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Birth cohort trends in the global epidemiology of alcohol use and alcohol-related harms in men and women: systematic review and meta-regression

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Competing interests:

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: financial support for the submitted work from the Australian National Health and Medical Research Council [NHMRC APP1041129]; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributors:

TS and CC conceived of the study, developed and implemented the search strategy, independently screened article abstracts for inclusion, developed the data coding scheme, coded the data, analysed the data, and drafted and revised the paper. They are the guarantors. WS coded the data, and contributed to drafting and revising the paper. KK contributed to interpretation of the data and to drafting and revising the paper. ZT independently screened

article abstracts for inclusion, coded the data and contributed to drafting and revising the paper, MT conceived of the study and drafted and revised the paper.

Data Sharing

No additional data are available.

Abstract

Objective: Historically, alcohol use and related harms are more prevalent in men than in women. However, emerging evidence suggests the epidemiology of alcohol use is changing in younger cohorts. The current study aimed to systematically summarize published literature on birth cohort changes in male to female ratios in indicators of alcohol use and related harms.

Methods: We identified 68 studies that met inclusion criteria. We calculated male to female ratios for three broad categories of alcohol use and harms (any alcohol use, problematic alcohol use and alcohol-related harms) stratified by five-year birth cohorts ranging from 1891 to 2001, generating 1568 sex ratios. Random effects meta-analyses produced pooled sex ratios within these three categories separately for each birth cohort.

Findings: There was a linear decrease over time in the sex ratio for all three categories of alcohol use and related harms. Among those born in the early 1900s males were 2.2 (95% CI 1.9-2.5) times more likely than females to consume alcohol, 3.0 (95% CI = 1.5-6.0) times more likely to drink alcohol in ways suggestive of problematic use and 3.6 (95% CI = 0.4-30.3) times more likely to experience alcohol-related harms. Among cohorts born in the late 1900s males were 1.1 (95% CI 1.1-1.2) times more likely than females to consume alcohol, 1.2 (95% CI = 1.1-1.4) times more likely to drink alcohol in ways suggestive of problematic use and 1.3 (95% CI = 1.2-1.3) times more likely to experience alcohol-related harms.

Conclusion: Findings confirm the closing male-female gap in indicators of alcohol use and related harms. The closing male-female gap is most evident among young adults, highlighting the importance of prospectively tracking young male and female cohorts as they age into their 30s, 40s and beyond.

Strengths and limitations of this study

- Prior to this study the evidence around gender convergence in alcohol use and alcohol-related harms was fragmented. This study systematically summarized all available literature and provided a quantification of the rate of gender convergence through the derivation of a single metric – the male to female ratio in alcohol use and alcohol-related harms.
- This study was strengthened by its examination of 11 separate indicators of alcohol use and alcohol-related harms, summarized in three broad categories and showed that gender convergence was evident across all indicator categories.
- Whilst the derivation of a single metric facilitated numerical synthesis of data, the analyses are not independent of measurement variance.
- The current study did not test specific hypotheses for why the male-female gap in alcohol use and alcohol-related harms is closing.

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Alcohol use and alcohol-related harms are among the most significant risk factors for burden of disease. Overall, they resulted in around 5 million deaths globally in 2010, and were responsible for more than 161 million years of life lost, equating to 5% of total global health burden [1]. Historically, the prevalence of alcohol use and related harms has been between 2 and 12 times higher in men than women [2-7]. However, there is emerging evidence to suggest that the gap between men and women in alcohol use and related harms is closing among more recently born cohorts [8-11]. Understanding sex-specific birth cohort trends in the epidemiology of alcohol use is vital as they point to key environmental and social mechanisms associated with population shifts in alcohol use patterns. Furthermore, substantial changes over time in the sex distribution of alcohol use may require a rethink of effective health policies, resource allocation models and intervention strategies to combat the societal costs associated with use.

Several individual studies have empirically addressed the question of sex differences in birth cohort effects on alcohol use. The most methodologically rigorous of these employs age-period-cohort (APC) modeling, a statistical approach designed to isolate temporal changes in prevalence that are independently associated with being in a specific birth cohort from changes associated with a specific age and/or a particular historical period. A subset of these APC analyses has examined whether the birth cohort effect is of the same magnitude for both men and women and reported mixed evidence (refs 12-16). A wider body of literature explores, in more indirect ways, the changing epidemiology of alcohol use over time. A narrative synthesis carried out nearly ten years ago concluded that the male-female gap in alcohol problems appears to be narrowing in some countries [12]. However, sex convergence was not numerically quantified making it difficult to judge the extent of the convergence. Moreover, the published literature on sex convergence in alcohol use has nearly doubled in size since 2008 indicating a timely need to revisit this issue. We report the results of a systematic review and meta-analysis of the male to female ratio in key indicators of alcohol

use and related harm to enumerate the magnitude of any observed male-female convergence in alcohol use and related harms over time.

METHODS

Methods

The current systematic review followed guidelines for the conducting and reporting of meta-analyses of observational studies in epidemiology (MOOSE; [13]) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; [14, 15]). The final reporting was informed by the findings of a systematic review of meta-analyses of observational studies in psychiatric epidemiology [16]. We used EppiReviewer Version 4 for the management of screening, coding and data extraction [17].

Study Inclusion Criteria

We used search terms that aimed to identify studies that reported on the following indicators of alcohol use and related harm: lifetime and/or current alcohol use disorder (abuse or dependence); alcohol-related problems (e.g. drunkenness, other negative consequences), alcohol-related treatment seeking; stages in the alcohol use and related problems cycle (e.g. onset of use, transition from use to disorder). We also explicitly looked for studies reporting data on commonly investigated drinking patterns (e.g. heavy episodic or binge drinking). We included studies published between January 1980 and June 2014 inclusive that:

1. measured at least one of the above indicators of alcohol use or related harm;
2. reported on a regionally or nationally representative population sample;
3. explicitly measured a cohort effect or presented indicator data across at least two birth cohorts; and

4. presented indicator data separately for males and females or carried out explicit comparisons between males and females (this included sex by time or sex by cohort interactions).

We included studies based on samples of high school or college students where these samples were regionally or nationally representative. We excluded studies that only sampled targeted groups within the population (e.g. people seeking treatment). The decision was made to focus only on representative population samples in order to characterize overall changes in general population means and prevalence estimates at regional and national levels. Full electronic search strategies including search terms are contained in Tables 1-3.

Insert Tables 1-3

Search Strategy

We searched three databases (Medline, EMBASE, PsychINFO) using three separate search strategies. The search strategies were developed by TS and CC in consultation with the librarian at the National Drug and Alcohol Research Centre (MK).

Search Strategy 1: aimed to identify studies that explicitly derived parameter estimates of changes over time in indicators of alcohol use and related harms. This strategy focused on keywords that are commonly used to describe age-period-cohort analyses (APC) and these were combined with database specific MeSH headings and keywords for alcohol use and related harms. Relevant MeSH terms were identified separately in each database and were "exploded" to capture the broadest possible set of alcohol studies. When subject headings did not accurately cover the target domain we added .mp to the search term (see Table 1).

Search Strategy 2: aimed to identify studies that focused on sex differences in alcohol use and related harms but did not explicitly conduct APC analyses. This strategy included search

terms related to sex or gender, sex or gender convergence and sex or gender gap and these were combined with the broad database specific terms for alcohol and related harm outlined for search strategy 1 (see Table 2).

Search Strategy 3: aimed to identify studies that reported data split by sex and birth cohorts or by sex and age groups (as a proxy for birth cohorts) but did not explicitly conduct age-period-cohort analysis or examine sex convergence. In order to obtain adequate sensitivity and specificity this search was restricted to gold standard epidemiological studies based on guidelines developed for the WHO 2010 Global Burden of Disease study protocols [18] and used narrower terms to capture studies that have focused on alcohol use and related harms.

The initial search of the three databases was undertaken in January 2013 and then updated at the end of June 2014. All article abstracts were screened independently by one of the authors (TS, CC, or ZT) to exclude those that were ineligible for inclusion. We obtained full texts of remaining articles and the same authors independently assessed them in detail for inclusion. Non-English texts were not included in the review. Approximately 20% of abstracts and full text articles were independently screened by a second reviewer. The electronic search strategy was supplemented by hand-searching of existing literature reviews and reference lists of key papers. TS developed the screening and data extraction codes in EppiReviewer and CC and ZT extracted data from included studies. WS and KK advised on the qualitative synthesis and WS checked extracted data from all included studies. TS checked extracted data for all studies included in the meta-analysis.

Figure 1 shows the number of articles obtained using the search strategy and number of records excluded with reasons. The present study had a secondary aim of examining evidence for the closing sex gap in indicators of cannabis use and the screening protocol was designed to screen records for both alcohol and cannabis. Findings with respect to cannabis are

presented in another paper (Chapman et al., under review). The electronic search strategy identified 1445 unique records and an additional 20 records were retrieved via examining existing literature reviews and reference lists of key papers. After screening abstracts, 314 full text articles were retrieved and examined for inclusion. A total of 68 papers met the alcohol-related inclusion criteria. Quantitative synthesis was conducted on 50 studies. Table 4 provides detailed characteristics of all included studies by individual citation. Table 5 provides summary characteristics of all included studies.

Insert Figure 1 and Tables 4 and 5

Data extraction

Data were extracted in the following domains: study design, population, country, survey name, survey year, sample age, sample size, birth cohorts covered, indicators reported including indicator definitions, definition timeframe and whether the authors reported evidence of gender convergence on any indicators of interest. Studies varied in the parameters used to define alcohol use and related harms. For example, studies reporting data on prevalence of any alcohol use differed with regard to timeframe (lifetime, past 12 months, current), definition of alcohol use (one or more standard drinks, 12+ or more standard drinks), frequency of drinking (weekly, monthly, yearly) and whether a continuous or categorical measure was used. Similarly, studies that measured alcohol related harms (e.g., abuse and dependence, alcohol related problems) differed in terms of diagnostic system (DSM-III, DSM-IIIR, DSM-IV), timeframe (lifetime, past 12 months) and type of negative consequence considered (e.g., drunkenness, drink-driving, risky sexual behaviour). Whilst some of these differences are methodological, others reflect important conceptual distinctions [19]. Attention to these methodological and conceptual distinctions resulted in an initial coding

of 11 key indicators of alcohol use and related harm that were further grouped into three broad categories:

A. Indicators of any alcohol use, including:

1. Prevalence of any alcohol use (categorical),
2. Prevalence of alcohol abstinence (categorical),
3. Total amount of alcohol consumed (continuous),
4. Frequency of alcohol use (continuous)

B. Indicators of alcohol use that is suggestive of problematic use, including:

5. Prevalence of heavy episodic or binge drinking (categorical),
6. Prevalence of risky drinking (categorical),
7. Frequency of heavy episodic or binge drinking (continuous)
8. Age of onset of alcohol use (continuous)

C. Indicators of alcohol-related harms:

9. Prevalence of alcohol-related problems (categorical),
10. Prevalence of alcohol use disorder (categorical),
11. Frequency of alcohol-related problems (continuous)

See Table 4 for more details of individual indicator definitions for each included study.

Statistical analysis

In addition to the extracted qualitative data described above, quantitative data (e.g., percentages, means etc.) on the 11 key indicators for each available birth cohort for males and females were also extracted and summarized using meta-analysis. To facilitate

quantitative synthesis across varying indicator definitions we calculated a single metric, the male to female ratio, to express the relationship between male and female levels of alcohol use and related harms. This sex ratio represents the relative, not absolute, difference between males and females. A value greater than 1 indicates greater alcohol use or more alcohol-related harms in males compared to females. For two indicators, age of onset of alcohol use and alcohol abstinence, the ratio was reversed. Sex ratios on each of the 11 key indicators were calculated separately for each birth cohort in each study where data were available. For sex ratios based on binary indicators, estimates in which both the male and female prevalence fell below 5% (n=39, 2·4% of all estimates) were considered baserate outliers and not further analyzed. Sensitivity analyses indicated that this exclusion did not impact the overall findings. All sex ratios were logarithmically transformed and all meta-analyses were carried out on these logarithmically transformed values, with back-transformation for reporting purposes. Log sex ratios for binary indicators were considered equivalent to log risk ratios and standard errors were calculated accordingly. Standard errors for each (log) sex ratio derived from means of continuous indicators were calculated using formulae contained in Friedrich et al. [20]. Pooled (log) sex ratios with 95% CIs were calculated separately for each birth cohort with STATA (version 12.1). Significant heterogeneity, as assessed by the I-squared index, was evident. Thus, random-effects meta-analyses were carried out and statistical heterogeneity was handled using the Knapp-Hartung approach (Cornell, 2014). Random-effects meta-regression analyses, were carried out to determine how much of this heterogeneity in sex ratios was explained by birth cohort, controlling for important methodological characteristics. These characteristics included: age at the time of data collection, world region, study design and indicator timeframe. These analyses were carried out and are presented separately for each of the three broad alcohol indicator categories. Formal tests of publication bias were not applicable in the context of the current analysis.

RESULTS

Summary of characteristics of included studies

We identified 68 citations that met inclusion criteria (see Figure 1, Table 4, Table 5). Data used in the studies were collected between the years 1948 and 2014 representing birth cohorts from 1891 to 2000. One quarter of the studies used data collected across a twenty or more year timespan (n=16), five of which used data collected over 30 years or more. More than one third of studies (36·7%) were conducted in North America, 39·7% in Europe, 5·9% in Asia, 7·4% in Oceania, 2·9% in another world region and 7·4% across more than one world region. Study sample sizes ranged from 1056 to 809 281 (median: 15 144), 27·9% of studies had a sample size of >50 000, resulting in a combined total sample size of 4 426 673. The majority of studies were repeated cross-sectional studies (n=48), eight of which conducted APC analyses, 19 were single cross-sectional studies, and one used data from a longitudinal study. The most common assessment timeframe used was lifetime (n=27) followed by past 12 months (n=17). The most common indicator group examined was indicators of any alcohol use (N=35), followed by indicators of problematic alcohol use (N=30) and indicators of alcohol related harms (n=18). Following qualitative review, forty-two of the 68 studies reported evidence of sex convergence in more recent cohorts on at least one alcohol indicator (see Table 4). The majority of these (n=31; 73·8%) reported that convergence was driven by greater and/or more consistent increases in subsequent birth cohorts on one or more alcohol indicators among females compared to males. Six studies reported that convergence was driven by decreases in males across birth cohorts and five studies reported mixed findings depending on the country or indicator under investigation.

Individual study estimates

Of the 68 citations we identified 50 that provided indicator estimates separately for males and females across at least two separate birth cohorts. While not every citation provided estimates in every birth cohort, collectively these citations spanned birth cohorts starting in 1891 and ending in 2000. These citations allowed for the calculation of 1568 separate sex ratios, 845 related to any alcohol use, 439 to problematic alcohol use and 323 to alcohol-related harm. Due to low numbers of estimates the earliest four birth cohorts were collapsed into one category (1891-1910), as were the latest two birth cohorts (1991-2000). Amongst the subset of n=518 estimates based on categorical indicators of any alcohol use the matched female (X-Axis) and male (Y-Axis) prevalence estimates are graphed, by birth cohort, in Figure 2. A diagonal line is superimposed on each graph indicating where male and female estimates would be equal and therefore where the sex ratio would be one. As expected, most estimates fall above this line of equality, denoting a male excess in the prevalence of any alcohol use. However, in more recent birth cohorts, particularly those born from 1976 onwards, the estimates are shifting closer to the line of equality, indicating a narrowing of the male-female gap.

Insert Figure 2

Pooled results from meta-analyses

For all three broad indicator categories (any alcohol use, problematic alcohol use and alcohol-related harms) the pooled sex ratios declined over successive birth cohorts (see Tables 6-8). With regards to indicators of any alcohol use, the sex ratio was 2·2 (95% confidence intervals (CI) = 1·9-2·5) in the 1891-1910 birth cohort indicating that males born between 1891 and 1910 were around two times more likely to report any alcohol use than their female counterparts born during the same time. The sex ratios decreased to a low of 1·1 (95% CI = 1·1-1·2) in those born between 1991 and 2000. The same pattern of findings was evident for indicators of problematic alcohol use (declining from 3·0 (95% CI = 1·5-6·0) in the 1891-

1910 birth cohort to 1·2 (95% CI = 0·9-1·5) in the 1991-2000 birth cohort) and indicators of alcohol-related harm (declining from 3.6 (95% CI = 0.4-30.4) in the 1891-1910 birth cohort to 1·3 (95% CI = 1·2-1·3) in the 1991-2000 birth cohort). For all three broad indicator categories meta-regression analyses indicated that the sex ratio declined linearly across birth cohorts. For example, when birth cohort was entered into the meta-regression as a continuous variable each successive five-year birth cohort was associated with a 4.2% (95% CI = 3.7%-4.6%, t=-16.14, p<0.001) decrease in the sex ratio. This effect remained once controlling for methodological characteristics. With these characteristics included in the model the sex ratio decreased linearly by 3.2% (95% CI = 2.4%-4.0%, t=-7.85, p<0.001) with each successive five-year birth cohort.

Insert Table 6

DISCUSSION

The current study summarized the available published literature on sex convergence in indicators of alcohol use and related harms across the world. By extracting estimates from studies and deriving a single metric, the male to female ratio, we were able to use meta-analysis to numerically summarize the overall relationship of male to female alcohol use, problematic alcohol use and alcohol-related harms. To our knowledge, this is the first study to do so. The results of the meta-analysis indicate that the male-female gap in alcohol use is closing over time.

The results of the qualitative review demonstrated support for sex convergence among more recent cohorts. Sixty-two percent of identified studies found evidence of sex convergence among more recent cohorts on at least one of the 11 individual alcohol-related indicators, four of which were APC analyses. Meta-analysis confirmed these qualitative results indicating, for example, that the sex ratio in any alcohol use has decreased from 2·2 amongst

those born in the earliest years of the 20th century to 1·1 amongst those born during the end of the 20th century. Follow-up analyses on the rate of change in sex ratios demonstrated that the decline in the sex ratio was steepest in cohorts born from 1966 onwards. For example, overall, the sex ratios for any alcohol use decreased by 4.2% with each successive five-year birth cohort between 1891 and 2000. However, this rate of change was 1.2% for successive cohorts born from 1891 to 1966 and 10.1% for cohort born from 1966 to 2000.

It is important to note that the sex ratio metric used in the current study provides information on the *relative* prevalence of alcohol use or related harms in males versus females. This metric does not empirically determine whether observed changes in the sex ratio are being driven by increases or decreases in male or female prevalence or whether, in fact, there is a more complex indicator-specific and/or birth cohort-dependent relationship between male and female alcohol use and/or harms that is driving the change in sex ratios over time. However, the qualitative review determined that of the 42 studies that reported some evidence for sex convergence in alcohol use or related harms, the majority of these reported that convergence was driven by greater and/or more consistent increases in indicators of alcohol use among females compared to males from more recent cohorts [5, 6, 8, 9, 11, 21-46]. Within this context, it is interesting to note that 5% of the sex ratios were less than one, indicating that, in some cases, females have surpassed males in their drinking levels. The majority of such estimates (60%) came from cohorts born after 1981.

A number of limitations require discussion. We restricted our search to published studies and did not include an assessment of the grey literature, thus increasing the chances of publication bias. The pooling of estimates within birth cohorts across studies meant we are not able to utilize traditional publication bias assessments (e.g. [47]). However, our conclusions were informed most by large nationally representative surveys several of which were strengthened by APC analyses and it is unlikely that we would have missed large unpublished surveys or

relevant APC studies that were only available in the grey literature. Moreover, our findings are consistent with the latest data on trends and social disparities in alcohol consumption in OECD member countries around the world [48]. Whilst the derivation of a single metric facilitated numerical synthesis of data, the analyses are not independent of measurement variance. If, for example, definitions that are associated with smaller sex ratios were more likely to be used by studies reporting more recent cohorts, this could have inflated the observed cohort effect on sex convergence. Whilst the number of different definitions used by studies precludes direct testing of this effect, the fact that sex convergence across birth cohorts was found controlling for important methodological characteristics and across the three broad categories of indicators examined, implies that the finding is at least somewhat robust to the variability in methods and measurement across studies. Finally, 68% of studies included in the meta-analysis reported data on multiple indicators and as such a significant proportion of the sex ratios were derived from the same respondents within a given study. Whilst violating the assumption of independence, this multiplicity was far more often observed *across* rather than *within* the broad indicator categories. Given we pooled sex ratios within broad indicator categories this observation is unlikely to impact on the summary estimates.

The current study did not test specific hypotheses for why the male-female gap in substance use is closing. However, speculative explanations can be proposed. Changes over time in female gender role traditionality may be one explanation for the closing male-female gap. In a large multi-country epidemiological study, Seedat et al. [5] measured female gender role traditionality using female to male ratios in factors such as the percentage participating in the labor force by age 35, the percentage with education levels in the upper quartile of the income distribution and the median age of first marriage. Using this definition they demonstrated that the narrowing sex differences in the prevalence of substance use disorders

across birth cohorts were strongest in those countries where female and male roles were converging over time. Beyond the impact of changing gender role traditionality, some have suggested that broader social, cultural and economic developments explain converging patterns of substance use in males and females [52]. The large-scale GENACIS (Gender, Alcohol and Culture: An International Study) project has shown that sex differences in alcohol use are linked, albeit in complex ways, to greater engagement by females in paid employment outside the home [53]. In a novel examination of generational changes in female drinking over a period of three decades Alati et al. [54] demonstrated that the daughters of 1053 mother/daughter dyads had more than five times the odds of heavy drinking than their mothers had at the same age. Moreover, they demonstrated that this increase was partly accounted for by later age at child bearing thus providing much needed direct evidence on potential mechanisms driving the generational increase in alcohol consumption.

These results have implications for the framing and targeting of alcohol use prevention and intervention programs. Alcohol use and alcohol use disorders have historically been viewed as a male phenomenon. The present study calls this assumption into question and suggests that young women in particular should be the target of concerted efforts to reduce the impact of substance use and related harms. Those born in the most recent cohorts (i.e. the 1990s) can, by definition, only have a maximum age of between 15 and 25. That the birth cohort effect on sex ratios has become more pronounced in these more recent birth cohorts points to the value of continuing to focus research on adolescent and young adult sex-specific trends in substance use. Given that this young age group are relatively early in their alcohol use careers these findings highlight the importance of further tracking young male and female cohorts as they age into their 30s, 40s and beyond.

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Table 1. Full electronic search strings for Search Strategy 1: studies that explicitly derived parameter estimates that reflect changes over time in indicators of alcohol and cannabis use and related harms.

Database	Search Group	Search Terms
EMBASE	Alcohol	**SH: exp alcohol consumption/ OR exp alcoholism/ OR exp alcohol abuse/ OR exp drinking behavior/ OR exp alcohol intoxication/**
	Cannabis	**SH: exp cannabis/ OR exp substance abuse/ OR exp drug abuse/ OR exp drug dependence/** OR marijuana.mp (*marijuana used as a keyword because not mapped to separate MeSH*)
PsychINFO	Alcohol	**SH: exp Alcohol Drinking Patterns/**
	Cannabis	**SH: exp cannabis/ OR exp marijuana usage/ OR exp Drug abuse/**
Medline	Alcohol	**SH: exp alcohol drinking/ OR exp alcohol-related disorders/**
	Cannabis	**SH: exp cannabis/ OR exp marijuana abuse/ OR exp substance-related disorders/**
EMBASE, PsychINFO, Medline	Cohort Effect	((age period and cohort) OR cohort effect OR secular trend OR secular change OR time trend OR cohort trend OR birth cohorts OR younger cohort OR older cohort OR recent cohort OR earlier cohort).mp

Search groups were combined as follows: [Alcohol **OR** Cannabis] **AND** [Gender]

Table 2. Full electronic search strings for search strategy 2: studies that focused on gender differences in alcohol or cannabis use and related harms but did not explicitly conduct age-period-cohort analyses.

Database	Search Group	Search Terms
EMBASE	Alcohol	**SH: exp alcohol consumption/ OR exp alcoholism/ OR exp alcohol abuse/ OR exp drinking behavior/ OR exp alcohol intoxication/**
	Cannabis	**SH: exp cannabis/ OR exp substance abuse/ OR exp drug abuse/ OR exp drug dependence/** OR marijuana.mp (*marijuana used as a keyword because not mapped to separate MeSH*)
PsychINFO	Alcohol	**SH: exp Alcohol Drinking Patterns/**
	Cannabis	**SH: exp cannabis/ OR exp marijuana usage/ OR exp Drug abuse/**
Medline	Alcohol	**SH: exp alcohol drinking/ OR exp alcohol-related disorders/**
	Cannabis	**SH: exp cannabis/ OR exp marijuana abuse/ OR exp substance-related disorders/**
EMBASE, PsychINFO, Medline	Gender	(((male AND female) OR (men AND women) OR sex OR gender) AND convergence).mp OR 'gender gap'.mp

Search groups were combined as follows: [Alcohol **OR** Cannabis] **AND** [Gender]

Table 3. Full electronic search strings for search strategy 3: studies which have examined indicators of alcohol or cannabis use or related harms by gender and birth cohort or gender and age groups (as a proxy for birth cohorts) but did not explicitly conduct age-period-cohort analysis or focus on gender convergence.

Database	Search Group	Search Terms
EMBASE	Alcohol	**SH: exp *alcohol consumption/ OR exp *alcoholism/ OR exp *alcohol abuse/ OR exp *drinking behavior/ OR exp *alcohol intoxication/**
	Cannabis	**SH: exp *cannabis/ OR *substance abuse/ OR *drug abuse/ OR *drug dependence/ OR *drug abuse pattern/ OR *cannabis addiction/**
	Gold Standard Epidemiology	**SH: exp *population/ OR exp *health survey/ OR exp *health care survey/** OR (general population OR general community OR survey OR representative).mp
	Indicator	**SH: exp *prevalence/ OR exp *help seeking behaviour/ OR exp *health care utilization/** OR (prevalence OR health care utilization OR health care utilisation OR help seeking behaviour OR help seeking behaviour OR treatment seeking or service utilisation or service utilization).mp
PsychINFO	Alcohol	**SH: exp *Alcohol Drinking Patterns/**
	Cannabis	**SH: exp *cannabis/ OR exp *marijuana usage/ OR *drug abuse/ OR *drug dependency/**
	Gold Standard Epidemiology	**SH: exp *surveys/** OR (general population OR general community OR survey OR representative).mp
	Indicator	**SH: exp *help seeking behavior/ OR exp *health care utilization/** OR (prevalence OR health care utilization OR health care utilisation OR help seeking behaviour OR help seeking behaviour OR treatment seeking).mp
Medline	Alcohol	**SH: exp *alcohol drinking/ OR exp *alcohol-related disorders/**
	Cannabis	**SH: exp *cannabis/ OR exp *marijuana abuse/ OR exp *substance-related disorders**
	Gold Standard Epidemiology	**SH: exp *health surveys/ OR exp *health care surveys/** OR (general population OR general community OR survey OR representative).mp
	Indicator	**SH: exp *prevalence/** OR (prevalence OR health care utilization OR health care utilisation OR help seeking behaviour OR help seeking behaviour OR treatment seeking).mp
EMBASE, PsychINFO,	Age	(younger or older).mp

Medline
Search groups were combined as follows: [Alcohol OR Cannabis] AND [Gold Standard Epidemiology] AND [Indicator] AND [age]

Table 4. Characteristics of included studies.

Citation	Study Design[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered[b.]	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Barnes (1997) 1	RCS	USA	Not reported	1983-1994	≈12-18	70 516	<1966-1982+	Past 12 months	Prevalence of any alcohol use	1+ drinks	Yes – greater increases among females for alcohol related problems drove convergence in more recent cohorts. Trends similar for males and females on other measures.
									Prevalence of HED	Monthly - 5+ drinks on 1+ occasions	
									Frequency of alcohol related problems	N of days with alcohol related consequences	
									Total alcohol consumption	Daily - mean oz ethanol	
Bergmark (2004)* 2	RCS	Sweden	Not reported	1979-2003	18-69	3 621	1910-1985	Past 12 months	Prevalence of HED	Monthly - 6+ drinks on 1+ occasions	Yes – increases among females and decreases among males in HED drove convergence in more recent cohorts. Trends for males and females similar on other measures.
									Prevalence of alcohol related problems	Drunk 1+ occasions	
									Prevalence of alcohol abstinence	0 drinks	
Bjork (2008)* 3	APC	Denmark	National Health and Morbidity Survey	1987-2005	50-75	15 144	1913-1955	Past week	Prevalence of risky drinking	Weekly - m: 22+ drinks , f: 15+ Drinks	Yes – increases in heavy drinking among females but not males drove convergence in more recent cohorts
Bloomfield (2001)* 4	RCS	Finland Germany Switzerland The Netherlands	Various	1981-1992	15-74	35 098	<1940 -1949+	Lifetime/ Past 12 month/Past week	Prevalence of risky drinking	Daily - m: 20g+, f: 40g+ ethanol	Yes – some evidence of convergence in Finland driven by greater increases in prevalence of risky drinking and consumption by females. Trends among males and females similar in other countries.
									Prevalence of alcohol abstinence	0 drinks	
									Total alcohol consumption	Daily - mean g ethanol	
Breslow (2003)* 5	SCS	USA	National Health Interview Survey (NHIS) Behavioural Risk Factor Surveillance System (BRFSS) National Household Survey on Drug Abuse (NHSDA)	2000-2001	12+	316 638	<1917-1936	Lifetime/ Past 12 months/ Past month	Prevalence of risky drinking	Daily - 1+ drinks	No – trends similar for males and females.
									Prevalence of alcohol abstinence	0 drinks	
Bromet (2005)* 6	SCS	Ukraine	Ukraine World Mental Health Survey	2002	18+	4 725	<1953-1984	Lifetime	Prevalence of AUD	DSM-IV Abuse or dependence	Yes – greater and more consistent increases in prevalence among females drove gender convergence in more recent cohorts.
Brooks-Russell (2014)* 7	RCS	USA	Health Behaviour in School Aged Children Study (HBSC)	1998-2010	11-15	50 656	1983-1999	Lifetime/ past 12 months	Prevalence of any alcohol use	Monthly - 1+ drinks	No – trends similar for males and females
									Prevalence of alcohol related problems	Drunk 1+ occasions	
Cabrera (2003)* 8	RCS	Sweden	Not reported	1971-1993	70	3128	1901-1922	Not reported	Prevalence of any alcohol use	1+ drinks	No – trends similar for males and females.
Colell (2013)* 9	RCS	Spain	Spanish National Survey on Drugs (EDADES)	1995-2009	15-64	131 330	1930-1994	Lifetime	Prevalence of any alcohol use	1+ drinks	Yes – greater decreases in age of onset and greater increases in

Citation	Study Design[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered[b.]	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
									Age of onset of alcohol use Cumulative Incidence of use	Age at 1st use Based on 1st occasion of use	prevalence among females drove convergence in more recent cohorts.
Degenhardt (2008) 10	SCS	Various[e.]	World Health Organisation World Mental Health Surveys (WHO-WMH)	2001-2005	16+	85 052	<1942-1987	Lifetime	Cumulative Incidence of use	Based on 1st occasion of use	Yes – greater increases among females drove gender convergence in more recent cohorts in 13 countries.
Grant (1997)*11	SCS	USA	National Longitudinal Alcohol Epidemiology Survey (NLAES)	1992	18+	42 862	<1894-1974	Lifetime/ Past 12 months	Prevalence of any alcohol use Cumulative incidence of use Prevalence of AUD	Yearly - 12+ drinks Based on 1st occasion of use DSM-IV Alcohol dependence	No – trends similar for males and females.
Grucza (2008a)* 12	RCS	USA	National Longitudinal Alcohol Epidemiologic Survey (NLAES) National Epidemiologic Survey on Alcohol and Related Conditions (NESARC)	1991-2002	18-57	85 955	1934-1983	Lifetime	Prevalence of any alcohol use Prevalence of AUD	Yearly - 12+ drinks DSM-IV alcohol dependence	Yes – increases in use among females but not males drove convergence in more recent cohorts.
Grucza (2008b)* 13	RCS	USA	National Longitudinal Alcohol Epidemiology Survey (NLAES) National Epidemiologic Survey of Alcohol and Related Conditions (NESARC)	1991-2002	18+	85 955	1934-1983	Lifetime	Prevalence of AUD Age of onset of alcohol use	DSM-IV alcohol dependence Age at 1st use	Yes – greater decreases in onset of drinking among females drove convergence in age of onset and dependence in more recent cohorts.
Gum (2009)* 14	SCS	USA	National Comorbidity Survey – Replication (NCS-R)	2001-2003	18+	9 282	<1927-1985	Lifetime	Prevalence of AUD	DSM-IV alcohol abuse	Yes – greater increases in abuse among females drove convergence in more recent cohorts.
Hahm (2005)* 15	RCS	South Korea	Not reported	1984-1999	18-65	6 159	1920-1981	Lifetime	Prevalence of AUD Age of onset of AUD	DSM-IV alcohol abuse and dependence Age at 1st expereince of symptoms	Yes – increases in AUD among females and decreases among males drove gender convergence in more recent cohorts. Greater decreases in onset of AUD among females drove convergence in onset of AUD in more recent cohorts.
Harkonen (2011)* 16	APC	Finland	Drinking Habits Surveys	1968-2008	15-69	16 385	1898-1993	Past 12 months	Frequency of HED	Yearly - n of occasions m:6+ drinks, f:4+ drinks	Yes – greater and more consistent increases in frequency of HED among females drove convergence in more recent cohorts.
Hasin (2004) 17	SCS	USA	National Epidemiologic Survey of Alcohol and Related Conditions (NESARC)	2001-2002	18+	43 093	<1937-1984	Lifetime	Prevalence of AUD	DSM-IV alcohol dependence	No – trends similar for males and females.

Citation	Study Design[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered[b.]	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Hill (1993)* 18	RCS	Australia	Not reported	1984-1990	12-15	26 429 (1990)	1967-1978	Past week	Prevalence of any alcohol use	1+ drinks	No - trends similar for males and females
Hilton (1988)* 19	RCS	USA	Not reported	1964-1984	18+	9 739	<1900-1966	Past 12 months	Prevalence of any alcohol use	1+ drinks	No - trends similar for males and females
									Prevalence of risky drinking	Daily - 1+ ounce ethanol	
									Frequency of alcohol use	Daily/Weekly/Monthly/Yearly	
									Frequency of HED	Weekly/Monthly 5+ drinks on 1+ occasions	
									Frequency of alcohol related problems	Weekly/Monthly drunk 1+ occasions	
Huckle (2011)* 20	RCS	New Zealand	Not reported	1995-2004	14-65	16 546	1930-1990	Past 12 months	Prevalence of any alcohol use	1+ drinks	No – trends similar for males and females.
									Prevalence of HED	5+ drinks typical occasion	
									Total alcohol consumption	Yearly - n of drinks	
Johnson (1998)* 21	SCS	USA	National Household Survey on Drug Abuse (NHSDA)	1991-1993	12+	87 915	1919-1975	Lifetime	Prevalence of any alcohol use	1+ drinks before age 21	Yes - greater increases in use before 21 yrs among females drove convergence in more recent cohorts.
									Prevalence of regular use	Monthly - 1+ drinks before age 21	
Johnson (2000) 22	APC	USA	National Household Survey on Drug Abuse (NHSDA) National Survey on Drug Use and Health (NSDUH)	1982-1995	12+	Not reported	1935-1979	Lifetime	Incidence of alcohol use	Based on 1st occasion of use	No – trends similar for males and females
Kallmen (2011)* 23	RCS	Sweden	Not reported	1997-2009	17-71	3439	1926-1992	Past 12 months	Prevalence of alcohol related problems	AUDIT - m:8+, f:6+	Yes – increases in problem drinking among females and decreases among males aged 61-71 drove convergence in more recent cohorts. Trends similar for males and females in other age groups.
Karam (2004)* 24	RCS	Lebanon	The IDRAC University Substance Use Monitoring Study	1991-1999	16-22+	4 308	<1970-1983	Lifetime	Prevalence of any alcohol use	1+ drinks	Yes – greater increases on all measures except abuse among females drove convergence in more recent cohorts.
									Prevalence of alcohol related problems	1+ alcohol related consequence	
									Prevalence of AUD	DSM-III/DSM-IV alcohol abuse and dependence	
Kemm (2003)* 25	RCS	UK	General Household Survey	1978-1998	16+	≈20 000 per year	1902-1981	12 months	Prevalence of alcohol abstinence	<1 drink	Yes – greater and more consistent increases in heavy drinking among females drove convergence in more recent cohorts.
									Prevalence of risky drinking	Weekly - m:22+ drinks, f:15+ drinks	
Kerr (2004) 26	APC	USA	National Alcohol Surveys (NAS)	1979-2000	18+	21 588	1901-1985	Past 12 months	Total alcohol consumption	Monthly - n of drinks (beer, wine, spirits)	No – trends similar for males and females

Citation	Study Design[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered[b.]	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Kerr (2009)* 27	APC	USA	National Alcohol Surveys (NAS)	1979-2005	18+	28 507	1900-1988	Past 12 months	Frequency of HED	Yearly - n of occasions 5+ drinks	Yes - greater increases among females drove convergence in HED.
									Total alcohol consumption	Monthly - n of drinks (beer, wine, spirits)	Trends for consumption similar for males and females
Kerr (2013) 28	APC	USA	National Alcohol Surveys (NAS)	1979-2010	18+	36 432	1900-1992	Past 12 months	Frequency of HED	Yearly - n of occasions 5+ drinks	No – trends similar for males and females
									Total alcohol consumption	Yearly - n of oz ethanol (beer, wine, spirits)	
Keyes (2008)* 29	SCS	USA	National Epidemiologic Survey of Alcohol and Related Conditions (NESARC)	2001-2002	18+	43 093	1913-1984	Lifetime	Prevalence of HED	Weekly - 5+ drinks on 1+ occasions (heaviest drinking period)	Yes - greater and/or more consistent increases among females drove gender convergence on all indicators, especially in prevalence of HED
									Prevalence of AUD	DSM-IV alcohol abuse and dependence	
									Total alcohol consumption (HED)	Largest n of drinks on single occasion	
Keyes (2010)* 30	RCS	USA	National Epidemiologic Survey of Alcohol and Related Conditions (NESARC)	1991-2002	18+	85 955	1934-1983	Lifetime	Age of onset of alcohol use	Age at 1st use	Yes – greater increases in rates of alcohol initiation and dependence among females drove gender convergence in more recent cohorts. However, greater decreases in time from 1st use to dependence among males drove divergence in more recent cohorts on this indicator.
			National Longitudinal Alcohol Epidemiology Survey (NLAES)						Time from 1st use to dependence	Years from age at 1st use to age at 1st symptoms DSM-IV alcohol dependence	
									Time from dependence to tmt	Years from age at first symptoms DSM-IV alcohol dependence to age at 1st treatment contact	
Keyes (2013)* 31	APC	USA	National Survey on Drug Use and Health (NSDUH)	1985-2009	12+	809 281	1910-1994	Past month	Prevalence of HED	Monthly - 5+ drinks on 1+ occasions	No – trends similar for males and females
Kim (2008)* 32	SCS	Hong Kong, China	Not reported	2006	18-70	9 860	1936-1988	Lifetime	Prevalence of any alcohol use	1+ drinks	Yes – greater increases among females drove convergence in more recent cohorts.
Kokkevi (2000) 33	RCS	Greece	Not reported	1984-1998	12-64	8 056	1920-1986	Past month	Prevalence of risky drinking	Monthly - 1+ drinks on 20+ occasions	Yes – greater increases among females drove convergence in more recent cohorts
Kraus (2000)* 34	RCS	Germany	Not reported	1994-1996	18-59	7 501	1935-1978	Lifetime	Prevalence of any alcohol use	Monthly - 1+ drinks	Yes – greater increases in use, and decreases in age of onset among females drove convergence in more recent cohorts.
									Prevalence of alcohol related problems	CAGE - 2+	
									Age of onset of alcohol use	Age at 1st regular use (monthly - 1+ occasions)	
									Cumulative probability of use	Based on 1st occasion of regular use (monthly - 1+ occasions)	
Kuntsche (2006)* 35	RCS	Switzerland	Health Behaviour in School Aged Children	1994-2002	≈15	3 792	1979-1987	Lifetime/ past 12	Frequency of alcohol related problems	Drunk 0, 1, 2-3 occasions, 4-10 occasions, 10+	No - Analysis primarily focused on changes in reasons for drinking,

Citation	Study Design[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered[b.]	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
			Survey (HBSC)					months		occasions	however, trends on other measures were similar for males and females.
									Frequency of alcohol use	never, < monthly, monthly, weekly, daily	
Kuntsche (2011)* 36	RCS	North America, Europe[f.]	Health Behaviour in School Aged Children Survey (HBSC)	1997-2006	≈15	77 586	1982-1991	Lifetime	Frequency of alcohol related problems	Drunk 0, 1, 2-3 occasions, 4-10 occasions, 10+ occasions	Yes – greater decreases in drunkenness among males drove convergence in Western countries. However, greater increases in drunkenness among females drove convergence in Eastern European countries.
Lim (2007)* 37	RCS	Singapore	National Health Survey (NHS)	1992-2004	18-69	12 375	1923-1986	Past 12 months/ past month	Prevalence of any alcohol use	Weekly - 1+ drinks on 1-4 occasions, 1+ drinks on 5+ occasions	Yes – greater increases among females drove gender convergence in more recent cohorts.
									Prevalence of HED	Monthly - 5+ drinks on 1+ occasions	
Marques-Vidal (2005)* 38	RCS	Portugal	National Health Survey	1995-1999	15+	98 374	1920-1984	Past 12 months/ past week	Prevalence of any alcohol use	1+ drinks	No – trends similar for males and females
									Total alcohol consumption	Daily - mean ml ethanol	
McPherson (2004)* 39	RCS	New Zealand	Not reported	1995-2000	14-65	9 345	1930-1986	Past 12 momths	Prevalence of risky drinking	Yearly - 20+L ehtanol	Yes – Increases on most indicators among females drove convergence in more recent cohorts. Males showed either smaller increases or no change depending on the indicator examined.
									Prevalence of alcohol related problems	Weekly - drunk 1+ occasions	
									Total alcohol consumption	Yealry - total ml ethanol	
									Frequency of alcohol use	Yearly - n of drinking occasions	
Melchior (2008)* 40	SCS	France	GAZEL Youth Study	1999	12-26	1 333	1973-1987	Lifetime	Prevalence of any alcohol use	1+ drinks	No – trends similar for males and females
Meng (2014)* 41	APC	UK	General Lifestyle Survey (GLF)	1984-2009	16+	≈20 000 per year	1900-1994	Past 12 months	Prevalence of alcohol abstinence	0 drinks	Yes – increases in consumption among females and decreases among males drove convergence in more recent cohorts. Trends in abstinence similar for males and females.
									Total alcohol consumption	Weekly - mean n of drinks	
Mercer (1990)* 42	RCS	USA	Not reported	1977-1985	≈19-24	2 756	Not reported	Past 12 months	Prevalence of alcohol abstinence	0 drinks	Yes – greater increases among females on most measures drove convergence in more recent cohorts.
									Total alcohol consumption	Yearly - n of oz ethanol (beer, wine, spirits)	
									Frequency of alcohol use	0-11, never-daily	
									Total alcohol consumption (HED)	N of oz typical HED occasion	

Citation	Study Design[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered[b.]	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Michaud (2006) 43	RCS	Switzerland	Swiss Multicenter Adolescent Surveys on Health (SMASH)	1993-2002	16-20	16 696	1973-1986	Lifetime	Prevalence of alcohol related problems	Drunk 2+ occasions & driving 1+ times while drunk or 2+ drinking occasions per day	No - trends similar for males and females.
Naimi (2003)* 44	RCS	USA	Behavioural Risk Factor Surveillance System (BRFSS)	1993-2001	18+	724 479	<1939-1983	Past month	Prevalence of HED	Monthly - 5+ drinks on 1+ occasions	No - trends similar for males and females
Nelson (1998a)* 45	SCS	Germany	Early Developmental Stages of Psychopathology Study (EDSP)	1994	14-24	3 021	1970-1980	Lifetime	Prevalence of any alcohol use	24+ drinks in any year	Yes – greater increases among females drove convergence in more recent cohorts.
									Prevalence of AUD	DSM-IV alcohol abuse and dependence	
									Age of onset of AUD	Age at 1st experience of symptoms	
Nelson (1998b) 46	SCS	USA	National Comorbidity Survey (NCS)	1990-1992	15-54	8 098	1936-1975	Lifetime	Prevalence of AUD	DSM-IIIR alcohol dependence (any criterion)	Yes – greater decreases in age of symptom onset among females drove gender convergence in more recent cohorts.
									Age of onset of AUD	Age at 1st experience of symptoms	
									Age of onset of alcohol use	Age at 1st use	
Neve (1993)* 47	RCS	The Netherlands	Not reported	1958-1989	21-70	10 361	1888-1968	Past week	Prevalence of risky drinking	Weekly - m:22+ drinks, f:15+ drinks	Yes –greater and more consistent increases among females in consumption and risky drinking drove convergence in more recent cohorts. Trends for abstinence similar for males and females
									Prevalence of alcohol abstinence	0 drinks	
									Total alcohol consumption	Weekly - mean n of drinks	
Neve (1996)* 48	RCS	The Netherlands	Not reported	1958-1993	21-70	15 428	1888-1972	Past week	Prevalence of risky drinking	Weekly - m:22+ drinks, f:15+ drinks	No - trends similar for males and females.
									Total alcohol consumption	Weekly - mean n of drinks	
									Prevalence of alcohol abstinence	0 drinks	
Osaki (2009)* 49	RCS	Japan	Not reported	1996-2004	≈12-18	324 562	≈1978-1988	Lifetime/ Past month	Prevalence of any alcohol use	1+ drinks	Yes – greater decreases in use among males drove convergence in more recent cohorts. Trends similar for males and females on other measures.
									Prevalence of risky drinking	1+ occasions every weekend, several occasions per week or 1+ occasions per day	
									Prevalence of HED	Monthly - 6+ drinks on 1+ occasions	
									Prevalence of alcohol related problems	1+ alcohol related consequence	
Parry (2005)* 50	SCS	South Africa	South African Demographic and Health Survey (SADHS)	1998	15+	13 826	<1934-1983	Lifetime	Prevalence of any alcohol use	1+ drinks	No – trends similar for men and women
									Prevalence of alcohol related problems	CAGE : 2+	

Citation	Study Design[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered[b.]	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Perkins (1992) 51	RCS	USA	Not reported	1979-1989	17-23	3 875	1956-1972	Past 12 months/ past 2 weeks	Prevalence of Risky Drinking Prevalence of alcohol related problems	Fortnightly - 31+ drinks 1+ alcohol related consequence	No – trends similar for males and females
Raum (2007)* 52	SCS	Germany	ESTHER Study	2000-2002	50-75	9 953	1925-1952	Current	Total alcohol consumption	Daily - mean g ethanol	Yes – greater increases among females from more recent birth cohorts drove gender convergence
Roche (2002) 53	RCS	Australia	National Drug Strategy Household Survey (NDSHS)	1985-1995	12+	Not reported	1968-1981	Not reported	Prevalence of HED	m:5+ drinks, f:3+ drinks	Yes – greater increases among females drove convergence in more recent cohorts
Royo-Bordonada (1997)* 54	SCS	Spain	Not reported	1989	18+	2 495	<1924-1971	Lifetime	Prevalence of any alcohol use	1+ drinks	Yes – greater increases among females drove convergence in younger cohorts
Seedat (2009) 55	SCS	Various[g.]	World Health Organisation World Mental Health Surveys (WHO-WMH)	2001-2005	18+	72 933	<1937-1987	Lifetime	Prevalence of AUD	DSM-IV alcohol abuse and dependence	Yes – greater and/or more consistent increases among females drove convergence in more recent cohorts in 12 countries.
Simons-Morton (2009)* 56	RCS	Various[h.]	Health Behaviour in School Aged Children Survey (HBSC)	1998-2006	11-15	120 548	1983-1995	Lifetime/ Past month	Prevalence of any alcohol use Prevalence of alcohol related problems	Monthly - 1+ occasions Drunk 2+ occasions	Yes – greater increases in use among females drove gender convergence in more recent cohorts in 10 countries. Increases in drunkenness among females but not males drove gender convergence in more recent cohorts in 9 countries.
Smyth (2011)* 57	RCS	Ireland	Not reported	2002-2006	15-64	9 885	1935-1991	Lifetime	Age of onset of alcohol use	Age at 1st use	Yes – greater decreases in age of onset among females drove gender convergence in more recent cohorts.
Sourander (2012)* 58	RCS	Finland	Not reported	1998-2008	13-17	3 027	1981-1995	Current	Prevalence of any alcohol use Prevalence of alcohol related problems	Monthly - 1+ occasions Monthly/Weekly - Drunk 1+ occasions	No – greater decreases on both measures among females drove gender divergence.
Stoltenberg (1999) 59	SCS	USA	Not reported	Not reported	Not reported	1 990	<1930->1949	Lifetime	Prevalence of AUD Age of onset of alcohol use	DSM-IIIR dependence before age 25 Age at 1st use	Yes - greater decreases in age of onset among females drove gender convergence in more recent cohorts. Trends for dependence before age 25 similar for males and females.
Vieno (2013) 60	RCS	Italy	Health Behaviour in School Aged Children Survey (HBSC)	2002-2010	11-15	13 174	1987-1999	Lifetime	Prevalence of alcohol related problems	Drunk 1+ occasions	Yes - decreases among males but not females drove convergence in 2 out of 5 regions in Italy.
Villalbi (1995)* 61	RCS	Spain	FRISC Study	1987-1992	12-15	2 135	1972-1980	Lifetime/ Current	Prevalence of risky drinking	Daily - 1+ drinks	Yes – decreases in daily risky drinking among males but not

Citation	Study Design[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered[b.]	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
			PASE Project						Prevalence of alcohol related problems	Drunk 1+, 2+ occasions	females and increases in drunkenness among females but not males drove convergence in more recent cohorts.
Von Soest (2014) 62	RCS	Norway	Not reported	1992-2010	16-17	9 245	1975-1994	Past 12 months	Frequency of alcohol related problems	Yearly - Drunk 0-50+ occasions	No – trends similar for males and females
Waern (2014)* 63	RCS	Sweden	Not reported	1976-2006	75	1 056	1901-1930	Current	Prevalence of risky drinking	Daily - 3+ drinks	Yes – increases in risky drinking among females but not males drove gender convergence in more recent cohorts. Trends for abstinence similar for males and females.
									Prevalence of alcohol abstinence	0 drinks	
White (2000)* 64	RCS	Australia	Not reported	1984-1996	12-17	31 529	1967-1984	Lifetime/ Current	Prevalence of any alcohol use	Weekly - 1+ occasions	No – trends similar for males and females.
									Prevalence of risky drinking	Not specified	
									Prevalence of alcohol abstinence	0 drinks	
									Total alcohol consumption	Weekly - n of drinks	
Wilsnack (2009) 65	SCS	Various[i.]	Gender, Alcohol and Culture: an International Study (GENACIS)	1997-2007	15+	113 901	1932-1989	Lifetime/ past 12 months/current	Prevalence of any alcohol use	1+ drinks	No – trends similar for males and females
									Prevalence of risky drinking	Weekly - 5+ occasions, yearly - 8468+ g ethanol	
									Prevalence of HED	Daily - 60+g	
									Prevalence of alcohol abstinence	0 drinks	
York (2004) 66	SCS	USA	Not reported	1999/2000	18+	2 631	1908-1982	Lifetime	Prevalence of any alcohol use	1+ drinks before age 15	Yes – greater decreases in age of onset among females drove gender convergence in age of onset and prevalence of first use before age 15 in more recent cohorts.
									Age of onset of alcohol use	1st drink before age 15	
Zhang (2008)* 67	Long.	USA	The Framingham Heart Study	1948-2003	18+	10 333	<1900-1959	Past month	Prevalence of risky drinking	m:25+g ethanol per day or 1+ HED occasions, f:13+g ehtanol per day or 1+ HED occasions	No – trends similar for males and females
									Cumulative incidence of AUD	ICD-9 alcohol abuse, dependence, withdrawl, alcoholic cardiomyopathy, alcoholic cirrhosis, delerium tremens, alcohol detoxification therapy	
									Total alcohol consumption	Daily - mean g ethanol	

Citation	Study Design[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered[b.]	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Zhong (2010) 68	RCS	USA	Monitoring the Future Study (MTF)	1980-2005	13-18	Not reported	1962-1992	Past 12 months/ past 2 weeks	Prevalence of any alcohol use	1+ drinks on 1+, 6+, 40+ occasions	No – trends similar for males and females.
									Prevalence of HED	5+ drinks on 1+ occasions	
									Prevalence of alcohol related problems	Drunk 1+, 6+, 40+ occasions	

RCS – Repeated cross-sectional surveys; SCS – Single cross-sectional surveys; APC – Age period cohort studies; Long. – Longitudinal.
*Included in quantitative synthesis. Studies were excluded if they did not collect data on a key indicator, did not report sample size, reported both male and female prevalence of indicator as less than 5%, raw prevalence estimates could not be extracted from the paper, or data were extracted from another study.
a. Study design refers to the way in which the data were analysed eg Analysis of single-wave data from repeated cross-sectional surveys were classed as single cross-sectional surveys. APC studies were conducted exclusively on repeated cross-sectional surveys.
b. Sample age and size refer in most cases to the entire survey/s. If subgroup analyses were conducted and full survey sample sizes were not reported, sample size refers to that of the subgroup. Cohorts covered refer to those included in the analyses. Estimates included in meta-analyses used sample ages, sizes and cohorts specific to each estimate.
c. Timeframe varied by indicator, survey occasion or country for some studies. Estimates included in meta-analyses used the timeframe specific to each estimate.
d. In some cases additional alcohol-related indicators were measured but did not contribute to assessment of gender convergence. For single cross-sectional studies, only indicators that were assessed over lifetime were included.
e. Belgium, China, Colombia, France, Germany, Israel, Italy, Japan, Lebanon, Mexico, New Zealand, Nigeria, South Africa, Spain, The Netherlands, Ukraine, United States.
f. Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Greenland, Hungary, Ireland, Lithuania, Norway, Poland, Portugal, Russian Federation, Sweden, Switzerland, United Kingdom, United States.
g. Belgium, Colombia, France, Germany, Israel, Italy, Japan, Lebanon, Mexico, New Zealand, South Africa, Spain, The Netherlands, Ukraine, United States.
h. Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Greenland, Hungary, Ireland, Israel, Lithuania, Norway, Poland, Portugal, Russian Federation, Sweden, Switzerland, United States.
i. Argentina, Australia, Belize, Brazil, Canada, Costa Rica, Czech Republic, Denmark, Finland, Germany, Hungary, Iceland, India, Ireland, Isle of Man, Japan, Kazakhstan, Mexico, New Zealand, Nicaragua, Nigeria, Norway, Peru, Spain, Sri Lanka, Sweden, Switzerland, The Netherlands, Uganda, United Kingdom, United States, Uruguay

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Table 5. Summary characteristics of included studies.

	Total (n=68)	
Characteristic	n	%
Design		
Repeated cross-sectional	48	70.6
Single cross-sectional	19	27.9
Longitudinal	1	1.5
World Region[a.]		
North America	25	36.7
Europe	27	39.7
Asia	4	5.9
Oceania	5	7.4
Other world region	2	2.9
>1 world region	5	7.4
Sample Age[a.]		
Adolescent & young adult (11-26)	18	26.5
Adult (18+)	28	41.2
Adolescent and adult (12+)	21	30.9
Sample Size[a.]		
1 000 - 4 999	16	23.5
5 000 – 9 999	11	16.2
10 000 – 19 999	10	14.7
20 000 – 49 999	9	13.2
50 000 – 99 999	10	14.7
>100 000	9	13.5
Indicator type (broad category and individual indicator)[b.]		
Indicators of any alcohol use	*35*	*51.5*
Prevalence of any use	26	38.2
Prevalence of abstinence	11	16.2
Total amount of alcohol consumed	19	27.9
Frequency of alcohol use	5	7.4
Indicators of problematic alcohol use	*30*	*44.1*
Prevalence of heavy episodic or binge drinking	10	14.7
Prevalence of risky drinking	16	14.9
Frequency of heavy episodic or binge drinking	5	7.4
Age of onset of alcohol use	8	11.8
Indicators of alcohol-related harms	*18*	*26.5*
Prevalence of alcohol-related problems or negative consequences	18	26.5
Prevalence of alcohol use disorder	13	19.1
Frequency of alcohol-related problems or negative consequences	4	5.9

a. Summary groupings are presented here, however, estimates included in meta-analysis coded country, sample age and size specific to each estimate. Sample size and age were not reported by all studies.
b. Percentages sum to >100% for alcohol indicators as many studies reported data on more than one indicator.

Table 6. Random effects meta-analysis pooled sex ratios for indicators of any alcohol use within 5-year birth cohorts

Birth cohort	N of individual sex ratio estimates	N of citations[1.]	N of countries	Random effects pooled sex ratio (95% CI)
1891-1910	23	7	6	2.2 (1.9-2.5)
1911-1915	25	9	9	2.4 (2.1-2.8)
1916-1920	34	9	9	2.4 (2.1-2.7)
1921-1925	42	13	12	2.3 (2.1-2.6)
1926-1930	47	14	12	2.4 (2.2-2.7)
1931-1935	54	19	14	2.3 (2.1-2.6)
1936-1940	56	19	15	2.3 (2.1-2.6)
1941-1945	58	20	16	2.1 (1.9-2.3)
1946-1950	60	19	18	2.0 (1.8-2.3)
1951-1955	57	20	18	2.0 (1.8-2.3)
1956-1960	56	21	18	2.0 (1.8-2.3)
1961-1965	52	20	17	2.0 (1.8-2.3)
1966-1970	48	18	18	2.0 (1.8-2.2)
1971-1975	45	20	20	1.7 (1.5-1.9)
1976-1980	45	20	21	1.5 (1.4-1.7)
1981-1985	58	19	35	1.3 (1.2-1.4)
1986-1990	40	11	30	1.2 (1.2-1.3)
1991-2000	33	6	27	1.1 (1.1-1.2)

1. Represents the number of citations from which the individual estimates were extracted. Some citations reported results from separate repeated cross-sectional surveys, or separate surveys conducted in a number of different countries.

Table 7. Random effects meta-analysis pooled sex ratios for indicators of problematic alcohol use within 5-year birth cohorts

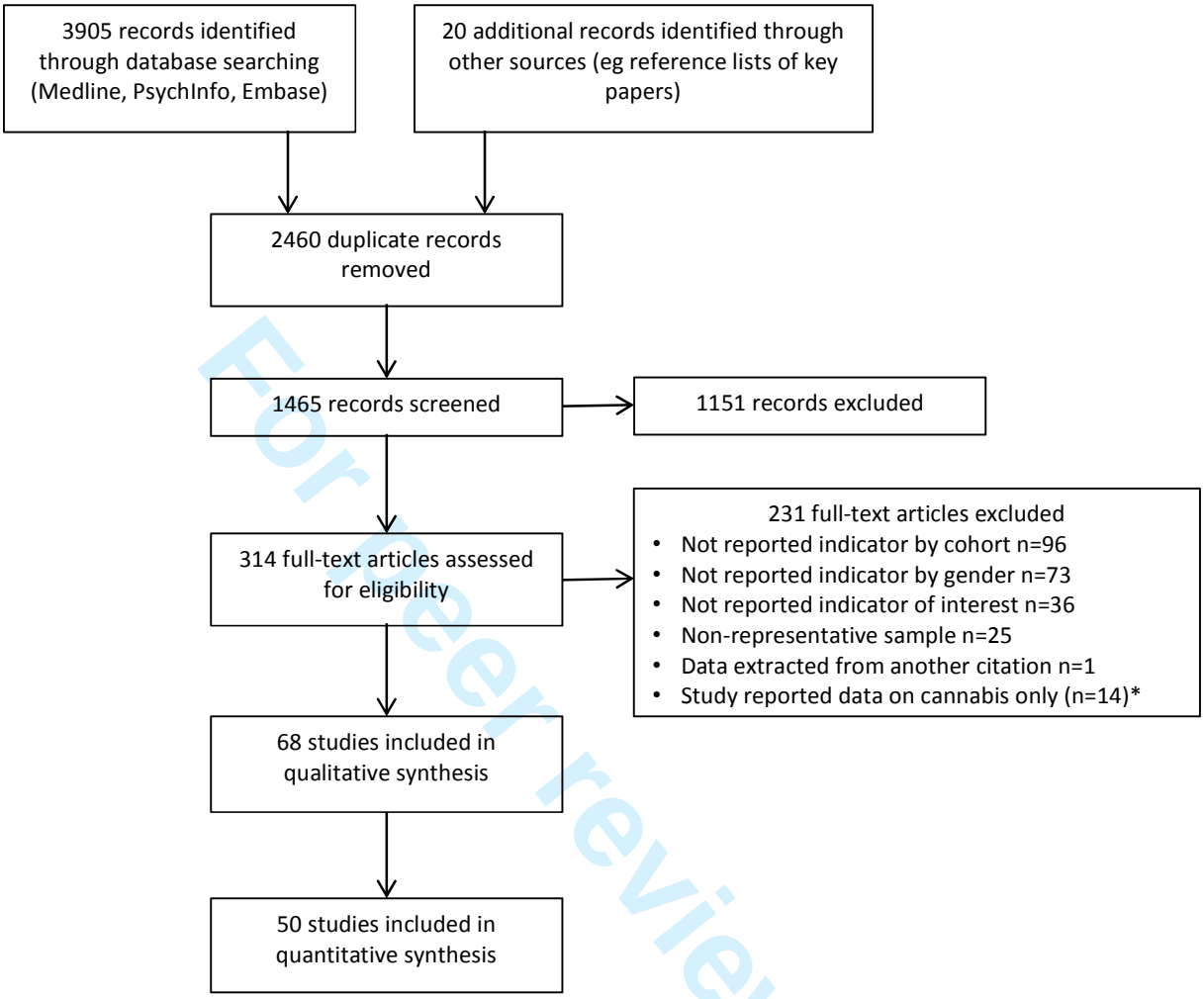
Birth cohort	N of individual sex ratio estimates	N of citations[1.]	N of countries	Random effects pooled sex ratio (95% CI)
1891-1910	12	6	6	3.0 (1.5-6.0)
1911-1915	12	6	9	2.7 (1.3-5.8)
1916-1920	18	8	9	2.8 (1.6-5.1)
1921-1925	19	7	12	2.2 (1.4-3.3)
1926-1930	21	9	12	2.2 (1.5-3.3)
1931-1935	22	9	14	2.3 (1.6-3.3)
1936-1940	31	15	15	2.3 (1.8-2.9)
1941-1945	31	14	16	2.3 (1.7-3.0)
1946-1950	35	16	18	2.0 (1.6-2.5)
1951-1955	33	15	18	2.2 (1.8-2.8)
1956-1960	34	16	18	2.0 (1.7-2.4)
1961-1965	27	13	17	2.1 (1.6-2.8)
1966-1970	28	15	18	2.0 (1.5-2.5)
1971-1975	27	15	20	2.0 (1.5-2.7)
1976-1980	28	15	21	1.9 (1.5-2.3)
1981-1985	27	14	35	1.6 (1.3-2.0)
1986-1990	13	6	30	1.2 (0.9-1.5)
1991-2000	4	3	27	1.2 (1.1-1.4)

1. Represents the number of citations from which the individual estimates were extracted. Some citations reported results from separate repeated cross-sectional surveys, or separate surveys conducted in a number of different countries.

Table 8. Random effects meta-analysis pooled sex ratios for indicators of alcohol-related harms within 5-year birth cohorts

Birth cohort	N of individual sex ratio estimates	N of citations[1.]	N of countries	Random effects pooled sex ratio (95% CI)
1891-1910	0	-	-	-
1911-1915	3	2	9	3.6 (0.4-30.4)
1916-1920	3	4	9	3.6 (0.4-30.4)
1921-1925	4	4	12	3.8 (0.8-18.1)
1926-1930	6	5	12	4.1 (1.4-11.8)
1931-1935	7	8	14	2.4 (1.6-3.6)
1936-1940	11	8	15	2.2 (1.6-2.9)
1941-1945	12	10	16	2.1 (1.6-2.8)
1946-1950	16	10	18	2.6 (1.8-3.6)
1951-1955	17	10	18	2.2 (1.6-2.9)
1956-1960	17	10	18	2.1 (1.6-2.9)
1961-1965	16	10	17	2.2 (1.6-2.9)
1966-1970	16	10	18	2.0 (1.6-2.7)
1971-1975	22	13	20	2.1 (1.7-2.7)
1976-1980	21	14	21	1.8 (1.5-2.1)
1981-1985	64	13	35	1.5 (1.3-1.6)
1986-1990	27	5	30	1.3 (1.2-1.4)
1991-2000	51	4	27	1.3 (1.2-1.3)

1. Represents the number of citations from which the individual estimates were extracted. Some citations reported results from separate repeated cross-sectional surveys, or separate surveys conducted in a number of different countries.



*Cannabis indicators were analysed separately and are reported elsewhere (Chapman et al., under review).

Figure 1. Flowchart of systematic review procedure for identifying citations reporting indicators of alcohol use and related harms by gender

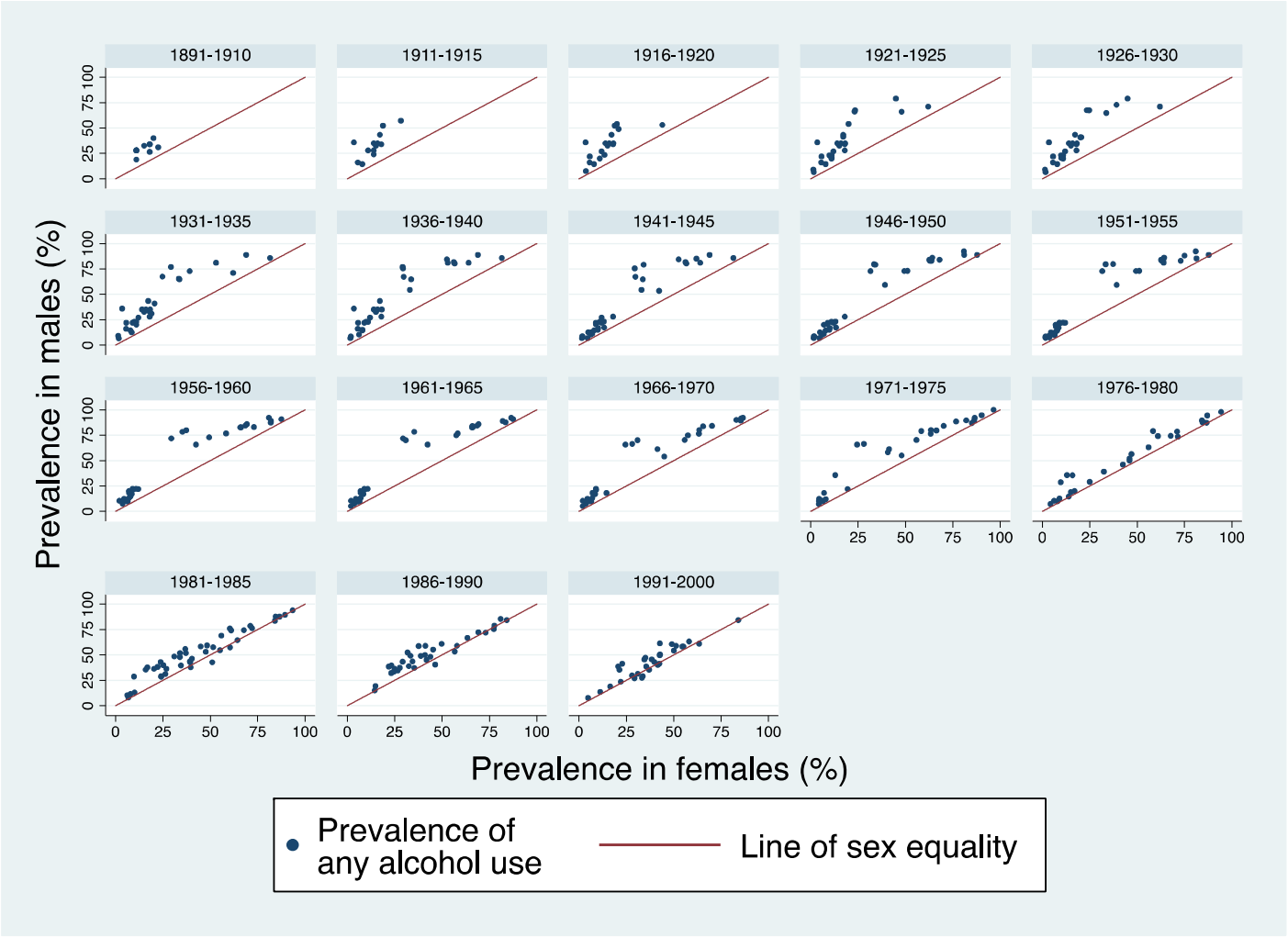


Figure 2. Prevalence of any alcohol use (%) in females (x-axis) and males (y-axis) by five-year birth cohort. Each dot represents a single prevalence estimate.

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	6-7
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6-7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	NA
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	8
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	27-29
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7-8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	10-11
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	10-11
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	NA
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	11
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	11-12

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	12
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	12
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	13
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	31-39
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	45-47
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	14-15
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	14-15
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16-17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16-18
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	19

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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Birth cohort trends in the global epidemiology of alcohol use and alcohol-related harms in men and women: systematic review and meta-regression

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Birth cohort trends in the global epidemiology of alcohol use and alcohol-related harms in men and women: systematic review and meta-regression

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Competing interests:

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: financial support for the submitted work from the Australian National Health and Medical Research Council [NHMRC APP1041129]; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributors:

TS and CC conceived of the study, developed and implemented the search strategy, independently screened article abstracts for inclusion, developed the data coding scheme, coded the data, analysed the data, and drafted and revised the paper. They are the guarantors. WS coded the data, and contributed to drafting and revising the paper. KK contributed to interpretation of the data and to drafting and revising the paper. ZT independently screened

article abstracts for inclusion, coded the data and contributed to drafting and revising the paper, MT conceived of the study and drafted and revised the paper.

Data sharing statement:

No additional data are available.

Abstract

Objective: Historically, alcohol use and related harms are more prevalent in men than in women. However, emerging evidence suggests the epidemiology of alcohol use is changing in younger cohorts. The current study aimed to systematically summarize published literature on birth cohort changes in male to female ratios in indicators of alcohol use and related harms.

Methods: We identified 68 studies that met inclusion criteria. We calculated male to female ratios for three broad categories of alcohol use and harms (any alcohol use, problematic alcohol use and alcohol-related harms) stratified by five-year birth cohorts ranging from 1891 to 2001, generating 1568 sex ratios. Random effects meta-analyses produced pooled sex ratios within these three categories separately for each birth cohort.

Findings: There was a linear decrease over time in the sex ratio for all three categories of alcohol use and related harms. Among those born in the early 1900s males were 2.2 (95% CI 1.9-2.5) times more likely than females to consume alcohol, 3.0 (95% CI = 1.5-6.0) times more likely to drink alcohol in ways suggestive of problematic use and 3.6 (95% CI = 0.4-30.3) times more likely to experience alcohol-related harms. Among cohorts born in the late 1900s males were 1.1 (95% CI 1.1-1.2) times more likely than females to consume alcohol, 1.2 (95% CI = 1.1-1.4) times more likely to drink alcohol in ways suggestive of problematic use and 1.3 (95% CI = 1.2-1.3) times more likely to experience alcohol-related harms.

Conclusion: Findings confirm the closing male-female gap in indicators of alcohol use and related harms. The closing male-female gap is most evident among young adults, highlighting the importance of prospectively tracking young male and female cohorts as they age into their 30s, 40s and beyond.

Strengths and limitations of this study

- Prior to this study the evidence around gender convergence in alcohol use and alcohol-related harms was fragmented. This study systematically summarized all available literature and provided a quantification of the rate of gender convergence through the derivation of a single metric – the male to female ratio in alcohol use and alcohol-related harms.
- This study was strengthened by its examination of 11 separate indicators of alcohol use and alcohol-related harms, summarized in three broad categories and showed that gender convergence was evident across all indicator categories.
- Whilst the derivation of a single metric facilitated numerical synthesis of data, the analyses are not independent of measurement variance.
- The current study did not test specific hypotheses for why the male-female gap in alcohol use and alcohol-related harms is closing.

Funding:

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Alcohol use and alcohol-related harms are among the most significant risk factors for burden of disease. Overall, they resulted in around 5 million deaths globally in 2010, and were responsible for more than 161 million years of life lost, equating to 5% of total global health burden [1]. Historically, the prevalence of alcohol use and related harms has been between 2 and 12 times higher in men than women [2-7]. However, there is emerging evidence to suggest that the gap between men and women in alcohol use and related harms is closing among more recently born cohorts [8-11]. Understanding sex-specific birth cohort trends in the epidemiology of alcohol use is vital as they point to key environmental and social mechanisms associated with population shifts in alcohol use patterns. For example, studies have attributed these generational shifts in sex-specific drinking to changes in traditional gender roles over time[5], changes in sex-specific attitudes toward drinking[12] and/or changes in the contexts and environments in which men and women now drink[4]. Furthermore, substantial changes over time in the sex distribution of alcohol use may require a rethink of effective health policies, resource allocation models and intervention strategies to combat the societal costs associated with use. In fact a recent evidence synthesis of the effectiveness of population-level alcohol policy interventions argued that with shifting sex-specific population trends in alcohol use there is a pressing need to understand the effectiveness of policy interventions separately for males and females[13].

Several individual studies have empirically addressed the question of sex differences in birth cohort effects on alcohol use. The most methodologically rigorous of these employs age-period-cohort (APC) modeling, a statistical approach designed to isolate temporal changes in prevalence that are independently associated with being in a specific birth cohort from changes associated with a specific age and/or a particular historical period. A subset of these APC analyses has examined whether the birth cohort effect is of the same magnitude for both men and women and reported mixed evidence[14-18] . For example, analyzing data from the

Finnish Drinking Habits Survey Harkonen et al. (2011)[14] found male to female convergence in the frequency of heavy episodic drinking (defined as 6+ drinks on one occasion for males and 4+ drinks on one occasion for females) in more recent cohorts. However, Keyes and Miech (2013)[17], demonstrated that while heavy episodic drinking (defined as 5+ drinks on one occasion for males and females) decreased in more recent birth cohorts there was little evidence of sex differences in this cohort effect. Over and above these APC studies a wider body of literature has explored, in more indirect ways, the changing epidemiology of alcohol use over time. A narrative synthesis carried out nearly ten years ago concluded that the male-female gap in alcohol problems appears to be narrowing in some countries [19].

However, in this narrative synthesis sex convergence was not numerically quantified making it difficult to judge the extent of the convergence. Moreover, the published literature on sex convergence in alcohol use has nearly doubled in size since 2008 indicating a timely need to revisit this issue. We report the results of a systematic review and meta-analysis of the male to female ratio in key indicators of alcohol use and related harm to enumerate the magnitude of any observed male-female convergence in alcohol use and related harms over time.

METHODS

Methods

The current systematic review followed guidelines for the conducting and reporting of meta-analyses of observational studies in epidemiology (MOOSE; [20]) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; [21 22]). The final reporting was informed by the findings of a systematic review of meta-analyses of observational studies in psychiatric epidemiology [23]. We used EppiReviewer Version 4 for the management of screening, coding and data extraction [24].

Study Inclusion Criteria

We used search terms that aimed to identify studies that reported on the following indicators of alcohol use and related harm: lifetime and/or current alcohol use disorder (abuse or dependence); alcohol-related problems (e.g. drunkenness, other negative consequences), alcohol-related treatment seeking; stages in the alcohol use and related problems cycle (e.g. onset of use, transition from use to disorder). We also explicitly looked for studies reporting data on commonly investigated drinking patterns (e.g. heavy episodic or binge drinking). We included studies published between January 1980 and June 2014 inclusive that:

1. measured at least one of the above indicators of alcohol use or related harm;
2. reported on a regionally or nationally representative population sample;
3. explicitly measured a cohort effect or presented indicator data across at least two birth cohorts; and
4. presented indicator data separately for males and females or carried out explicit comparisons between males and females (this included sex by time or sex by cohort interactions).

We included studies based on samples of high school or college students where these samples were regionally or nationally representative. We excluded studies that only sampled targeted groups within the population (e.g. people seeking treatment). The decision was made to focus only on representative population samples in order to characterize overall changes in general population means and prevalence estimates at regional and national levels. Full electronic search strategies including search terms are contained in Tables 1-3.

Insert Tables 1-3

Search Strategy

We searched three databases (Medline, EMBASE, PsychINFO) using three separate search strategies. The search strategies were developed by TS and CC in consultation with the librarian at the National Drug and Alcohol Research Centre (MK).

Search Strategy 1: aimed to identify studies that explicitly derived parameter estimates of changes over time in indicators of alcohol use and related harms. This strategy focused on keywords that are commonly used to describe age-period-cohort analyses (APC) and these were combined with database specific MeSH headings and keywords for alcohol use and related harms. Relevant MeSH terms were identified separately in each database and were "exploded" to capture the broadest possible set of alcohol studies. When subject headings did not accurately cover the target domain we added .mp to the search term (see Table 1).

Search Strategy 2: aimed to identify studies that focused on sex differences in alcohol use and related harms but did not explicitly conduct APC analyses. This strategy included search terms related to sex or gender, sex or gender convergence and sex or gender gap and these were combined with the broad database specific terms for alcohol and related harm outlined for search strategy 1 (see Table 2).

Search Strategy 3: aimed to identify studies that reported data split by sex and birth cohorts or by sex and age groups (as a proxy for birth cohorts) but did not explicitly conduct age-period-cohort analysis or examine sex convergence. In order to obtain adequate sensitivity and specificity this search was restricted to gold standard epidemiological studies based on guidelines developed for the WHO 2010 Global Burden of Disease study protocols [25] and used narrower terms to capture studies that have focused on alcohol use and related harms.

The initial search of the three databases was undertaken in January 2013 and then updated at the end of June 2014. All article abstracts were screened independently by one of the authors

(TS, CC, or ZT) to exclude those that were ineligible for inclusion. We obtained full texts of remaining articles and the same authors independently assessed them in detail for inclusion. Non-English texts were not included in the review. Approximately 20% of abstracts and full text articles were independently screened by a second reviewer. The electronic search strategy was supplemented by hand-searching of existing literature reviews and reference lists of key papers. TS developed the screening and data extraction codes in EppiReviewer and CC and ZT extracted data from included studies. WS and KK advised on the qualitative synthesis and WS checked extracted data from all included studies. TS checked extracted data for all studies included in the meta-analysis.

Figure 1 shows the number of articles obtained using the search strategy and number of records excluded with reasons. The present study had a secondary aim of examining evidence for the closing sex gap in indicators of cannabis use and the screening protocol was designed to screen records for both alcohol and cannabis. Findings with respect to cannabis are presented in another paper (Chapman et al., under review). The electronic search strategy identified 1445 unique records and an additional 20 records were retrieved via examining existing literature reviews and reference lists of key papers. After screening abstracts, 314 full text articles were retrieved and examined for inclusion. A total of 68 papers met the alcohol-related inclusion criteria. Quantitative synthesis was conducted on 50 studies. Table 4 provides detailed characteristics of all included studies by individual citation. Table 5 provides summary characteristics of all included studies.

Insert Figure 1 and Tables 4 and 5

Data extraction

Data were extracted in the following domains: study design, population, country, survey name, survey year, sample age, sample size, birth cohorts covered, indicators reported

including indicator definitions, definition timeframe and whether the authors reported evidence of gender convergence on any indicators of interest. Studies varied in the parameters used to define alcohol use and related harms. For example, studies reporting data on prevalence of any alcohol use differed with regard to timeframe (lifetime, past 12 months, current), definition of alcohol use (one or more standard drinks, 12+ or more standard drinks), frequency of drinking (weekly, monthly, yearly) and whether a continuous or categorical measure was used. Similarly, studies that measured alcohol related harms (e.g., abuse and dependence, alcohol related problems) differed in terms of diagnostic system (DSM-III, DSM-IIIR, DSM-IV), timeframe (lifetime, past 12 months) and type of negative consequence considered (e.g., drunkenness, drink-driving, risky sexual behaviour). Whilst some of these differences are methodological, others reflect important conceptual distinctions [26]. Attention to these methodological and conceptual distinctions resulted in an initial coding of 11 key indicators of alcohol use and related harm that were further grouped into three broad categories:

A. Indicators of any alcohol use, including:

1. Prevalence of any alcohol use (categorical),
2. Prevalence of alcohol abstinence (categorical),
3. Total amount of alcohol consumed (continuous),
4. Frequency of alcohol use (ordinal or continuous)

B. Indicators of alcohol use that is suggestive of problematic use, including:

5. Prevalence of heavy episodic or binge drinking (categorical),
6. Prevalence of risky drinking (categorical),
7. Frequency of heavy episodic or binge drinking (ordinal or continuous)

8. Age of onset of alcohol use (continuous)

C. Indicators of alcohol-related harms:

9. Prevalence of alcohol-related problems (categorical),

10. Prevalence of alcohol use disorder (categorical),

11. Frequency of alcohol-related problems (continuous)

See Table 4 for more details of individual indicator definitions for each included study.

Study quality

Study quality was rated based on the critical appraisal tool for use in systematic reviews addressing questions of prevalence developed by Munn et al. (2014;[27]), as well as the study design and analysis used to examine gender convergence in indicators of alcohol use and related harms. Level 1 studies were repeated cross-sectional studies that conducted Age-Period-Cohort analysis; Level 2 studies were repeated cross-sectional studies that separated age and cohort effects (either by presenting data across cohorts in a single age group or by presenting data across cohorts in separate age groups); Level 3 studies were repeated cross-sectional studies that did not attempt to separate age and cohort effects; Level 4 studies were single cross-sectional studies that reported lifetime estimates of at least one target indicator by sex and age groups (proxy for birth cohorts). Study quality was assessed for all included studies by two independent raters, with final ratings achieved through consensus.

Statistical analysis

In addition to the extracted qualitative data described above, quantitative data (e.g., percentages, means etc.) on the 11 key indicators for each available birth cohort for males and females were also extracted and summarized using meta-analysis. To facilitate

quantitative synthesis across varying indicator definitions we calculated a single metric, the male to female ratio, to express the relationship between male and female levels of alcohol use and related harms. This sex ratio represents the relative, not absolute, difference between males and females. A value greater than 1 indicates greater alcohol use or more alcohol-related harms in males compared to females. For two indicators, age of onset of alcohol use and alcohol abstinence, the ratio was reversed. Sex ratios on each of the 11 key indicators were calculated separately for each birth cohort in each study where data were available. For sex ratios based on binary indicators, estimates in which both the male and female prevalence fell below 5% (n=39, 2·4% of all estimates) were considered baserate outliers and not further analyzed. Sensitivity analyses indicated that this exclusion did not impact the overall findings. All sex ratios were logarithmically transformed and all meta-analyses were carried out on these logarithmically transformed values, with back-transformation for reporting purposes. Log sex ratios for binary indicators were considered equivalent to log risk ratios and standard errors were calculated accordingly. Standard errors for each (log) sex ratio derived from means of continuous indicators were calculated using formulae contained in Friedrich et al. [28]. Pooled (log) sex ratios with 95% CIs were calculated separately for each birth cohort with STATA (version 12.1). Significant heterogeneity, as assessed by the I-squared index, was evident. Thus, random-effects meta-analyses were carried out and statistical heterogeneity was handled using the Knapp-Hartung approach (Cornell, 2014). Random-effects meta-regression analyses, were carried out to determine how much of this heterogeneity in sex ratios was explained by birth cohort, controlling for important methodological characteristics. These characteristics included: age at the time of data collection, world region, study design and indicator timeframe. These analyses were carried out and are presented separately for each of the three broad alcohol indicator categories. Formal tests of publication bias were not applicable in the context of the current analysis.

RESULTS

Summary of characteristics of included studies

We identified 68 citations that met inclusion criteria (see Figure 1, Table 4, Table 5). Data used in the studies were collected between the years 1948 and 2014 representing birth cohorts from 1891 to 2000. One quarter of the studies used data collected across a twenty or more year timespan (n=16), five of which used data collected over 30 years or more. More than one third of studies (36·7%) were conducted in North America, 39·7% in Europe, 5·9% in Asia, 7·4% in Oceania, 2·9% in another world region and 7·4% across more than one world region. Study sample sizes ranged from 1056 to 809 281 (median: 15 144), 27·9% of studies had a sample size of >50 000, resulting in a combined total sample size of 4 426 673. The majority of studies were repeated cross-sectional studies (n=48), eight of which conducted APC analyses, 19 were single cross-sectional studies, and one used data from a longitudinal study. The most common assessment timeframe used was lifetime (n=27) followed by past 12 months (n=17). The most common indicator group examined was indicators of any alcohol use (N=35), followed by indicators of problematic alcohol use (N=30) and indicators of alcohol related harms (n=18). Following qualitative review, forty-two of the 68 studies reported evidence of sex convergence in more recent cohorts on at least one alcohol indicator (see Table 4). The majority of these (n=31; 73·8%) reported that convergence was driven by greater and/or more consistent increases in subsequent birth cohorts on one or more alcohol indicators among females compared to males. Six studies reported that convergence was driven by decreases in males across birth cohorts and five studies reported mixed findings depending on the country or indicator under investigation.

Individual study estimates

Of the 68 citations we identified 50 that provided indicator estimates separately for males and females across at least two separate birth cohorts. While not every citation provided estimates in every birth cohort, collectively these citations spanned birth cohorts starting in 1891 and ending in 2000. These citations allowed for the calculation of 1568 separate sex ratios, 845 related to any alcohol use, 439 to problematic alcohol use and 323 to alcohol-related harm. Due to low numbers of estimates the earliest four birth cohorts were collapsed into one category (1891-1910), as were the latest two birth cohorts (1991-2000). Amongst the subset of n=518 estimates based on categorical indicators of any alcohol use the matched female (X-Axis) and male (Y-Axis) prevalence estimates are graphed, by birth cohort, in Figure 2. A diagonal line is superimposed on each graph indicating where male and female estimates would be equal and therefore where the sex ratio would be one. As expected, most estimates fall above this line of equality, denoting a male excess in the prevalence of any alcohol use. However, in more recent birth cohorts, particularly those born from 1976 onwards, the estimates are shifting closer to the line of equality, indicating a narrowing of the male-female gap.

Insert Figure 2

Pooled results from meta-analyses

For all three broad indicator categories (any alcohol use, problematic alcohol use and alcohol-related harms) the pooled sex ratios declined over successive birth cohorts (see Tables 6-8). With regards to indicators of any alcohol use, the sex ratio was 2·2 (95% confidence intervals (CI) = 1·9-2·5) in the 1891-1910 birth cohort indicating that males born between 1891 and 1910 were around two times more likely to report any alcohol use than their female counterparts born during the same time. The sex ratios decreased to a low of 1·1 (95% CI = 1·1-1·2) in those born between 1991 and 2000. The same pattern of findings was evident for indicators of problematic alcohol use (declining from 3·0 (95% CI = 1·5-6·0) in the 1891-

1910 birth cohort to 1·2 (95% CI = 0·9-1·5) in the 1991-2000 birth cohort) and indicators of alcohol-related harm (declining from 3.6 (95% CI = 0.4-30.4) in the 1891-1910 birth cohort to 1·3 (95% CI = 1·2-1·3) in the 1991-2000 birth cohort). For all three broad indicator categories meta-regression analyses indicated that the sex ratio declined linearly across birth cohorts. For example, for indicators of any alcohol use when birth cohort was entered into the meta-regression as a continuous variable each successive five-year birth cohort was associated with a 4.2% (95% CI = 3.7%-4.6%, t=-16.14, p<0.001) decrease in the sex ratio. This effect remained once controlling for methodological characteristics. With these characteristics included in the model the sex ratio decreased linearly by 3.2% (95% CI = 2.4%-4.0%, t=-7.85, p<0.001) with each successive five-year birth cohort.

Insert Table 6

Insert Table 7

Insert Table 8

DISCUSSION

The current study summarized the available published literature on sex convergence in indicators of alcohol use and related harms across the world. By extracting estimates from studies and deriving a single metric, the male to female ratio, we were able to use meta-analysis to numerically summarize the overall relationship of male to female alcohol use, problematic alcohol use and alcohol-related harms. To our knowledge, this is the first study to do so. The results of the meta-analysis indicate that the male-female gap in alcohol use is closing over time.

The results of the qualitative review demonstrated support for sex convergence among more recent cohorts. Sixty-two percent of identified studies found evidence of sex convergence

among more recent cohorts on at least one of the 11 individual alcohol-related indicators, four of which were APC analyses. Meta-analysis confirmed these qualitative results indicating, for example, that the sex ratio in any alcohol use has decreased from 2·2 amongst those born in the earliest years of the 20th century to 1·1 amongst those born during the end of the 20th century. Follow-up analyses on the rate of change in sex ratios demonstrated that the decline in the sex ratio was steepest in cohorts born from 1966 onwards. For example, overall, the sex ratios for any alcohol use decreased by 4.2% with each successive five-year birth cohort between 1891 and 2000. However, this rate of change was 1.2% for successive cohorts born from 1891 to 1966 and 10.1% for cohort born from 1966 to 2000.

It is important to note that the sex ratio metric used in the current study provides information on the *relative* prevalence of alcohol use or related harms in males versus females. This metric does not empirically determine whether observed changes in the sex ratio are being driven by increases or decreases in male or female prevalence or whether, in fact, there is a more complex indicator-specific and/or birth cohort-dependent relationship between male and female alcohol use and/or harms that is driving the change in sex ratios over time. However, the qualitative review determined that of the 42 studies that reported some evidence for sex convergence in alcohol use or related harms, the majority of these reported that convergence was driven by greater and/or more consistent increases in indicators of alcohol use among females compared to males from more recent cohorts [5 6 8 9 11 14 15 29-52]. Within this context, it is interesting to note that 5% of the sex ratios were less than one, indicating that, in some cases, females have surpassed males in their drinking levels. The majority of such estimates (60%) came from cohorts born after 1981.

A number of limitations require discussion. We restricted our search to published studies and did not include an assessment of the grey literature, thus increasing the chances of publication bias. The databases searched were not exhaustive of all possible databases. However, they did

represent three of the largest and most commonly searched health-related databases. The pooling of estimates within birth cohorts across studies meant we are not able to utilize traditional publication bias assessments (e.g. [53]). However, our conclusions were informed most by large nationally representative surveys several of which were strengthened by APC analyses and it is unlikely that we would have missed large unpublished surveys or relevant APC studies that were only available in the grey literature. Moreover, our findings are consistent with the latest data on trends and social disparities in alcohol consumption in Organization for Economic Co-operation and Development (OECD) member countries around the world [54]. Whilst the derivation of a single metric facilitated numerical synthesis of data, the analyses are not independent of measurement variance. If, for example, definitions that are associated with smaller sex ratios were more likely to be used by studies reporting more recent cohorts, this could have inflated the observed cohort effect on sex convergence. Whilst the number of different definitions used by studies precludes direct testing of this effect, the fact that sex convergence across birth cohorts was found controlling for important methodological characteristics and across the three broad categories of indicators examined, implies that the finding is at least somewhat robust to the variability in methods and measurement across studies. Finally, 68% of studies included in the meta-analysis reported data on multiple indicators and as such a significant proportion of the sex ratios were derived from the same respondents within a given study. Whilst violating the assumption of independence, this multiplicity was far more often observed *across* rather than *within* the broad indicator categories. Given we pooled sex ratios within broad indicator categories this observation is unlikely to impact on the summary estimates.

The current study did not test specific hypotheses for why the male-female gap in substance use is closing. However, speculative explanations can be proposed. Changes over time in female gender role traditionality may be one explanation for the closing male-female gap. In

a large multi-country epidemiological study, Seedat et al. [5] measured female gender role traditionality using female to male ratios in factors such as the percentage participating in the labor force by age 35, the percentage with education levels in the upper quartile of the income distribution and the median age of first marriage. Using this definition they demonstrated that the narrowing sex differences in the prevalence of substance use disorders across birth cohorts were strongest in those countries where female and male roles were converging over time. Beyond the impact of changing gender role traditionality, some have suggested that broader social, cultural and economic developments explain converging patterns of substance use in males and females [55]. The large-scale GENACIS (Gender, Alcohol and Culture: An International Study) project has shown that sex differences in alcohol use are linked, albeit in complex ways, to greater engagement by females in paid employment outside the home [12]. In a novel examination of generational changes in female drinking over a period of three decades Alati et al. [56] demonstrated that the daughters of 1053 mother/daughter dyads had more than five times the odds of heavy drinking than their mothers had at the same age. Moreover, they demonstrated that this increase was partly accounted for by later age at child bearing thus providing much needed direct evidence on potential mechanisms driving the generational increase in alcohol consumption.

These results have implications for the framing and targeting of alcohol use prevention and intervention programs. Alcohol use and alcohol use disorders have historically been viewed as a male phenomenon. The present study calls this assumption into question and suggests that young women in particular should be the target of concerted efforts to reduce the impact of substance use and related harms. Those born in the most recent cohorts (i.e. the 1990s) can, by definition, only have a maximum age of between 15 and 25. That the birth cohort effect on sex ratios has become more pronounced in these more recent birth cohorts points to the value of continuing to focus research on adolescent and young adult sex-specific trends in

substance use. Given that this young age group are relatively early in their alcohol use careers these findings highlight the importance of further tracking young male and female cohorts as they age into their 30s, 40s and beyond.

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Table 1. Full electronic search strings for Search Strategy 1: studies that explicitly derived parameter estimates that reflect changes over time in indicators of alcohol and cannabis use and related harms.

Database	Search Group	Search Terms
EMBASE	Alcohol	**SH: exp alcohol consumption/ OR exp alcoholism/ OR exp alcohol abuse/ OR exp drinking behavior/ OR exp alcohol intoxication/**
	Cannabis*	**SH: exp cannabis/ OR exp substance abuse/ OR exp drug abuse/ OR exp drug dependence/** OR marijuana.mp (*marijuana used as a keyword because not mapped to separate MeSH*)
PsychINFO	Alcohol	**SH: exp Alcohol Drinking Patterns/**
	Cannabis*	**SH: exp cannabis/ OR exp marijuana usage/ OR exp Drug abuse/**
Medline	Alcohol	**SH: exp alcohol drinking/ OR exp alcohol-related disorders/**
	Cannabis*	**SH: exp cannabis/ OR exp marijuana abuse/ OR exp substance-related disorders/**
EMBASE, PsychINFO, Medline	Cohort Effect	((age period and cohort) OR cohort effect OR secular trend OR secular change OR time trend OR cohort trend OR birth cohorts OR younger cohort OR older cohort OR recent cohort OR earlier cohort).mp

Search groups were combined as follows: [Alcohol **OR** Cannabis] **AND** [Gender]

*Cannabis indicators were analysed separately and are reported elsewhere (Chapman et al., under review).

Table 2. Full electronic search strings for search strategy 2: studies that focused on gender differences in alcohol or cannabis use and related harms but did not explicitly conduct age-period-cohort analyses.

Database	Search Group	Search Terms
EMBASE	Alcohol	**SH: exp alcohol consumption/ OR exp alcoholism/ OR exp alcohol abuse/ OR exp drinking behavior/ OR exp alcohol intoxication/**
	Cannabis*	**SH: exp cannabis/ OR exp substance abuse/ OR exp drug abuse/ OR exp drug dependence/** OR marijuana.mp (*marijuana used as a keyword because not mapped to separate MeSH*)
PsychINFO	Alcohol	**SH: exp Alcohol Drinking Patterns/**
	Cannabis*	**SH: exp cannabis/ OR exp marijuana usage/ OR exp Drug abuse/**
Medline	Alcohol	**SH: exp alcohol drinking/ OR exp alcohol-related disorders/**
	Cannabis*	**SH: exp cannabis/ OR exp marijuana abuse/ OR exp substance-related disorders/**
EMBASE, PsychINFO, Medline	Gender	(((male AND female) OR (men AND women) OR sex OR gender) AND convergence).mp OR 'gender gap'.mp

Search groups were combined as follows: [Alcohol **OR** Cannabis] **AND** [Gender]

*Cannabis indicators were analysed separately and are reported elsewhere (Chapman et al., under review).

Table 3. Full electronic search strings for search strategy 3: studies which have examined indicators of alcohol or cannabis use or related harms by gender and birth cohort or gender and age groups (as a proxy for birth cohorts) but did not explicitly conduct age-period-cohort analysis or focus on gender convergence.

Database	Search Group	Search Terms
EMBASE	Alcohol	**SH: exp *alcohol consumption/ OR exp *alcoholism/ OR exp *alcohol abuse/ OR exp *drinking behavior/ OR exp *alcohol intoxication/**
	Cannabis*	**SH: exp *cannabis/ OR *substance abuse/ OR *drug abuse/ OR *drug dependence/ OR *drug abuse pattern/ OR *cannabis addiction/**
	Gold Standard Epidemiology	**SH: exp *population/ OR exp *health survey/ OR exp *health care survey/** OR (general population OR general community OR survey OR representative).mp
	Indicator	**SH: exp *prevalence/ OR exp *help seeking behaviour/ OR exp *health care utilization/** OR (prevalence OR health care utilization OR health care utilisation OR help seeking behaviour OR help seeking behaviour OR treatment seeking or service utilisation or service utilization).mp
PsychINFO	Alcohol	**SH: exp *Alcohol Drinking Patterns/**
	Cannabis*	**SH: exp *cannabis/ OR exp *marijuana usage/ OR *drug abuse/ OR *drug dependency/**
	Gold Standard Epidemiology	**SH: exp *surveys/** OR (general population OR general community OR survey OR representative).mp
	Indicator	**SH: exp *help seeking behavior/ OR exp *health care utilization/** OR (prevalence OR health care utilization OR health care utilisation OR help seeking behaviour OR help seeking behaviour OR treatment seeking).mp
Medline	Alcohol	**SH: exp *alcohol drinking/ OR exp *alcohol-related disorders/**
	Cannabis*	**SH: exp *cannabis/ OR exp *marijuana abuse/ OR exp *substance-related disorders**
	Gold Standard Epidemiology	**SH: exp *health surveys/ OR exp *health care surveys/** OR (general population OR general community OR survey OR representative).mp
	Indicator	**SH: exp *prevalence/** OR (prevalence OR health care utilization OR health care utilisation OR help seeking behaviour OR help seeking behaviour OR treatment seeking).mp
EMBASE, PsychINFO,	Age	(younger or older).mp

Medline

Search groups were combined as follows: [Alcohol OR Cannabis] AND [Gold Standard Epidemiology] AND [Indicator] AND [age]*Cannabis indicators were analysed separately and are reported elsewhere (Chapman et al., under review).

Table 4. Characteristics of included studies.

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Barnes (1997)	RCS	2	USA	Not reported	1983-1994	≈12-18	70 516	<1966-1982+	Past 12 months	Prevalence of any alcohol use	1+ drinks	Yes – greater increases among females for alcohol related problems drove convergence in more recent cohorts. Trends similar for males and females on other measures.
										Prevalence of HED	Monthly - 5+ drinks on 1+ occasions	
										Frequency of alcohol related problems	N of days with alcohol related consequences	
										Total alcohol consumption	Daily - mean oz ethanol	
Bergmark (2004)*	RCS	3	Sweden	Not reported	1979-2003	18-69	3 621	1910-1985	Past 12 months	Prevalence of HED	Monthly - 6+ drinks on 1+ occasions	Yes – increases among females and decreases among males in HED drove convergence in more recent cohorts. Trends for males and females similar on other measures.
										Prevalence of alcohol related problems	Drunk 1+ occasions	
										Prevalence of alcohol abstinence	0 drinks	
Bjork (2008)*	APC	1	Denmark	National Health and Morbidity Survey	1987-2005	50-75	15 144	1913-1955	Past week	Prevalence of risky drinking	Weekly - m: 22+ drinks , f: 15+ Drinks	Yes – increases in heavy drinking among females but not males drove convergence in more recent cohorts
Bloomfield (2001)*	RCS	3	Finland Germany Switzerland The Netherlands	Various	1981-1992	15-74	35 098	<1940 - 1949+	Lifetime Past 12 months Past week	Prevalence of risky drinking	Daily - m: 20g+, f: 40g+ ethanol	Yes – some evidence of convergence in Finland driven by greater increases in prevalence of risky drinking and consumption by females. Trends among males and females similar in other countries.
										Prevalence of alcohol abstinence	0 drinks	
										Total alcohol consumption	Daily - mean g ethanol	
Breslow (2003)*	SCS	4	USA	National Health Interview Survey (NHIS) Behavioural Risk Factor Surveillance System (BRFSS) National Household Survey on Drug Abuse (NHSDA)	2000-2001	12+	316 638	<1917-1936	Lifetime Past 12 months	Prevalence of risky drinking	Daily - 1+ drinks	No convergence – trends similar for males and females.
									Past month	Prevalence of alcohol abstinence	0 drinks	

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Bromet (2005)*	SCS	4	Ukraine	Ukraine World Mental Health Survey	2002	18+	4 725	<1953-1984	Lifetime	Prevalence of AUD	DSM-IV Abuse or dependence	Yes – greater and more consistent increases in prevalence among females drove gender convergence in more recent cohorts.
Brooks-Russell (2014)*	RCS	2	USA	Health Behaviour in School Aged Children Study (HBSC)	1998-2010	11-15	50 656	1983-1999	Lifetime Past 12 months	Prevalence of any alcohol use Prevalence of alcohol related problems	Monthly - 1+ drinks Drunk 1+ occasions	No convergence – trends similar for males and females
Cabrera (2003)*	RCS	2	Sweden	Not reported	1971-1993	70	3128	1901-1922	Not reported	Prevalence of any alcohol use	1+ drinks	No convergence – trends similar for males and females.
Colell (2013)*	RCS	2	Spain	Spanish National Survey on Drugs (EDADES)	1995-2009	15-64	131 330	1930-1994	Lifetime	Prevalence of any alcohol use Age of onset of alcohol use Cumulative Incidence of use	1+ drinks Age at 1st use Based on 1st occasion of use	Yes – greater decreases in age of onset and greater increases in prevalence among females drove convergence in more recent cohorts.
Degenhardt (2008)	SCS	4	Various[e.]	World Health Organisation World Mental Health Surveys (WHO-WMH)	2001-2005	16+	85 052	<1942-1987	Lifetime	Cumulative Incidence of use	Based on 1st occasion of use	Yes – greater increases among females drove gender convergence in more recent cohorts in 13 countries.
Grant (1997)*	SCS	4	USA	National Longitudinal Alcohol Epidemiology Survey (NLAES)	1992	18+	42 862	<1894-1974	Lifetime Past 12 months	Prevalence of any alcohol use Cumulative incidence of use Prevalence of AUD	Yearly - 12+ drinks Based on 1st occasion of use DSM-IV Alcohol dependence	No convergence – trends similar for males and females.
Grucza (2008a)*	RCS	2	USA	National Longitudinal Alcohol Epidemiologic Survey (NLAES) National Epidemiologic Survey on Alcohol and Related Conditions (NESARC)	1991-2002	18-57	85 955	1934-1983	Lifetime	Prevalence of any alcohol use Prevalence of AUD	Yearly - 12+ drinks DSM-IV alcohol dependence	Yes – increases in use among females but not males drove convergence in more recent cohorts.

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Grucza (2008b)*	RCS	2	USA	National Longitudinal Alcohol Epidemiology Survey (NLAES) National Epidemiologic Survey of Alcohol and Related Conditions (NESARC)	1991-2002	18+	85 955	1934-1983	Lifetime	Prevalence of AUD Age of onset of alcohol use	DSM-IV alcohol dependence Age at 1st use	Yes – greater decreases in onset of drinking among females drove convergence in age of onset and dependence in more recent cohorts.
Gum (2009)*	SCS	4	USA	National Comorbidity Survey – Replication (NCS-R)	2001-2003	18+	9 282	<1927-1985	Lifetime	Prevalence of AUD	DSM-IV alcohol abuse	Yes – greater increases in abuse among females drove convergence in more recent cohorts.
Hahm (2005)*	RCS	2	South Korea	Not reported	1984-1999	18-65	6 159	1920-1981	Lifetime	Prevalence of AUD Age of onset of AUD	DSM-IV alcohol abuse and dependence Age at 1st expereince of symptoms	Yes – increases in AUD among females and decreases among males drove gender convergence in more recent cohorts. Greater decreases in onset of AUD among females drove convergence in onset of AUD in more recent cohorts.
Harkonen (2011)*	APC	1	Finland	Drinking Habits Surveys	1968-2008	15-69	16 385	1898-1993	Past 12 months	Frequency of HED	Yearly - n of occasions m:6+ drinks, f:4+ drinks	Yes – greater and more consistent increases in frequency of HED among females drove convergence in more recent cohorts.
Hasin (2004)	SCS	4	USA	National Epidemiologic Survey of Alcohol and Related Conditions (NESARC)	2001-2002	18+	43 093	<1937-1984	Lifetime	Prevalence of AUD	DSM-IV alcohol dependence	No convergence – trends similar for males and females.
Hill (1993)*	RCS	2	Australia	Not reported	1984-1990	12-15	26 429 (1990)	1967-1978	Past week	Prevalence of any alcohol use	1+ drinks	No convergence - trends similar for males and females

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Hilton (1988)*	RCS	2	USA	Not reported	1964-1984	18+	9 739	<1900-1966	Past 12 months	Prevalence of any alcohol use	1+ drinks	No convergence - trends similar for males and females
										Prevalence of risky drinking	Daily - 1+ ounce ethanol	
										Frequency of alcohol use	Daily/Weekly/Monthly/Yearly	
										Frequency of HED	Weekly/Monthly 5+ drinks on 1+ occasions	
										Frequency of alcohol related problems	Weekly/Monthly drunk 1+ occasions	
Huckle (2011)*	RCS	2	New Zealand	Not reported	1995-2004	14-65	16 546	1930-1990	Past 12 months	Prevalence of any alcohol use	1+ drinks	No convergence – trends similar for males and females.
										Prevalence of HED	5+ drinks typical occasion	
										Total alcohol consumption	Yearly - n of drinks	
Johnson (1998)*	SCS	4	USA	National Household Survey on Drug Abuse (NHSDA)	1991-1993	12+	87 915	1919-1975	Lifetime	Prevalence of any alcohol use	1+ drinks before age 21	Yes - greater increases in use before 21 yrs among females drove convergence in more recent cohorts.
										Prevalence of regular use	Monthly - 1+ drinks before age 21	
Johnson (2000)	APC	1	USA	National Household Survey on Drug Abuse (NHSDA) National Survey on Drug Use and Health (NSDUH)	1982-1995	12+	Not reported	1935-1979	Lifetime	Incidence of alcohol use	Based on 1st occasion of use	No convergence – trends similar for males and females
Kallmen (2011)*	RCS	2	Sweden	Not reported	1997-2009	17-71	3439	1926-1992	Past 12 months	Prevalence of alcohol related problems	AUDIT - m:8+, f:6+	Yes – increases in problem drinking among females and decreases among males aged 61-71 drove convergence in more recent cohorts. Trends similar for males and females in other age groups.
Karam (2004)*	RCS	2	Lebanon	The IDRAC University Substance Use Monitoring Study	1991-1999	16-22+	4 308	<1970-1983	Lifetime	Prevalence of any alcohol use	1+ drinks	Yes – greater increases on all measures except abuse among females drove convergence in more recent cohorts.
										Prevalence of alcohol related problems	1+ alcohol related consequence	
										Prevalence of AUD	DSM-III/DSM-IV alcohol abuse and dependence	

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Kemm (2003)*	RCS	3	UK	General Household Survey	1978-1998	16+	≈20 000 per year	1902-1981	Past 12 months	Prevalence of alcohol abstinence	<1 drink	Yes – greater and more consistent increases in heavy drinking among females drove convergence in more recent cohorts.
										Prevalence of risky drinking	Weekly - m:22+ drinks, f:15+ drinks	
Kerr (2004)	APC	1	USA	National Alcohol Surveys (NAS)	1979-2000	18+	21 588	1901-1985	Past 12 months	Total alcohol consumption	Monthly - n of drinks (beer, wine, spirits)	No convergence – trends similar for males and females
Kerr (2009)*	APC	1	USA	National Alcohol Surveys (NAS)	1979-2005	18+	28 507	1900-1988	Past 12 months	Frequency of HED	Yearly - n of occasions 5+ drinks	Yes - greater increases among females drove convergence in HED. Trends for consumption similar for males and females
										Total alcohol consumption	Monthly - n of drinks (beer, wine, spirits)	
Kerr (2013)	APC	1	USA	National Alcohol Surveys (NAS)	1979-2010	18+	36 432	1900-1992	Past 12 months	Frequency of HED	Yearly - n of occasions 5+ drinks	No convergence – trends similar for males and females
										Total alcohol consumption	Yearly - n of oz ethanol (beer, wine, spirits)	
Keyes (2008)*	SCS	4	USA	National Epidemiologic Survey of Alcohol and Related Conditions (NESARC)	2001-2002	18+	43 093	1913-1984	Lifetime	Prevalence of HED	Weekly - 5+ drinks on 1+ occasions (heaviest drinking period)	Yes - greater and/or more consistent increases among females drove gender convergence on all indicators, especially in prevalence of HED
										Prevalence of AUD	DSM-IV alcohol abuse and dependence	
										Total alcohol consumption (HED)	Largest n of drinks on single occasion	
Keyes (2010)*	RCS	2	USA	National Epidemiologic Survey of Alcohol and Related Conditions (NESARC) National Longitudinal Alcohol Epidemiology Survey (NLAES)	1991-2002	18+	85 955	1934-1983	Lifetime	Age of onset of alcohol use	Age at 1st use	Yes – greater increases in rates of alcohol initiation and dependence among females drove gender convergence in more recent cohorts. However, greater decreases in time from 1st use to dependence among males drove divergence in more recent cohorts on this indicator.
										Time from 1st use to dependence	Years from age at 1st use to age at 1st symptoms DSM-IV alcohol dependence	
										Time from dependence to tmt	Years from age at first symptoms DSM-IV alcohol dependence to age at 1st treatment contact	
Keyes (2013)*	APC	1	USA	National Survey on Drug Use and Health (NSDUH)	1985-2009	12+	809 281	1910-1994	Past month	Prevalence of HED	Monthly - 5+ drinks on 1+ occasions	No convergence – trends similar for males and females

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Kim (2008)*	SCS	4	Hong Kong, China	Not reported	2006	18-70	9 860	1936-1988	Lifetime	Prevalence of any alcohol use	1+ drinks	Yes – greater increases among females drove convergence in more recent cohorts.
Kokkevi (2000)	RCS	3	Greece	Not reported	1984-1998	12-64	8 056	1920-1986	Past month	Prevalence of risky drinking	Monthly - 1+ drinks on 20+ occasions	Yes – greater increases among females drove convergence in more recent cohorts
Kraus (2000)*	RCS	2	Germany	Not reported	1994-1996	18-59	7 501	1935-1978	Lifetime	Prevalence of any alcohol use Prevalence of alcohol related problems Age of onset of alcohol use Cumulative probability of use	Monthly - 1+ drinks CAGE - 2+ Age at 1st regular use (monthly - 1+ occasions) Based on 1st occasion of regular use (monthly - 1+ occasions)	Yes – greater increases in use, and decreases in age of onset among females drove convergence in more recent cohorts.
Kuntsche (2006)*	RCS	2	Switzerland	Health Behaviour in School Aged Children Survey (HBSC)	1994-2002	≈15	3 792	1979-1987	Lifetime Past 12 months	Frequency of alcohol related problems Frequency of alcohol use	Drunk 0, 1, 2-3 occasions, 4-10 occasions, 10+ occasions never, < monthly, monthly, weekly, daily	No convergence - Analysis primarily focused on changes in reasons for drinking, however, trends on other measures were similar for males and females.
Kuntsche (2011)*	RCS	2	North America, Europe[f.]	Health Behaviour in School Aged Children Survey (HBSC)	1997-2006	≈15	77 586	1982-1991	Lifetime	Frequency of alcohol related problems	Drunk 0, 1, 2-3 occasions, 4-10 occasions, 10+ occasions	Yes – greater decreases in drunkenness among males drove convergence in Western countries. However, greater increases in drunkenness among females drove convergence in Eastern European countries.
Lim (2007)*	RCS	3	Singapore	National Health Survey (NHS)	1992-2004	18-69	12 375	1923-1986	Past 12 months Past month	Prevalence of any alcohol use Prevalence of HED	Weekly - 1+ drinks on 1-4 occasions, 1+ drinks on 5+ occasions Monthly - 5+ drinks on 1+ occasions	Yes – greater increases among females drove gender convergence in more recent cohorts.
Marques-Vidal (2005)*	RCS	3	Portugal	National Health Survey	1995-1999	15+	98 374	1920-1984	Past 12 months Past week	Prevalence of any alcohol use Total alcohol consumption	1+ drinks Daily - mean ml ethanol	No convergence – trends similar for males and females

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
McPherson (2004)*	RCS	2	New Zealand	Not reported	1995-2000	14-65	9 345	1930-1986	Past 12 months	Prevalence of risky drinking	Yearly - 20+L ehtanol	Yes – Increases on most indicators among females drove convergence in more recent cohorts. Males showed either smaller increases or no change depending on the indicator examined.
										Prevalence of alcohol related problems	Weekly - drunk 1+ occasions	
										Total alcohol consumption	Yearly - total ml ethanol	
										Frequency of alcohol use	Yearly - n of drinking occasions	
Melchior (2008)*	SCS	4	France	GAZEL Youth Study	1999	12-26	1 333	1973-1987	Lifetime	Prevalence of any alcohol use	1+ drinks	No convergence – trends similar for males and females
Meng (2014)*	APC	1	UK	General Lifestyle Survey (GLF)	1984-2009	16+	≈20 000 per year	1900-1994	Past 12 months	Prevalence of alcohol abstinence	0 drinks	Yes – increases in consumption among females and decreases among males drove convergence in more recent cohorts. Trends in abstinence similar for males and females.
										Total alcohol consumption	Weekly - mean n of drinks	
Mercer (1990)*	RCS	2	USA	Not reported	1977-1985	≈19-24	2 756	Not reported	Past 12 months	Prevalence of alcohol abstinence	0 drinks	Yes – greater increases among females on most measures drove convergence in more recent cohorts.
										Total alcohol consumption	Yearly - n of oz ethanol (beer, wine, spirits)	
										Frequency of alcohol use	0-11, never-daily	
										Total alcohol consumption (HED)	N of oz typical HED occasion	
Michaud (2006)	RCS	2	Switzerland	Swiss Multicenter Adolescent Surveys on Health (SMASH)	1993-2002	16-20	16 696	1973-1986	Lifetime	Prevalence of alcohol related problems	Drunk 2+ occasions & driving 1+ times while drunk or 2+ drinking occasions per day	No convergence - trends similar for males and females.
Naimi (2003)*	RCS	3	USA	Behavioural Risk Factor Surveillance System (BRFSS)	1993-2001	18+	724 479	<1939-1983	Past month	Prevalence of HED	Monthly - 5+ drinks on 1+ occasions	No convergence - trends similar for males and females
Nelson (1998a)*	SCS	4	Germany	Early Developmental Stages of Psychopathology Study (EDSP)	1994	14-24	3 021	1970-1980	Lifetime	Prevalence of any alcohol use	24+ drinks in any year	Yes – greater increases among females drove convergence in more recent cohorts.
										Prevalence of AUD	DSM-IV alcohol abuse and dependence	
										Age of onset of AUD	Age at 1st experience of symptoms	

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Nelson (1998b)	SCS	4	USA	National Comorbidity Survey (NCS)	1990-1992	15-54	8 098	1936-1975	Lifetime	Prevalence of AUD	DSM-IIIR alcohol dependence (any criterion)	Yes – greater decreases in age of symptom onset among females drove gender convergence in more recent cohorts.
										Age of onset of AUD	Age at 1st experience of symptoms	
										Age of onset of alcohol use	Age at 1st use	
Neve (1993)*	RCS	2	The Netherlands	Not reported	1958-1989	21-70	10 361	1888-1968	Past week	Prevalence of risky drinking	Weekly - m:22+ drinks, f:15+ drinks	Yes –greater and more consistent increases among females in consumption and risky drinking drove convergence in more recent cohorts. Trends for abstinence similar for males and females
										Prevalence of alcohol abstinence	0 drinks	
										Total alcohol consumption	Weekly - mean n of drinks	
Neve (1996)*	RCS	3	The Netherlands	Not reported	1958-1993	21-70	15 428	1888-1972	Past week	Prevalence of risky drinking	Weekly - m:22+ drinks, f:15+ drinks	No convergence - trends similar for males and females.
										Total alcohol consumption	Weekly - mean n of drinks	
										Prevalence of alcohol abstinence	0 drinks	
Osaki (2009)*	RCS	2	Japan	Not reported	1996-2004	≈12-18	324 562	≈1978-1988	Lifetime Past month	Prevalence of any alcohol use	1+ drinks	Yes – greater decreases in use among males drove convergence in more recent cohorts. Trends similar for males and females on other measures.
										Prevalence of risky drinking	1+ occasions every weekend, several occasions per week or 1+ occasions per day	
										Prevalence of HED	Monthly - 6+ drinks on 1+ occasions	
										Prevalence of alcohol related problems	1+ alcohol related consequence	
Parry (2005)*	SCS	4	South Africa	South African Demographic and Health Survey (SADHS)	1998	15+	13 826	<1934-1983	Lifetime	Prevalence of any alcohol use	1+ drinks	No convergence – trends similar for men and women
										Prevalence of alcohol related problems	CAGE : 2+	
Perkins (1992)	RCS	2	USA	Not reported	1979-1989	17-23	3 875	1956-1972	Past 12 months	Prevalence of Risky Drinking	Fortnightly - 31+ drinks	No convergence – trends similar for males and females
									Past 2 weeks	Prevalence of alcohol related problems	1+ alcohol related consequence	

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Raum (2007)*	SCS	4	Germany	ESTHER Study	2000-2002	50-75	9 953	1925-1952	Current	Total alcohol consumption	Daily - mean g ethanol	Yes – greater increases among females from more recent birth cohorts drove gender convergence
Roche (2002)	RCS	2	Australia	National Drug Strategy Household Survey (NDSHS)	1985-1995	12+	Not reported	1968-1981	Not reported	Prevalence of HED	m:5+ drinks, f:3+ drinks	Yes – greater increases among females drove convergence in more recent cohorts
Royo-Bordonada (1997)*	SCS	4	Spain	Not reported	1989	18+	2 495	<1924-1971	Lifetime	Prevalence of any alcohol use	1+ drinks	Yes – greater increases among females drove convergence in younger cohorts
Seedat (2009)	SCS	4	Various[g.]	World Health Organisation World Mental Health Surveys (WHO-WMH)	2001-2005	18+	72 933	<1937-1987	Lifetime	Prevalence of AUD	DSM-IV alcohol abuse and dependence	Yes – greater and/or more consistent increases among females drove convergence in more recent cohorts in 12 countries.
Simons-Morton (2009)*	RCS	2	Various[h.]	Health Behaviour in School Aged Children Survey (HBSC)	1998-2006	11-15	120 548	1983-1995	Lifetime Past month	Prevalence of any alcohol use Prevalence of alcohol related problems	Monthly - 1+ occasions Drunk 2+ occasions	Yes – greater increases in use among females drove gender convergence in more recent cohorts in 10 countries. Increases in drunkenness among females but not males drove gender convergence in more recent cohorts in 9 countries.
Smyth (2011)*	RCS	3	Ireland	Not reported	2002-2006	15-64	9 885	1935-1991	Lifetime	Age of onset of alcohol use	Age at 1st use	Yes – greater decreases in age of onset among females drove gender convergence in more recent cohorts.
Sourander (2012)*	RCS	2	Finland	Not reported	1998-2008	13-17	3 027	1981-1995	Current	Prevalence of any alcohol use Prevalence of alcohol related problems	Monthly - 1+ occasions Monthly/Weekly - Drunk 1+ occasions	No convergence – greater decreases on both measures among females drove gender divergence.
Stoltenberg (1999)	SCS	4	USA	Not reported	Not reported	Not reported	1 990	<1930->1949	Lifetime	Prevalence of AUD Age of onset of alcohol use	DSM-IIIR dependence before age 25 Age at 1st use	Yes - greater decreases in age of onset among females drove gender convergence in more recent cohorts. Trends for dependence before age 25 similar for males and females.
Vieno (2013)	RCS	2	Italy	Health Behaviour in School Aged Children Survey (HBSC)	2002-2010	11-15	13 174	1987-1999	Lifetime	Prevalence of alcohol related problems	Drunk 1+ occasions	Yes - decreases among males but not females drove convergence in 2 out of 5 regions in Italy.

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Villalbi (1995)*	RCS	2	Spain	FRISC Study	1987-1992	12-15	2 135	1972-1980	Lifetime/ Current	Prevalence of risky drinking	Daily - 1+ drinks	Yes – decreases in daily risky drinking among males but not females and increases in drunkenness among females but not males drove convergence in more recent cohorts.
				PASE Project						Prevalence of alcohol related problems	Drunk 1+, 2+ occasions	
Von Soest (2014)	RCS	2	Norway	Not reported	1992-2010	16-17	9 245	1975-1994	Past 12 months	Frequency of alcohol related problems	Yearly - Drunk 0-50+ occasions	No convergence – trends similar for males and females
Waern (2014)*	RCS	2	Sweden	Not reported	1976-2006	75	1 056	1901-1930	Current	Prevalence of risky drinking	Daily - 3+ drinks	Yes – increases in risky drinking among females but not males drove gender convergence in more recent cohorts. Trends for abstinence similar for males and females.
										Prevalence of alcohol abstinence	0 drinks	
White (2000)*	RCS	2	Australia	Not reported	1984-1996	12-17	31 529	1967-1984	Lifetime Current	Prevalence of any alcohol use	Weekly - 1+ occasions	No convergence – trends similar for males and females.
										Prevalence of risky drinking	Not specified	
										Prevalence of alcohol abstinence	0 drinks	
										Total alcohol consumption	Weekly - n of drinks	
Wilsnack (2009)	SCS	4	Various[i.]	Gender, Alcohol and Culture: an International Study (GENACIS)	1997-2007	15+	113 901	1932-1989	Lifetime Past 12 months Current	Prevalence of any alcohol use	1+ drinks	No convergence – trends similar for males and females
										Prevalence of risky drinking	Weekly - 5+ occasions, yearly - 8468+ g ethanol	
										Prevalence of HED	Daily - 60+g	
										Prevalence of alcohol abstinence	0 drinks	
York (2004)	SCS	4	USA	Not reported	1999/2000	18+	2 631	1908-1982	Lifetime	Prevalence of any alcohol use	1+ drinks before age 15	Yes – greater decreases in age of onset among females drove gender convergence in age of onset and prevalence of first use before age 15 in more recent cohorts.
										Age of onset of alcohol use	1st drink before age 15	

Citation	Study Design	Study quality[a]	Country	Survey Name	Survey Years Covered	Sample Age[b.]	Survey Sample Size[b.]	Cohorts Covered	Time-frame[c.]	Indicators Included[d.]	Indicator Definition	Evidence of Gender Convergence
Zhang (2008)*	Long.	2	USA	The Framingham Heart Study	1948-2003	18+	10 333	<1900-1959	Past month	Prevalence of risky drinking	m:25+g ethanol per day or 1+ HED occasions, f:13+g ehtanol per day or 1+ HED occasions	No convergence – trends similar for males and females
										Cumulative incidence of AUD	ICD-9 alcohol abuse, dependence, withdrawl, alcoholic cardiomyopathy, alcoholic cirrhosis, delerium tremens, alcohol detoxification therapy	
										Total alcohol consumption	Daily - mean g ethanol	
Zhong (2010)	RCS	2	USA	Monitoring the Future Study (MTF)	1980-2005	13-18	Not reported	1962-1992	Past 12 months Past 2 weeks	Prevalence of any alcohol use	1+ drinks on 1+, 6+, 40+ occasions	No convergence – trends similar for males and females.
										Prevalence of HED	5+ drinks on 1+ occasions	
										Prevalence of alcohol related problems	Drunk 1+, 6+, 40+ occasions	

RCS – Repeated cross-sectional surveys; SCS – Single cross-sectional surveys; APC – Age period cohort studies; Long. – Longitudinal.
*Included in quantitative synthesis. Studies were excluded if they did not collect data on a key indicator, did not report sample size, reported both male and female prevalence of indicator as less than 5%, raw prevalence estimates could not be extracted from the paper, or data were extracted from another study.

a. 1 = repeated cross-sectional studies that conducted Age-Period-Cohort analysis; 2 = repeated cross-sectional studies that separated age and cohort effects (either by presenting data across cohorts in a single age group or by presenting data across cohorts in separate age groups); 3 = repeated cross-sectional studies that did not attempt to separate age and cohort effects; 4 = single cross-sectional studies that reported lifetime estimates of at least one target indicator by sex and age groups (proxy for birth cohorts).
b. Sample age and size refer in most cases to the entire survey/s. If subgroup analyses were conducted and full survey sample sizes were not reported, sample size refers to that of the subgroup. Estimates included in meta-analyses used sample ages, sizes and cohorts specific to each estimate.
c. Timeframe varied by indicator, survey occasion or country for some studies. Estimates included in meta-analyses used the timeframe specific to each estimate.
d. In some cases additional alcohol-related indicators were measured but did not contribute to assessment of gender convergence. For single cross-sectional studies, only indicators that were assessed over lifetime were included.
e. Belgium, China, Colombia, France, Germany, Israel, Italy, Japan, Lebanon, Mexico, New Zealand, Nigeria, South Africa, Spain, The Netherlands, Ukraine, United States.
f. Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Greenland, Hungary, Ireland, Lithuania, Norway, Poland, Portugal, Russian Federation, Sweden, Switzerland, United Kingdom, United States.
g. Belgium, Colombia, France, Germany, Israel, Italy, Japan, Lebanon, Mexico, New Zealand, South Africa, Spain, The Netherlands, Ukraine, United States.
h. Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Greenland, Hungary, Ireland, Israel, Lithuania, Norway, Poland, Portugal, Russian Federation, Sweden, Switzerland, United States.
i. Argentina, Australia, Belize, Brazil, Canada, Costa Rica, Czech Republic, Denmark, Finland, Germany, Hungary, Iceland, India, Ireland, Isle of Man, Japan, Kazakhstan, Mexico, New Zealand, Nicaragua, Nigeria, Norway, Peru, Spain, Sri Lanka, Sweden, Switzerland, The Netherlands, Uganda, United Kingdom, United States, Uruguay

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Table 5. Summary characteristics of included studies.

	Total (n=68)	
Characteristic	n	%
Design		
Repeated cross-sectional	48	70.6
Single cross-sectional	19	27.9
Longitudinal	1	1.5
World Region[a.]		
North America	25	36.7
Europe	27	39.7
Asia	4	5.9
Oceania	5	7.4
Other world region	2	2.9
>1 world region	5	7.4
Sample Age[a.]		
Adolescent & young adult (11-26)	18	26.5
Adult (18+)	28	41.2
Adolescent and adult (12+)	21	30.9
Sample Size[a.]		
1 000 - 4 999	16	23.5
5 000 – 9 999	11	16.2
10 000 – 19 999	10	14.7
20 000 – 49 999	9	13.2
50 000 – 99 999	10	14.7
>100 000	9	13.5
Indicator type (broad category and individual indicator)[b.]		
Indicators of any alcohol use	*35*	*51.5*
Prevalence of any use	26	38.2
Prevalence of abstinence	11	16.2
Total amount of alcohol consumed	19	27.9
Frequency of alcohol use	5	7.4
Indicators of problematic alcohol use	*30*	*44.1*
Prevalence of heavy episodic or binge drinking	10	14.7
Prevalence of risky drinking	16	14.9
Frequency of heavy episodic or binge drinking	5	7.4
Age of onset of alcohol use	8	11.8
Indicators of alcohol-related harms	*18*	*26.5*
Prevalence of alcohol-related problems or negative consequences	18	26.5
Prevalence of alcohol use disorder	13	19.1
Frequency of alcohol-related problems or negative consequences	4	5.9

a. Summary groupings are presented here, however, estimates included in meta-analysis coded country, sample age and size specific to each estimate. Sample size and age were not reported by all studies.
b. Percentages sum to >100% for alcohol indicators as many studies reported data on more than one indicator.

Table 6. Random effects meta-analysis pooled sex ratios for indicators of any alcohol use within 5-year birth cohorts

Birth cohort	N of individual sex ratio estimates	N of citations[1.]	N of countries	Random effects pooled sex ratio (95% CI)
1891-1910	23	7	6	2.2 (1.9-2.5)
1911-1915	25	9	9	2.4 (2.1-2.8)
1916-1920	34	9	9	2.4 (2.1-2.7)
1921-1925	42	13	12	2.3 (2.1-2.6)
1926-1930	47	14	12	2.4 (2.2-2.7)
1931-1935	54	19	14	2.3 (2.1-2.6)
1936-1940	56	19	15	2.3 (2.1-2.6)
1941-1945	58	20	16	2.1 (1.9-2.3)
1946-1950	60	19	18	2.0 (1.8-2.3)
1951-1955	57	20	18	2.0 (1.8-2.3)
1956-1960	56	21	18	2.0 (1.8-2.3)
1961-1965	52	20	17	2.0 (1.8-2.3)
1966-1970	48	18	18	2.0 (1.8-2.2)
1971-1975	45	20	20	1.7 (1.5-1.9)
1976-1980	45	20	21	1.5 (1.4-1.7)
1981-1985	58	19	35	1.3 (1.2-1.4)
1986-1990	40	11	30	1.2 (1.2-1.3)
1991-2000	33	6	27	1.1 (1.1-1.2)

1. Represents the number of citations from which the individual estimates were extracted. Some citations reported results from separate repeated cross-sectional surveys, or separate surveys conducted in a number of different countries.

Table 7. Random effects meta-analysis pooled sex ratios for indicators of problematic alcohol use within 5-year birth cohorts

Birth cohort	N of individual sex ratio estimates	N of citations[1.]	N of countries	Random effects pooled sex ratio (95% CI)
1891-1910	12	6	6	3.0 (1.5-6.0)
1911-1915	12	6	9	2.7 (1.3-5.8)
1916-1920	18	8	9	2.8 (1.6-5.1)
1921-1925	19	7	12	2.2 (1.4-3.3)
1926-1930	21	9	12	2.2 (1.5-3.3)
1931-1935	22	9	14	2.3 (1.6-3.3)
1936-1940	31	15	15	2.3 (1.8-2.9)
1941-1945	31	14	16	2.3 (1.7-3.0)
1946-1950	35	16	18	2.0 (1.6-2.5)
1951-1955	33	15	18	2.2 (1.8-2.8)
1956-1960	34	16	18	2.0 (1.7-2.4)
1961-1965	27	13	17	2.1 (1.6-2.8)
1966-1970	28	15	18	2.0 (1.5-2.5)
1971-1975	27	15	20	2.0 (1.5-2.7)
1976-1980	28	15	21	1.9 (1.5-2.3)
1981-1985	27	14	35	1.6 (1.3-2.0)
1986-1990	13	6	30	1.2 (0.9-1.5)
1991-2000	4	3	27	1.2 (1.1-1.4)

1. Represents the number of citations from which the individual estimates were extracted. Some citations reported results from separate repeated cross-sectional surveys, or separate surveys conducted in a number of different countries.

Table 8. Random effects meta-analysis pooled sex ratios for indicators of alcohol-related harms within 5-year birth cohorts

Birth cohort	N of individual sex ratio estimates	N of citations[1.]	N of countries	Random effects pooled sex ratio (95% CI)
1891-1910	0	-	-	-
1911-1915	3	2	9	3.6 (0.4-30.4)
1916-1920	3	4	9	3.6 (0.4-30.4)
1921-1925	4	4	12	3.8 (0.8-18.1)
1926-1930	6	5	12	4.1 (1.4-11.8)
1931-1935	7	8	14	2.4 (1.6-3.6)
1936-1940	11	8	15	2.2 (1.6-2.9)
1941-1945	12	10	16	2.1 (1.6-2.8)
1946-1950	16	10	18	2.6 (1.8-3.6)
1951-1955	17	10	18	2.2 (1.6-2.9)
1956-1960	17	10	18	2.1 (1.6-2.9)
1961-1965	16	10	17	2.2 (1.6-2.9)
1966-1970	16	10	18	2.0 (1.6-2.7)
1971-1975	22	13	20	2.1 (1.7-2.7)
1976-1980	21	14	21	1.8 (1.5-2.1)
1981-1985	64	13	35	1.5 (1.3-1.6)
1986-1990	27	5	30	1.3 (1.2-1.4)
1991-2000	51	4	27	1.3 (1.2-1.3)

1. Represents the number of citations from which the individual estimates were extracted. Some citations reported results from separate repeated cross-sectional surveys, or separate surveys conducted in a number of different countries.

Figure 1. Flowchart of systematic review procedure for identifying citations reporting indicators of alcohol use and related harms by gender

Figure 2. Prevalence of any alcohol use (%) in females (x-axis) and males (y-axis) by five-year birth cohort. Each dot represents a single prevalence estimate.

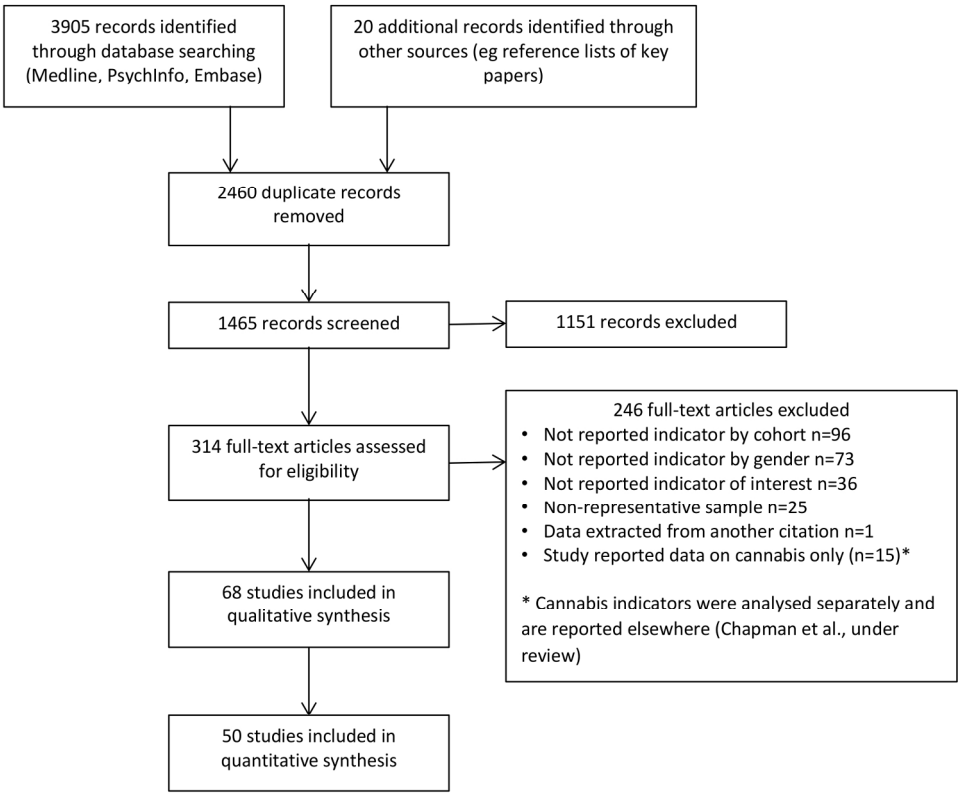

Figure 1. Flowchart of systematic review procedure for identifying citations reporting indicators of alcohol use and related harms by gender

178x150mm (300 x 300 DPI)

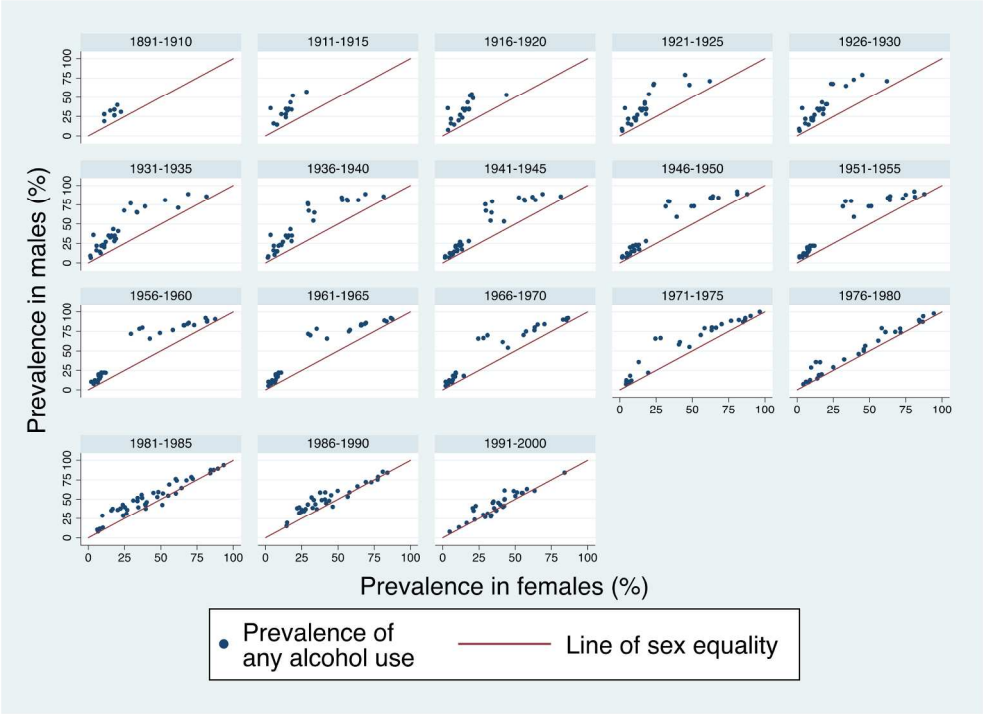

Figure 2. Prevalence of any alcohol use (%) in females (x-axis) and males (y-axis) by five-year birth cohort. Each dot represents a single prevalence estimate

200x147mm (300 x 300 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	6-7
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6-7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	NA
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	8
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	27-29
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7-8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	10-11
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	10-11
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	NA
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	11
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	11-12

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	12
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	12
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	13
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	31-39
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	45-47
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	14-15
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	14-15
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	16-17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16-18
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	19

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