge, J.M., 2017. Masculine and feminine traits on the Bem Sex-Role Inventory, 1993–2012: A cross-temporal meta-analysis. Sex Roles 76(9-10), 556-565.

Fleming, M.F., Barry, K.L., MacDonald, R., 1991. The alcohol use disorders identification test (AUDIT) in a college sample. International Journal of the Addictions 26(11), 1173-1185.

Fletcher, T.D., 2012. QuantPsyc: Quantitative Psychology Tools. R package version 1.5.

Grant, B.F., Chou, S.P., Saha, T.D., Pickering, R.P., Kerridge, B.T., Ruan, W.J., Huang, B., Jung, J., Zhang, H., Fan, A., 2017. Prevalence of 12-month alcohol use, high-risk drinking, and DSM-IV alcohol use disorder in the United States, 2001-2002 to 2012-2013: results from the National Epidemiologic Survey on Alcohol and Related Conditions. JAMA psychiatry 74(9), 911-923.

Griswold, M.G., Fullman, N., Hawley, C., Arian, N., Zimsen, S.R., Tymeson, H.D., Venkateswaran, V., Tapp, A.D., Forouzanfar, M.H., Salama, J.S., 2018. Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet 392(10152), 1015-1035.

Hallett, J., Howat, P.M., Maycock, B.R., McManus, A., Kypri, K., Dhaliwal, S.S., 2012. Undergraduate student drinking and related harms at an Australian university: web-based survey of a large random sample. BMC Public Health 12, 37.

Johnston, L.D., O'Malley, P.M., Bachman, J.G., Schulenberg, J.E., Miech, R.A., 2016. Monitoring the Future national survey results on drug use, 1975-2015: Volume 2, college students and adults ages 19-55, Ann Arbor: Institute for Social Research, The University of Michigan.

Keyes, K.M., Li, G., Hasin, D.S., 2011. Birth cohort effects and gender differences in alcohol epidemiology: a review and synthesis. Alcoholism: Clinical and Experimental Research 35(12), 2101-2112.

Kills Small, N.J., Simons, J.S., Stricherz, M., 2007. Assessing criterion validity of the Simple Screening Instrument for Alcohol and Other Drug Abuse (SSI-AOD) in a college population. Addictive Behaviors 32(10), 2425-2431.

Kraus, L., Tinghög, M.E., Lindell, A., Pabst, A., Piontek, D., Room, R., 2015. Age, period and cohort effects on time trends in alcohol consumption in the Swedish adult population 1979–2011. Alcohol and Alcoholism 50(3), 319-327.

Kreusch, F., Vilenne, A., Quertemont, E., 2013. Assessing the stimulant and sedative effects of alcohol with explicit and implicit measures in a balanced placebo design. Journal of Studies on Alcohol & Drugs 74(6), 923-930.

Kypri, K., Langley, J.D., McGee, R., Saunders, J.B., Williams, S., 2002. High prevalence, persistent hazardous drinking among New Zealand tertiary students. Alcohol & Alcoholism 37(5), 457-464.

Lennings, C.J., 1998. Substance use and emotional state in university students. Journal of Substance Misuse 3(4), 221-225.

Lindgren, K.P., Ramirez, J.J., Namaky, N., Olin, C.C., Teachman, B.A., 2016. Evaluating the relationship between explicit and implicit drinking identity centrality and hazardous drinking. Addictive Behaviors Reports 4, 87-96.

Livingston, M., 2008. Recent trends in risky alcohol consumption and related harm among young people in Victoria, Australia. Australian and New Zealand Journal of Public Health 32(3), 266-271.

Livingston, M., Raninen, J., Slade, T., Swift, W., Lloyd, B., Dietze, P., 2016. Understanding trends in Australian alcohol consumption—an age–period–cohort model. Addiction 111(9), 1590-1598.

Livingston, M., Vashishtha, R., 2019. Have recent reclines in adolescent drinking continued into young adulthood?, in Conroy, D., Measham, F. (Eds.), Young Adult Drinking Styles. Palgrave Macmillan, Cham, pp. 21-46.

Mackenzie, C.S., Erickson, J., Deane, F.P., Wright, M., 2014. Changes in attitudes toward seeking mental health services: A 40-year cross-temporal meta-analysis. Clinical Psychology Review 34(2), 99-106.

MacKillop, J., Acker, J.D., Bollinger, J., Clifton, A., Miller, J.D., Campbell, W.K., Goodie, A.S., 2013. Brief report: The Brief Alcohol Social Density Assessment (BASDA): convergent, criterion-related, and incremental validity. Journal of Studies on Alcohol & Drugs 74(5), 810-815.

Manthey, J., Shield, K.D., Rylett, M., Hasan, O.S., Probst, C., Rehm, J., 2019. Global alcohol exposure between 1990 and 2017 and forecasts until 2030: a modelling study. The Lancet 393(10190), 2493-2502.

Marczinski, C.A., Hertzenberg, H., Goddard, P., Maloney, S.F., Stamates, A.L., O'Connor, K., 2016. Alcohol-related Facebook activity predicts alcohol use patterns in college students. Addiction Research & Theory 24(5), 398-405.

McCambridge, J., McAlaney, J., Rowe, R., 2011. Adult consequences of late adolescent alcohol consumption: a systematic review of cohort studies. PLoS medicine 8(2), e1000413.

Meng, Y., Holmes, J., Hill-McManus, D., Brennan, A., Meier, P.S., 2014. Trend analysis and modelling of gender-specific age, period and birth cohort effects on alcohol abstention and consumption level for drinkers in G reat B ritain using the G eneral L ifestyle S urvey 1984–2009. Addiction 109(2), 206-215.

Moreno, M.A., Christakis, D.A., Egan, K.G., Brockman, L.N., Becker, T., 2012. Associations between displayed alcohol references on Facebook and problem drinking among college students. Archives of Pediatrics & Adolescent Medicine 166(2), 157-163.

Ng Fat, L., Shelton, N., Cable, N., 2018. Investigating the growing trend of non-drinking among young people; analysis of repeated cross-sectional surveys in England 2005–2015. BMC public health 18(1), 1090.

O'Brien, K.S., Kolt, G.S., Webber, A., Hunter, J.A., 2010. Alcohol consumption in sport: The influence of sporting idols, friends and normative drinking practices. Drug & Alcohol Review 29(6), 676-683.

Olthuis, J.V., Zamboanga, B.L., Ham, L.S., Van Tyne, K., 2011. The utility of a gender-specific definition of binge drinking on the AUDIT. Journal of American College Health 59(4), 239-245.
Pennay, A., Livingston, M., MacLean, S., 2015. Young people are drinking less: it is time to find out why. Drug and alcohol review 34(2), 115-118.
Pereira-Morales, A.J., Adan, A., Camargo, A., Forero, D.A., 2017. Substance use and suicide risk in a sample of young Colombian adults: An exploration of psychosocial factors. American Journal on Addictions 26(4), 388-394.
Prat, G., Adan, A., 2011. Influence of circadian typology on drug consumption, hazardous alcohol use, and hangover symptoms. Chronobiology International 28(3), 248-257.
Radaev, V., Roshchina, Y., 2019. Young cohorts of Russians drink less: age–period–cohort modelling of alcohol use prevalence 1994–2016. Addiction 114(5), 823-835.
Reinert, D.F., Allen, J.P., 2007. The alcohol use disorders identification test: an update of research findings. Alcoholism: Clinical and Experimental Research 31(2), 185-199.
Ridout, B., Campbell, A., Ellis, L., 2012. 'Off your Face(book)': alcohol in online social identity construction and its relation to problem drinking in university students. Drug & Alcohol Review 31(1), 20-26.
Roche, A., 2009. Making sense of Australia's alcohol guidelines. Adelaide: National Centre for Education and Training on Addiction, Flinders University.
Rudolph, C., Costanza, D., Zacher, H., 2018. Cross-Temporal Meta-Analysis: A Conceptual and Empirical Critique. PsyArXiv, doi: 10.31234/osf.io/exskp. (Accessed 11 September 2019).
Saunders, J.B., Aasland, O.G., Babor, T.F., De la Fuente, J.R., Grant, M., 1993. Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption-II. Addiction 88(6), 791-804.
Signorell, A., et al., 2019. DescTools: Tools for Descriptive Statistics. R package version 0.99.28.
Slade, T., Chapman, C., Swift, W., Keyes, K., Tonks, Z., Teesson, M., 2016. Birth cohort trends in the global epidemiology of alcohol use and alcohol-related harms in men and women: systematic review and metaregression. BMJ open 6(10), e011827.

Snipes, D.J., Jeffers, A.J., Green, B.A., Benotsch, E.G., 2015. Alcohol mixed with energy drinks are robustly associated with patterns of problematic alcohol consumption among young adult college students. Addictive Behaviors 41, 136-141.

Stahlbrandt, H., Johnsson, K.O., Berglund, M., 2007. Two-year outcome of alcohol interventions in Swedish university halls of residence: a cluster randomized trial of a brief skills training program, twelve-step-influenced intervention, and controls.[Erratum appears in Alcohol Clin Exp Res. 2007 Jul;31(7):1268]. Alcoholism: Clinical & Experimental Research 31(3), 458-466.

Twenge, J.M., 1997a. Attitudes toward women, 1970–1995: A meta-analysis. Psychology of Women Quarterly 21(1), 35-51.

Twenge, J.M., 1997b. Changes in masculine and feminine traits over time: A meta-analysis. Sex roles 36(5-6), 305-325.

Twenge, J.M., 2000. The age of anxiety? The birth cohort change in anxiety and neuroticism, 1952–1993. Journal of Personality and Social Psychology 79(6), 1007.

Twenge, J.M., 2001. Birth cohort changes in extraversion: A cross-temporal meta-analysis, 1966–1993. Personality and Individual Differences 30(5), 735-748.

Twenge, J.M., Campbell, W.K., 2001. Age and birth cohort differences in self-esteem: A cross-temporal meta-analysis. Personality and Social Psychology Review 5(4), 321-344.

Twenge, J.M., Gentile, B., DeWall, C.N., Ma, D., Lacefield, K., Schurtz, D.R., 2010. Birth cohort increases in psychopathology among young Americans, 1938–2007: A cross-temporal meta-analysis of the MMPI. Clinical psychology review 30(2), 145-154.

Twenge, J.M., Park, H., 2019. The decline in adult activities among US adolescents, 1976–2016. Child development 90(2), 638-654.

Twenge, J.M., Zhang, L., Im, C., 2004. It's beyond my control: A cross-temporal meta-analysis of increasing externality in locus of control, 1960-2002. Personality and Social Psychology Review 8(3), 308-319.

Wegman, L.A., Hoffman, B.J., Carter, N.T., Twenge, J.M., Guenole, N., 2018. Placing job characteristics in context: Cross-temporal meta-analysis of changes in job characteristics since 1975. Journal of Management 44(1), 352-386.

Whitney, N., Froiland, J.M., 2015. Parenting style, gender, beer drinking and drinking problems of college students. International Journal of Psychology: A Biopsychosocial Approach / Tarptautinis psichilogijos zumalas: Biopsichosocialinis poziuris 16, 93-109.

Wickham, H., 2016. ggplot2: Elegant Graphics for Data Analysis.

World Health Organization, 2000. International guide for monitoring alcohol consumption and related harm. Geneva: World Health Organization.

Young, C., de Klerk, V., 2008. Patterns of alcohol use on a South African university campus: The findings of two annual drinking surveys. African Journal of Drug and Alcohol Studies 7(2), 101-112.

Young, C., Mayson, T., 2010. The Alcohol Use Disorders Identification Scale (AUDIT) normative scores for a multiracial sample of Rhodes University residence students. Journal of Child and Adolescent Mental Health 22(1), 15-23.

Young, C.M., Rodriguez, L.M., Neighbors, C., 2013. Expressive writing as a brief intervention for reducing drinking intentions. Addictive Behaviors 38(12), 2913-2917.

Zverev, Y., 2008. Problem drinking among university students in Malawi. Collegium Antropologicum 32(1), 27-31.