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Birth cohort effects and gender differences in alcohol epidemiology: a review and synthesis

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Abstract

Background—Alcohol consumption has demonstrated substantial temporal trends, with some evidence suggesting strong birth cohort effects. The identification of at-risk birth cohorts can inform the interpretation of alcohol trends across age, time, and demographic characteristics such as gender. The present literature review has two objectives. First, we conduct a cross-national review of the literature on birth cohort differences in alcohol consumption, disorder, and mortality. Second, we determine the consistency of evidence for birth cohort effects on gender differences.

Methods—A search was conducted and key data on population characteristics, presence and direction of cohort effects, and interactions with gender compiled. Thirty-one articles were included.

Results—Evidence suggests that younger birth cohorts in North America, especially those born after World War II, are more likely than older cohorts to engage in heavy episodic drinking and develop alcohol disorders, but this cohort effect is not found in Australia and Western Europe. Cross-nationally, substantial evidence indicates that women in younger cohorts are at especially high risk for heavy episodic drinking and alcohol disorders.

Discussion—Younger birth cohorts in North America and Europe are engaging in more episodic and problem drinking. The gender gap in alcohol problems is narrowing in many countries, suggesting shifting social norms surrounding gender and alcohol consumption. These trends suggest that public health efforts to specifically target heavy drinking in women are necessary.

Introduction

The World Health Organization has called for the development of global strategies to reduce alcohol consumption (Casswell and Thamarangsi 2009), noting the high social, medical, and economic costs of excessive alcohol consumption worldwide (Rehm, Mathers et al. 2009). A greater understanding of temporal and geographic variation in key indicators of alcohol consumption (e.g., incidence of heavy episodic drinking, development of alcohol disorders,

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and alcohol-related mortality) is critical to achieving such a reduction. The assessment of birth cohort effects in these indicators can serve three important purposes. First, the identification of birth cohorts at high risk for alcohol-related problems can inform research on etiology by suggesting exposures specific to particular birth cohorts that can be investigated. Second, cohort effects are important to identify for methodological reasons; if time trends are attributable to birth cohort effects, then alcohol trend data should be aggregated and presented by cohort rather than the traditional aggregation by time period. Finally, identification of increased alcohol consumption and related problems in more recently born birth cohorts is important for public health planning and resource allocation.

Concerning etiologic research, birth cohort effects suggest unique social, political and environmental factors to which members of each birth cohort are exposed as they progress through the life course impact health in potentially important ways (Keyes, Utz et al. 2010). Skog and others have written about the “collectivity” of drinking cultures that is both geographically and temporally defined (Skog 1985; Room and Makela 2000; Ahern, Galea et al. 2008), creating the emergence of group-level variation in alcohol use that is distinct from individual-level variation in risk factors for alcohol use. Individuals within certain birth cohorts come of age during specific socio-political moments, sharing experiences that impact health and well-being at critical periods of the life course. Economic fluctuation, political instability, policies and laws, and social norms are group-level exposures that can vary between time periods and countries, potentially impacting particular birth cohorts in ways that affect their risk for problematic alcohol consumption and disorder. Identifying group-level exposures that impact the alcohol outcomes of certain birth cohorts may thus have substantial public health relevance for future prevention efforts.

Cohort effects are also important to identify for methodological reasons, as the presence of these effects obscures the interpretation of age-related trends in alcohol and drug outcomes. For example, cross-sectional studies consistently find that the prevalence of current alcohol consumption and disorders is lower among older individuals compared to younger individuals (Grant 1997; Johnson, Gruenewald et al. 1998; Hasin, Stinson et al. 2007). Prospective studies, however, show mixed results; while some studies demonstrate drinking reductions with age (Adams, Garry et al. 1990; Fillmore, Hartka et al. 1991; Caetano and Kaskutas 1995; Eigenbrodt, Mosley et al. 2001), many others show no change or even increases (Gordon and Kannel 1983; Klatsky, Siegelau et al. 1983; Glynn, Bouchard et al. 1985; Hubert, Eaker et al. 1987; Neve, Diederiks et al. 1993; Levenson, Aldwin et al. 1998; Wilsnack, Wilsnack et al. 2009). The discrepancy between cross-sectional and prospective findings could be a result of birth cohort effects. Individuals in cross-sectional studies represent many different birth cohorts; thus, age effects are difficult to separate from cohort effects. Conversely, individuals studied prospectively typically include only one or a few birth cohorts of individuals, making cohort effects difficult to detect because of a lack of adequate data across multiple birth cohorts. Examining findings from datasets with various sampling strategies and the estimation of formal age-period-cohort models may shed light on these seemingly discrepant results.

Differences in the effect of birth cohort on demographic risk factors may necessitate the replacement of old assumptions with new information. An important example concerns gender and alcohol. Greater risk in males is well-documented across countries and cultures (Brady and Randall 1999; Nolen-Hoeksema 2004; Nolen-Hoeksema and Hilt 2006; WHO 2011). However, recent evidence suggests a diminishing gender gap in the prevalence of alcohol use and disorders among more recently born cohorts (Gruzca, Norberg et al. 2008; Keyes, Grant et al. 2008; Seedat, Scott et al. 2009; Wilsnack, Wilsnack et al. 2009). A cohort-specific increase in female drinking would signal the need for increased prevention and intervention efforts to address drinking problems in the birth cohorts identified at

heightened risk. Further, if gender differences are truly diminishing, the paradigm of alcohol problems being a male-dominated health outcome will need to be shifted. Critical, careful review of the consistency of these findings across study designs and samples is therefore crucial, as the public health implications of such a major change are substantial.

To date, there have been no systematic reviews of information available regarding cohort effects on alcohol indicators across time, geographic location, and gender. This report aims to review and synthesize the existing population-based information on cohort effects for three alcohol consumption indicators: 1) lifetime prevalence of alcohol consumption; 2) current prevalence of alcohol consumption; and 3) lifetime prevalence of alcohol disorders, problems, and alcohol-related mortality. These outcomes were chosen to reflect key indicators of alcohol use across the life-course: initial use as represented by lifetime any alcohol consumption, regular patterns of alcohol consumption in terms of quantity and frequency, and alcohol-related problems such as alcohol use disorders and alcohol-attributable mortality. The review addresses three questions with respect to each of these outcomes: a) Is there evidence for a cohort effect, with risk higher in more recently born birth cohorts? b) Does the cohort effect vary cross-nationally? and c) Is there evidence for differences in the cohort effect across gender?

Methods

Selection of articles

Materials for this review were primarily identified through searches of three electronic databases for peer-reviewed published papers: the MEDLINE/Pubmed, PsychInfo, and Scopus. Search terms were selected based on initial review of relevant subject headings across databases that were likely to yield relevant results. Using MEDLINE/Pubmed, initial search terms included: “age-period-cohort” or “birth cohorts” and “alcohol” (N=47), “liver” (N=47), “cirrhosis” (N=21), “substance use” (N=10). We then added a search term for “gender” (N=2) and “women” (N=18). Using PsychInfo, initial search terms included: “cohort analysis”, “time trends” and “alcohol drinking patterns” (N=27), “liver” (N=26), “cirrhosis” (N=24), and “substance abuse” (N=15), and a search terms for “gender” (N=27) and “women” (N=13). Using Scopus, initial search terms included: “age-period-cohort” and “alcohol” (N=20) “liver” (N=18) “cirrhosis” (N=6), “substance abuse” (N=1) and additional search terms for “gender” (N=1) and “women” (N=1). A search of related articles in these databases, references in relevant papers, and consultation with recognized experts yielded additional 8 papers for review.

Figure 1 details the process of article refinement for inclusion in the review. After duplicate articles were removed, an initial set of 151 papers was reviewed. Inclusion criteria were as follows: (1) published in the last 20 years (i.e., after 1988, in order to focus the review on the most recent information regarding birth cohort effects); (2) written in English; (3) peer-reviewed; (4) original research (i.e., no review articles); (5) population- or community-based sample; (5) directly assessed possible cohort effects by comparing at least two birth cohorts; (6) included alcohol use, alcohol use disorder, or alcohol-related mortality as an outcome.

The final number of papers included was 31. Four articles included more than one outcome that was relevant to the present review (Grant 1997; Levenson, Aldwin et al. 1998; Keyes, Grant et al. 2008; Zhang, Guo et al. 2008); these outcomes were considered separately, for a total of 31 papers and 35 outcomes assessed.

Measures and definitions

Lifetime prevalence of alcohol use was defined as either the lifetime proportion of alcohol use (percentage of population who have ever used alcohol) or as the incidence density of alcohol use (percentage of new alcohol users per unit of person-time at risk of alcohol).

Prevalence of current alcohol use was defined as the proportion of alcohol users in a specified time frame (e.g., past week, month, or year).

Alcohol disorders/problems included any prevalent DSM (substance abuse or dependence) or ICD (harmful substance use or substance dependence) defined alcohol disorder, chart review for alcohol problems, or scales capturing alcohol-related impairment in social, occupational, or physical domains.

Alcohol-attributable morbidity/mortality was included as an outcome for papers that examined morbidity and mortality that is solely caused by alcohol (e.g., ICD-10 codes F10 [mental and behavioral disorders due to use of alcohol], X45 [accidental poisoning by and exposure to alcohol], and Y15 [poisoning by alcohol, undetermined intent]), or for which alcohol is a primary contributing case (e.g., ICD-10 code K70 [alcoholic liver disease]).

Identification of cohort effects: quality of evidence

We separated the studies into three quality levels of evidence, hierarchically organized by the rigor of the statistical modeling and the appropriateness of the dataset to answer age-period-cohort research questions. For convenience, we labeled these as Levels 1, 2 and 3.

Studies given a (1) provided the most rigorous evidence. These include cross-sectional studies repeated over time as well as panel designs (longitudinal follow-ups of sequential cohorts), and formal statistical modeling to decompose variance in trends over time into components that can be attributed to age, period, and cohort. We note that modeling of APC effects remain an ongoing statistical debate (Keyes, Utz et al. 2010), full elaboration of which is outside the scope of this review. All articles included in this review utilize common and well-documented methods for APC analysis.

Those studies given a (2) provided an intermediate level of evidence in terms of methodological rigor. These include longitudinal cohort studies with a limited number of birth cohorts (as opposed to panel designs with a greater number of birth cohorts), with and without statistical age-period-cohort models. While longitudinal studies offer more rigorous evidence for cohort effects than single time point cross-sectional studies, period and age effects are difficult to unconfound with cohort effects in the longitudinal design due to the often restricted variation in birth cohorts, and the fact that the cohorts age simultaneously with time so age and period effects cannot be disentangled.

Those studies given a (3) are those providing the least rigorous evidence, and for which the most caution should therefore be taken during synthesis and inference. Cross-sectional studies make up the majority of this category, since they offer the advantage of readily-available data. However, one-time cross-sectional studies rely heavily on retrospectively reported information, raising methodological issues in the validity of retrospective recall. Further, age and cohort effects cannot be rigorously disentangled in the cross-sectional design, as respondents' current age at the time of the survey determines birth cohort. However, cross-sectional studies often control for a collection of important confounders, thus, we include these types of APC analyses in this review, but use caution in interpreting the results. We included only those cross-sectional studies that report on birth cohorts, rather than cross-sectional studies that report differences across age alone. While age can be used

as a proxy for cohort in the cross-sectional design, we focused on studies that explicitly aimed to estimate parameters for birth cohorts.

Results

Lifetime prevalence of alcohol use

Seven studies examined cohort effects in the lifetime prevalence of alcohol use (Grant 1997; Johnson and Gerstein 1998; Degenhardt, Lynskey et al. 2000; Johnson and Gerstein 2000; Degenhardt, Chiu et al. 2007; Keyes, Grant et al. 2008; van Heerden, Grimsrud et al. 2009). Only one study of the lifetime prevalence of alcohol consumption had a level (1) (i.e., most rigorous) methodology to examine evidence for cohort effects in the lifetime prevalence of alcohol use (Johnson and Gerstein 2000). This study did not find evidence for cohort effects in the incidence density of alcohol initiation among repeated assessments of young adults aged 10–24 in the U.S. Measures of incidence and population at risk were reconstructed through retrospective reports. Restricted age range of this study could account for the lack of a demonstrated cohort effect for alcohol initiation, although cohort effects were detected for other outcomes (i.e., marijuana) in the same sample.

The remaining six studies (four based in the U.S., one in Australia and one in South Africa) were level three (i.e., cross sectional) studies, using questions on whether the respondent has ever consumed alcohol as a measure of lifetime prevalence. Of these six, Grant (Grant 1997), Keyes et al. (Keyes, Grant et al. 2008), Johnson & Gerstein (Johnson and Gerstein 1998), van Heerden et al. (van Heerden, Grimsrud et al. 2009) and Degenhardt et al. 2007 (Degenhardt, Chiu et al. 2007) report that the cumulative proportion of lifetime alcohol use has increased in younger cohorts in the U.S., especially those born after World War II.

Five of the seven studies examining lifetime prevalence of alcohol use were conducted in the U.S., and of these, four reported a cohort effect with the highest risk in the latest born cohort (Grant 1997; Johnson and Gerstein 1998; Degenhardt, Chiu et al. 2007; Keyes, Grant et al. 2008). Van Heerden et al. (2009) reported a similar effect in South Africa. In contrast, Degenhardt et al. 2000 (Degenhardt, Lynskey et al. 2000) reports no similar cohort effect in Australia. Explanation for the discrepancy can be drawn from different drinking patterns between countries; 27.2% of individuals in the oldest cohort of a U.S. sample (born 1894–1937) were lifetime abstainers (Grant 1997), while less than 3% of individuals in approximately the same birth cohort (born 1904–1932) were lifetime abstainers in the Australian sample (Degenhardt, Lynskey et al. 2000).

The four studies that assessed lifetime alcohol use by gender all reported converging rates across successively more recent birth cohorts, including the level (1) methodology study (Johnson and Gerstein 2000); male to female ratios approached 1.0 in the most recent cohorts in Johnson & Gerstein (1998), 1.2 in Grant (Grant 1997), and 1.0 in Johnson & Gerstein (2000). A significant interaction between cohort and gender was reported in Keyes et al. (Keyes, Grant et al. 2008), with the gender ratio in lifetime initiation of alcohol decreasing from 1.94:1 to 1.54:1.

Current alcohol consumption prevalence

Table 1 shows selected information on the 15 studies that assessed the prevalence of alcohol consumption. Five studies were level (1) methodology, indicating the most rigorous evidence for cohort effects. All five reported evidence of a cohort effect, and three studies report reported that youngest cohort was at the highest risk for heavy episodic drinking (Kemm 2003; Kerr, Greenfield et al. 2009) or high household alcohol expenditure (Aristei, Perali et al. 2008). A fourth study reported that that youngest cohort consumed the highest quantity of alcohol, although this effect was restricted to women (Bjork, Thygesen et al.

2008). Kerr et al. (Kerr, Greenfield et al. 2004) is the only study to examine beverage specificity; this study reported birth cohort variation in type of beverage consumed, with spirit consumption highest in older born U.S. cohorts (those born before 1940). Beer and wine consumption was highest in cohorts born 1965–1976 (men) and pre-1940 (women), respectively.

Among the four studies at an intermediate level of rigor (level (2)), three studies reported that a cohort effect was observed, but the youngest cohort was not at the highest risk for the outcome (Menard and Huizinga 1989; Moore, Gould et al. 2005; Zhang, Guo et al. 2008); cohorts found to be at high risk were primarily those born from around 1900–1920. One study reported no cohort effect (Karlmanangla, Zhou et al. 2006).

Finally, among those studies with the lowest level of rigor in assessing cohort effects (level (3)), five studies found evidence of a cohort effect (Black and Markides 1994; Johnstone, Leino et al. 1996; Levenson, Aldwin et al. 1998; Bachman, Freedman-Doan et al. 1999; Gilhooly 2005). Studies varied in the identified cohort with the highest alcohol consumption, but there was a general tendency toward younger cohorts consuming less mean alcohol than older cohorts per time period studied.

Nine of the fifteen studies examining current prevalence of alcohol use were conducted in the U.S., and of these, eight reported a cohort effect. Only two studies found that risk was highest in the latest-born cohort (Black and Markides 1994; Kerr, Greenfield et al. 2009), and one of these two only found highest risk in the latest-born cohort among Cuban Americans (Black and Markides 1994).

Studies in Great Britain (Kemm 2003), Scotland (Gilhooly 2005), Italy (Aristei, Perali et al. 2008), and Denmark (Bjork, Thygesen et al. 2008) have all documented cohort effects in alcohol consumption; the study in Italy found risk was highest in the latest born cohorts, and the studies in Denmark and Scotland found risk was highest in the latest born cohorts only in women. Two did not find evidence for a cohort effect; one in the Netherlands (Neve, Diederiks et al. 1993) and one cross-nationally (Johnstone, Leino et al. 1996).

Evidence for a narrowing of gender differences is mixed, although the strongest methodological studies all document convergence in gender differences in the U.S., Britain, and Denmark. Among level (1) studies, three studies document gender convergence (Kemm 2003; Bjork, Thygesen et al. 2008; Kerr, Greenfield et al. 2009); the remaining two studies did not assess gender differences. Among level (2) studies, two studies did not find evidence of a gender convergence (Moore, Gould et al. 2005; Karlmanangla, Zhou et al. 2006), and the remaining two studies did not assess gender. Among level (3) studies, two studies found evidence of gender convergence (Neve, Diederiks et al. 1993; Gilhooly 2005), one did not (Johnstone, Leino et al. 1996), and the remainder did not assess gender differences.

Alcohol disorder/problems/mortality

Studies of alcohol disorder, problems, and mortality are reviewed in Table 2. Of the twelve studies identified with alcohol disorders/problems as an outcome, ten found evidence of a cohort effect (Burke, Burke et al. 1991; Grant 1997; Heath, Bucholz et al. 1997; Levenson, Aldwin et al. 1998; Holdcraft and Iacono 2002; Rice, Neuman et al. 2003; Grucza, Bucholz et al. 2008; Keyes, Grant et al. 2008; Zhang, Guo et al. 2008; Seedat, Scott et al. 2009), and nine found a step-wise increase in risk with each successively younger cohort (Burke, Burke et al. 1991; Grant 1997; Heath, Bucholz et al. 1997; Levenson, Aldwin et al. 1998; Holdcraft and Iacono 2002; Rice, Neuman et al. 2003; Grucza, Bucholz et al. 2008; Keyes, Grant et al. 2008; Zhang, Guo et al. 2008; Seedat, Scott et al. 2009). The studies that did not find cohort effects (Kendler, Prescott et al. 1997; Dube, Felitti et al. 2003) were level (2) and (3) studies.

Two level (1) studies examined age, period, and cohort effects in directly measured alcohol-associated mortality. Rosen & Haglund report that alcohol-attributable mortality is lower among more recently born cohorts in Sweden (Rosen and Haglund 2006). Corrao et al. (Corrao, Ferrari et al. 1997) reported substantial cross-region differences in the emergence of a cohort effect for liver cirrhosis mortality. Younger birth cohorts in Eastern and Northern European countries evidence higher risk of cirrhosis mortality, whereas younger birth cohorts in Southern and Western European countries are at slightly lower risk of cirrhosis mortality. Neither study found evidence for a converging gender gap.

Nine of the twelve studies assessing cohort effects in alcohol problems have been conducted in the U.S. All studies but one (Dube, Felitti et al. 2003) document a cohort effect, and all but two (Dube, Felitti et al. 2003; Keyes, Grant et al. 2008) document that risk is highest in the most recently born cohort. Cohort effects with the youngest cohort at risk are documented in an Australian sample (Heath, Bucholz et al. 1997) and across fifteen different countries as part of the WHO-WMH surveys (Seedat, Scott et al. 2009).

One level (2) study (Zhang, Guo et al. 2008) found no convergence in rates of gender differences in alcohol-related mortality. The remaining studies documenting gender convergence were level (3) studies (Grant 1997; Holdcraft and Iacono 2002; Rice, Neuman et al. 2003; Keyes, Grant et al. 2008; Seedat, Scott et al. 2009). We note that these samples were primarily drawn from the U.S. However, Seedat et al. (Seedat, Scott et al. 2009) reported data from 15 countries, documenting the greatest reduction in the gender gap among countries where women's roles have evidenced the greatest shift from traditional to autonomous.

Discussion

Overview of findings

First, the most methodologically rigorous studies provide substantial (though not universal) evidence of a cohort effect in alcohol consumption, with younger birth cohorts consistently consuming more alcohol than older cohorts. Second, consistent evidence suggests increased risk of heavy episodic drinking and alcohol disorders in younger born cohorts compared to older cohorts. Third, studies are relatively consistent in demonstrating a narrowing of the gender gap for heavy drinking and alcohol disorders, whereby women in younger birth cohorts evidenced increasing prevalence of these outcomes over time while men did not. However, we note that most studies showing a converging gender gap are cross-sectional in design, indicating that caution should be taken when synthesizing this evidence due to the possibility of recall bias and the inability of these studies to separate cohort from age effects. Further, the predominance of evidence is from the U.S. and other English-speaking countries; these trends may not apply cross-nationally. Evidence is less consistent for gender gap narrowing in mean alcohol consumption. Fourth, substantial cross-cultural and demographic variation is evident in the emergence of cohort effects. Australia and Western European countries have little evidence of cohort effects, whereas Northern and Eastern European countries have increases in drinking, household expenditures on alcohol, and alcohol-related mortality. In summary, the picture that emerges is one in which younger birth cohorts, particularly in the U.S., Northern, and Eastern Europe, and increasingly women, consume more alcohol, engage in more episodic drinking and evidence more alcohol problems.

Taken together, the present review indicates substantial evidence for cohort effects in various alcohol indicators including lifetime use, consumption, and alcohol problems, suggesting that alcohol use across the life-course aggregates within cohorts. However, we note that synthesis of this evidence is limited by a reliance on cross-sectional designs. Of

those studies with the most rigorous methodology, the evidence for cohort effects in lifetime any alcohol use is weak (only one study rigorously assessed cohort effects and found none), the evidence for cohort effects in prevalent alcohol consumption across the life-course is strong (although variation in the cohort assessed, the measure used, and the geographic location of the sample make synthesis a challenge), and the evidence for cohort effects in alcohol problems/disorder is limited by the fact that no strong rigorous studies have been conducted (although less strong study designs predominately support evidence for a cohort effect across many countries).

Why are there cohort differences in alcohol use?

While the identification of at-risk cohorts provides an initial characterization of drinking patterns over time, cohort analysis does not typically test the mechanisms through which birth cohorts collectively change in their drinking patterns. Neve et al. (Neve, Diederiks et al. 1993) divides potential mechanisms for changing alcohol consumption patterns into 'endogenous' and 'exogenous' mechanisms. 'Endogenous' mechanisms for changing drinking patterns are characterized by social norms and social transmission of alcohol consumption behavior at the population level. Using the example of the U.S., scholars have noted rapid social change among younger generations in the latter half of the 20th century (Traub and Dodder 1988) whereby the social norms of the older generation are not transmitted to the younger generation. Historical analyses suggest that cohorts following those with permissive norms regarding alcohol and drug use will have more restrictive norms (Musto 1999). These shifting social norms across generations could potentially account for the observed decrease in mean drinking but the suggestive increase in heavy episodic drinking.

'Exogenous' mechanisms, on the other hand, are characterized by policies, laws, and economic factors that affect the availability of and consequences from alcohol consumption. Substantial evidence documents an ecological association between alcohol policy and consumption (Leifman and Romelsjo 1997; Henderson, Liu et al. 2004; Norstrom and Ramstedt 2005; Andreasson, Holder et al. 2006); countries with stricter policies have less per capita consumption (Brand, Saisana et al. 2007). In the U.S. in the 1980's, policies increased the minimum drinking age (O'Malley and Wagenaar 1991) and penalties for driving after drinking (Tippetts, Voas et al. 2004), with simultaneous decreases observed in traffic-associated alcohol-related mortality. However, the studies presented in this review suggest that problems are increasing among the more recent cohorts at the same time as increasingly strict policies. Thus, it is possible that policy changes could be an effect rather than a cause of change across cohorts, although more empirical data is necessary to formally disentangle these relationships. Data on the interplay between legal policies and age-specific drinking patterns would be helpful in understanding the underlying mechanisms driving these trends. Of course, endogenous and exogenous mechanisms are not independent; social norms drive the acceptability of policies and laws regarding alcohol use, and *vice versa* (Musto 1999).

Gender differences

Multiple lines of evidence suggest that gender differences in the prevalence of heavy episodic use and alcohol disorders are narrowing. Several studies reported here present a 1:1 ratio in the gender difference in initiation of alcohol among adolescents (Johnson and Gerstein 1998; Johnson and Gerstein 2000), and multiple lines of cross-national evidence suggest substantial increases in the prevalence of alcohol disorders among women in more recently born cohorts. Given that evidence suggests greater long-term health risks among women with chronic alcohol disorders compared to men (Klatsky, Armstrong et al. 1992; Deal and Cavalier 1994; Urbano-Marquez, Estruch et al. 1995; Key, Hodgson et al. 2006),

these trends suggest that public health efforts to specifically target heavy drinking in women are necessary.

As with the emergence of cohort effects more generally, the mechanisms through which this gender by cohort interaction arises remains unclear. Taking the example of the U.S., the 20th century was a period of substantial change in the societal structuring of gender roles. Women in the latter part of the 20th century entered higher education in high proportions, entered the workforce in record numbers, and delayed childbearing. Inglehart (Inglehardt 1977; Inglehardt 1990; Inglehardt and Baker 2000) has noted that economic prosperity and increased educational possibilities in the U.S. after World War II and extending into the 1970s, especially for women, provided a political framework in which norms and values could be shifted to more permissive attitudes toward drinking. International evidence from Seedat et al. (Seedat, Scott et al. 2009) suggest that these factors may have contributed to the increased risk of problematic alcohol consumption, in that gender-by-cohort interactions were much stronger in countries where these changes in gender roles were operative. Further, recent evidence indicates that differences in average frequency of drinking in certain venues between men and women can be partially explained by variation in economic participation and opportunity of women, above and beyond the influence of overall country wealth (Bond, Roberts et al.). Though speculative, the results of this study suggest that perhaps improvements in economic conditions for women over time may contribute to potential convergences in gender differences. A full explanation for these patterns, however, is unlikely to be straightforward. For example, there is evidence of socio-economic interactions with the effect of workplace on drinking in women (Brady and Randall 1999). Working outside the home is a protective factor for excessive alcohol consumption among women of lower-SES, and a risk factor for women of higher-SES (Brady and Randall 1999), suggesting that the web of competing risks for alcohol problems operate in a complex way in the development of drinking problems (Brady and Randall 1999; Nolen-Hoeksema 2004; Nolen-Hoeksema and Hilt 2006). Data from Gender, Alcohol, and Culture: An International Study (GenACIS) suggest that, cross-nationally, women who are paid for labor are more likely to engage in risky drinking compared to women who are not paid for labor, but that engagement in more than one life role (e.g., paid for labor but also in a partnership with children) is protective against risky drinking in both women and men (Kuntsche, Knibbe et al. 2009). Taken together, the role of the workplace on female drinking patterns remains understudied, yet important as an explanation for the patterns observed here.

Cross national variation

Cross-national comparisons are limited due to the predominance of evidence from the U.S. (19 of the 31 papers reviewed in this article are based on U.S. samples). While studies in additional countries are needed to provide a more complete global picture of time trends in alcohol use, available evidence indicates cross-national variation in some alcohol outcomes but not in others. Cross-national variation is most striking in the age-period-cohort analysis of cirrhosis mortality in Europe conducted by Corrao et al. (Corrao, Ferrari et al. 1997), whereby later born cohorts were at increased risk in Eastern and Northern European countries only. Also striking is the lack of cohort effects in the Australian data, due to the near-ubiquitous lifetime alcohol consumption across time (Degenhardt, Lynskey et al. 2000). There is also, however, some cross-national convergence in the emergence of cohort effects. For example, later-born cohorts are at higher risk for heavy drinking in the U.S. (Kerr, Greenfield et al. 2009), Britain (Kemm 2003), and Denmark (Bjork, Thygesen et al. 2008), with a narrowing of the gender gap documented across these countries as well. Cross-national variation for some alcohol indicators is unsurprising; countries differ substantially in the per capita alcohol consumption (WHO 2011) and in maturational norms with respect to drinking. Thus, the emergence of cohort effects in alcohol consumption and other alcohol

outcomes is bounded by the level of drinking in each country, making cross-national comparisons difficult and convergence in the effect unlikely.

Population-level policies and laws that differ between countries are likely to contribute to cross-national variation in alcohol patterns (Casswell and Thamarangsi 2009). As a case study in the effects of these policies and laws on a particular country, consider the recent changes in population-level alcohol consumption in Finland. While per capita consumption is higher than the world average (Rehm, Mathers et al. 2009), Finland has relatively low consumption compared to other European countries, with strict government control of the production and distribution of alcohol (World Health Organization: alcohol control database). Finland's entry into the European Union in 1995 required de-monopolization of many aspects of alcohol production and trade policy. In response to increasing international pressure, Finland substantially lowered alcohol taxes in 2004. In the following year, alcohol sales increased by 50% and per capita consumption rose by 10% (Anderson, Chisholm et al. 2009). This example highlights how local and international politics and history align to shape alcohol consumption patterns within and across geographic localities.

Methodological issues

This review also highlights some methodological issues that should be considered in future research on alcohol consumption patterns over time. We will focus on four primary recommendations for future research.

First, the lack of any standardization of alcohol quantity and frequency measures creates ambiguity in the synthesis of research on trends over time. This is difficult for practical purposes, as standard drink sizes and drinking practices vary across countries. However, most studies included in the present review reported only a single measure of alcohol consumption, typically either drinking quantity or drinking frequency. While different measures of quantity and frequency each provide unique and important information about changing alcohol consumption patterns, more research that reports multiple quantity/frequency measures within a single study (where standard drink size would be controlled) would be beneficial for drawing conclusions. An example of the utility of cross-measure comparison is seen in Kerr et al. (Kerr, Greenfield et al. 2009), where in a single study it was reported that younger cohorts were at higher risk for heavy episodic drinking but were consuming fewer monthly drinks. Moreover, the quality of the data ranges across studies in potentially systematic ways; for example, there may be cross-cultural variation in the extent to which alcohol consumption is validly reported on surveys, limiting the validity of cross-national differences observed here.

Second, limited data are available from prospective studies on cohort effects in the incidence of alcohol-related phenomena. Studies identified in this review either used the lifetime proportion of alcohol users or retrospective age of onset reporting to estimate some measure of incidence. While these studies provide important information, the potential for selection bias, confounding of age and period effects, and recall bias (Rehm, Irving et al. 2008) limit the ability to draw conclusions. While incidence data is difficult to collect on a large scale due to practical difficulties of time and expense involved in prospective data collection, it is critical for the tracking of trends over time in order to design and implement public health programs when necessary.

Third, data on cohort effects generally and cohort effects on gender differences from a broader cultural framework are needed. As noted, most studies in this review are based on U.S. samples; the remaining countries included in these papers are also predominately high-income western countries, save for Seedat et al. (2009) and van Heerden et al., (2009). The data from Seedat et al. (2009) indicate substantial cross-cultural variation in the effect of

birth cohorts on gender differences, suggesting that further data from a wider cross-section of countries could reveal important patterns that are obscured in the present published literature focused on Western countries. Emerging evidence suggests that young people, and especially girls, in many countries, and especially Eastern Europe, are increasing in the frequency of drunkenness faster than boys and girls in other countries, suggesting that data on cohort effects in these countries is urgently needed (Kuntsche, Kuntsche et al. 2011).

Finally, most studies included in this review are based on self-report of respondents via surveys. Those studies that did not collect data from self-report (Corrao, Ferrari et al. 1997; Kendler, Prescott et al. 1997; Rosen and Haglund 2006; Aristei, Perali et al. 2008; Zhang, Guo et al. 2008) did not consistently document cohort effects, raising questions about the validity of the self-report data. Survey data is an imperfect tool for gauging the total amount of alcohol consumed (Del Boca and Darkes 2003), and the validity of self-reported alcohol consumption is likely subject to some of the same social norms identified above as a potential mechanism driving cohort effects in alcohol consumption. Thus, to at least some extent, the cohort effects in alcohol consumption could arise from cohort effects in the *reporting* of alcohol consumption only. Age-period-cohort models using diverse data sources such as reported expenditures and alcohol-associated mortality would be beneficial to disaggregate cohort effects in consumption from those due to reporting.

Cohort effects on alcohol-related health phenomena: conclusion

The identification of at-risk cohorts provides crucial information on the dynamics of ever-changing societies. As each cohort progresses through life, they are collectively faced with different social, economic, and political barriers and resources that may impact health in significant ways. Birth cohort analyses can be used to predict future alcohol-associated harm and disability for public health planning and intervention by identifying the structural and societal-level forces that shape trends over time in alcohol phenomena. Collectively, the studies presented above suggest that drinking patterns aggregate in a cohort-specific manner, with variation in alcohol consumption over time that is best understood when incidence, consumption and disorder over time are modeled as a function of birth cohort. An especially important observation from this literature is that women in younger cohorts increasingly engage in risky drinking practices, challenging the paradigm of alcohol consumption as a male-dominated health issue, and suggesting a substantial role for population-level social norms in shaping consumption patterns.

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References

- Adams WL, Garry PJ, et al. Alcohol intake in the healthy elderly. Changes with age in a cross-sectional and longitudinal study. *J Am Geriatr Soc.* 1990; 38(3):211–216. [PubMed: 2313001]
- Ahern J, Galea S, et al. “Culture of drinking” and individual problems with alcohol use. *Am J Epidemiol.* 2008; 167(9):1041–1049. [PubMed: 18310621]
- Anderson P, Chisholm D, et al. Effectiveness and cost-effectiveness of policies and programmes to reduce the harm caused by alcohol. *Lancet.* 2009; 373(9682):2234–2246. [PubMed: 19560605]
- Andreasson S, Holder HD, et al. Estimates of harm associated with changes in Swedish alcohol policy: results from past and present estimates. *Addiction.* 2006; 101(8):1096–1105. [PubMed: 16869839]
- Aristei D, Perali F, et al. Cohort, Age, and Time Effects in Alcohol Consumption by Italian Households: a Double-Hurdle Approach. *Empirical Economics.* 2008; 35(1):26–61.

- Bachman JG, Freedman-Doan P, et al. Changing patterns of drug use among US military recruits before and after enlistment. *Am J Public Health*. 1999; 89(5):672–677. [PubMed: 10224977]
- Bjork C, Thygesen LC, et al. Time trends in heavy drinking among middle-aged and older adults in Denmark. *Alcohol Clin Exp Res*. 2008; 32(1):120–127. [PubMed: 18070244]
- Black SA, Markides KS. Aging and generational patterns of alcohol consumption among Mexican Americans, Cuban Americans and mainland Puerto Ricans. *Int J Aging Hum Dev*. 1994; 39(2):97–103. [PubMed: 8002101]
- Bond JC, Roberts SC, et al. Gender differences in public and private drinking contexts: a multi-level GENACIS analysis. *Int J Environ Res Public Health*. 7(5):2136–2160. [PubMed: 20623016]
- Brady KT, Randall CL. Gender differences in substance use disorders. *Psychiatr Clin North Am*. 1999; 22(2):241–252. [PubMed: 10385931]
- Brand DA, Saisana M, et al. Comparative analysis of alcohol control policies in 30 countries. *PLoS Med*. 2007; 4(4):e151. [PubMed: 17455992]
- Burke KC, Burke JD Jr, et al. Comparing age at onset of major depression and other psychiatric disorders by birth cohorts in five US community populations. *Arch Gen Psychiatry*. 1991; 48(9):789–795. [PubMed: 1929768]
- Caetano R, Kaskutas LA. Changes in drinking patterns among whites, blacks and Hispanics, 1984–1992. *J Stud Alcohol*. 1995; 56(5):558–565. [PubMed: 7475037]
- Casswell S, Thamarangsi T. Reducing harm from alcohol: call to action. *Lancet*. 2009; 373(9682):2247–2257. [PubMed: 19560606]
- Corrao G, Ferrari P, et al. Trends of liver cirrhosis mortality in Europe, 1970–1989: age-period-cohort analysis and changing alcohol consumption. *Int J Epidemiol*. 1997; 26(1):100–109. [PubMed: 9126509]
- Deal ST, Cavalier JS. Are women more susceptible than men to alcohol-induced cirrhosis? *Alcohol Health and Research World*. 1994; 18:189–191.
- Degenhardt L, Chiu WT, et al. Epidemiological patterns of extra-medical drug use in the United States: evidence from the National Comorbidity Survey Replication, 2001–2003. *Drug Alcohol Depend*. 2007; 90(2–3):210–223. [PubMed: 17481828]
- Degenhardt L, Lynskey M, et al. Cohort trends in the age of initiation of drug use in Australia. *Aust N Z J Public Health*. 2000; 24(4):421–426. [PubMed: 11011471]
- Del Boca FK, Darkes J. The validity of self-reports of alcohol consumption: state of the science and challenges for research. *Addiction*. 2003; 98(Suppl 2):1–12. [PubMed: 14984237]
- Dube SR V, Felitti J, et al. The impact of adverse childhood experiences on health problems: evidence from four birth cohorts dating back to 1900. *Prev Med*. 2003; 37(3):268–277. [PubMed: 12914833]
- Eigenbrodt ML, Mosley TH Jr, et al. Alcohol consumption with age: a cross-sectional and longitudinal study of the Atherosclerosis Risk in Communities (ARIC) study, 1987–1995. *Am J Epidemiol*. 2001; 153(11):1102–1111. [PubMed: 11390330]
- Fillmore KM, Hartka E, et al. A meta-analysis of life course variation in drinking. *Br J Addict*. 1991; 86(10):1221–1267. [PubMed: 1836408]
- Gilhooly MLM. Reduced drinking with age: Is it normal? *Addiction Research and Theory*. 2005; 13(3):267–280.
- Glynn RJ, Bouchard GR, et al. Aging and generational effects on drinking behaviors in men: results from the normative aging study. *Am J Public Health*. 1985; 75(12):1413–1419. [PubMed: 4061714]
- Gordon T, Kannel WB. Drinking and its relation to smoking, BP, blood lipids, and uric acid. The Framingham study. *Arch Intern Med*. 1983; 143(7):1366–1374. [PubMed: 6870410]
- Grant BF. Prevalence and correlates of alcohol use and DSM-IV alcohol dependence in the United States: results of the National Longitudinal Alcohol Epidemiologic Survey. *J Stud Alcohol*. 1997; 58(5):464–473. [PubMed: 9273910]
- Gruzca RA, Bucholz KK, et al. Secular trends in the lifetime prevalence of alcohol dependence in the United States: a re-evaluation. *Alcohol Clin Exp Res*. 2008; 32(5):763–770. [PubMed: 18336633]

- Grucza RA, Norberg K, et al. Correspondence between secular changes in alcohol dependence and age of drinking onset among women in the United States. *Alcohol Clin Exp Res*. 2008; 32(8):1493–1501. [PubMed: 18564104]
- Hasin DS, Stinson FS, et al. Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry*. 2007; 64(7):830–842. [PubMed: 17606817]
- Heath AC, Bucholz KK, et al. Genetic and environmental contributions to alcohol dependence risk in a national twin sample: consistency of findings in women and men. *Psychol Med*. 1997; 27(6): 1381–1396. [PubMed: 9403910]
- Henderson C, Liu X, et al. The effects of US state income inequality and alcohol policies on symptoms of depression and alcohol dependence. *Soc Sci Med*. 2004; 58(3):565–575. [PubMed: 14652052]
- Holdcraft LC, Iacono WG. Cohort effects on gender differences in alcohol dependence. *Addiction*. 2002; 97(8):1025–1036. [PubMed: 12144605]
- Hubert HB, Eaker ED, et al. Life-style correlates of risk factor change in young adults: an eight-year study of coronary heart disease risk factors in the Framingham offspring. *Am J Epidemiol*. 1987; 125(5):812–831. [PubMed: 3565356]
- Inglehardt, R. *The Silent Revolution: Changing Values and Political Styles in Advanced Industrial Society*. Princeton, NJ: Princeton University Press; 1977.
- Inglehardt, R. *Cultural Shift in Advanced Industrial Society*. Princeton, NJ: Princeton University Press; 1990.
- Inglehardt R, Baker WE. Modernization, cultural change, and the persistence of traditional values. *American Sociological Review*. 2000; 65:19–51.
- Johnson FW, Gruenewald PJ, et al. Drinking over the life course within gender and ethnic groups: a hyperparametric analysis. *J Stud Alcohol*. 1998; 59(5):568–580. [PubMed: 9718110]
- Johnson RA, Gerstein DR. Initiation of use of alcohol, cigarettes, marijuana, cocaine, and other substances in US birth cohorts since 1919. *Am J Public Health*. 1998; 88(1):27–33. [PubMed: 9584029]
- Johnson RA, Gerstein DR. Age, period, and cohort effects in marijuana and alcohol incidence: United States females and males, 1961–1990. *Subst Use Misuse*. 2000; 35(6–8):925–948. [PubMed: 10847217]
- Johnstone BM, Leino EV, et al. Determinants of life-course variation in the frequency of alcohol consumption: meta-analysis of studies from the collaborative alcohol-related longitudinal project. *J Stud Alcohol*. 1996; 57(5):494–506. [PubMed: 8858547]
- Karlman A, Zhou K, et al. Longitudinal trajectories of heavy drinking in adults in the United States of America. *Addiction*. 2006; 101(1):91–99. [PubMed: 16393195]
- Kemm J. An analysis by birth cohort of alcohol consumption by adults in Great Britain 1978–1998. *Alcohol Alcohol*. 2003; 38(2):142–147. [PubMed: 12634261]
- Kendler KS, Prescott CA, et al. Temperance board registration for alcohol abuse in a national sample of Swedish male twins, born 1902 to 1949. *Arch Gen Psychiatry*. 1997; 54(2):178–184. [PubMed: 9040286]
- Kerr WC, Greenfield TK, et al. Age, period and cohort influences on beer, wine and spirits consumption trends in the US National Alcohol Surveys. *Addiction*. 2004; 99(9):1111–1120. [PubMed: 15317631]
- Kerr WC, Greenfield TK, et al. Age-period-cohort modelling of alcohol volume and heavy drinking days in the US National Alcohol Surveys: divergence in younger and older adult trends. *Addiction*. 2009; 104(1):27–37. [PubMed: 19133886]
- Key J, Hodgson S, et al. Meta-analysis of studies of alcohol and breast cancer with consideration of the methodological issues. *Cancer Causes Control*. 2006; 17(6):759–770. [PubMed: 16783604]
- Keyes KM, Grant BF, et al. Evidence for a closing gender gap in alcohol use, abuse, and dependence in the United States population. *Drug Alcohol Depend*. 2008; 93(1–2):21–29. [PubMed: 17980512]

- Keyes KM, Utz RL, et al. What is a cohort effect? Comparison of three statistical methods for modeling cohort effects in obesity prevalence in the United States, 1971–2006. *Social Science and Medicine*. 2010; 70:1100–1108. [PubMed: 20122771]
- Klatsky AL, Armstrong MA, et al. Alcohol and mortality. *Ann Intern Med*. 1992; 117(8):646–654. [PubMed: 1530196]
- Klatsky AL, Siegelaub AB, et al. Racial patterns of alcoholic beverage use. *Alcohol Clin Exp Res*. 1983; 7(4):372–377. [PubMed: 6362460]
- Kuntsche E, Kuntsche S, et al. Cultural and gender convergence in adolescent drunkenness: evidence from 23 European and north american countries. *Arch Pediatr Adolesc Med*. 2011; 165(2):152–158. [PubMed: 20921343]
- Kuntsche S, Knibbe RA, et al. Social roles and alcohol consumption: a study of 10 industrialised countries. *Soc Sci Med*. 2009; 68(7):1263–1270. [PubMed: 19232807]
- Leifman H, Romelsjö A. The effect of changes in alcohol consumption on mortality and admissions with alcohol-related diagnoses in Stockholm County--a time series analysis. *Addiction*. 1997; 92(11):1523–1536. [PubMed: 9519494]
- Levenson MR, Aldwin CM, et al. Age, cohort and period effects on alcohol consumption and problem drinking: findings from the Normative Aging Study. *J Stud Alcohol*. 1998; 59(6):712–722. [PubMed: 9811093]
- Menard S, Huizinga D. Age, period, and cohort size effects on self-reported alcohol, marijuana, and polydrug use: Results from the National Youth Survey. *Social Science Research*. 1989; 18(2):174–194.
- Moore AA, Gould R, et al. Longitudinal patterns and predictors of alcohol consumption in the United States. *Am J Public Health*. 2005; 95(3):458–465. [PubMed: 15727977]
- Musto, D. *The American Disease: Origins of Narcotic Control*. 3. Oxford University Press; USA: 1999.
- Neve RJ, Diederiks JP, et al. Developments in drinking behavior in The Netherlands from 1958 to 1989, a cohort analysis. *Addiction*. 1993; 88(5):611–621. [PubMed: 8518711]
- Nolen-Hoeksema S. Gender differences in risk factors and consequences for alcohol use and problems. *Clin Psychol Rev*. 2004; 24(8):981–1010. [PubMed: 15533281]
- Nolen-Hoeksema S, Hilt L. Possible contributors to the gender differences in alcohol use and problems. *J Gen Psychol*. 2006; 133(4):357–374. [PubMed: 17128956]
- Norstrom T, Ramstedt M. Mortality and population drinking: a review of the literature. *Drug Alcohol Rev*. 2005; 24(6):537–547. [PubMed: 16361210]
- O'Malley PM, Wagenaar AC. Effects of minimum drinking age laws on alcohol use, related behaviors and traffic crash involvement among American youth: 1976–1987. *J Stud Alcohol*. 1991; 52(5):478–491. [PubMed: 1943105]
- Rehm J, Irving H, et al. Are lifetime abstainers the best control group in alcohol epidemiology? On the stability and validity of reported lifetime abstention. *Am J Epidemiol*. 2008; 168(8):866–871. [PubMed: 18701442]
- Rehm J, Mathers C, et al. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *Lancet*. 2009; 373(9682):2223–2233. [PubMed: 19560604]
- Rice JP, Neuman RJ, et al. Age and birth cohort effects on rates of alcohol dependence. *Alcohol Clin Exp Res*. 2003; 27(1):93–99. [PubMed: 12544012]
- Room R, Makela K. Typologies of the cultural position of drinking. *J Stud Alcohol*. 2000; 61(3):475–483. [PubMed: 10807222]
- Rosen M, Haglund B. Trends in alcohol-related mortality in Sweden 1969–2002: an age-period-cohort analysis. *Addiction*. 2006; 101(6):835–840. [PubMed: 16696627]
- Seedat S, Scott KM, et al. Cross-national associations between gender and mental disorders in the World Health Organization World Mental Health Surveys. *Arch Gen Psychiatry*. 2009; 66(7):785–795. [PubMed: 19581570]
- Skog OJ. The collectivity of drinking cultures: a theory of the distribution of alcohol consumption. *Br J Addict*. 1985; 80(1):83–99. [PubMed: 3856453]

- Tippetts AS, Voas RB, et al. A meta-analysis of .08 BAC laws in 19 jurisdictions in the United States. *Addic Anal Prev*. 2004; 37:149–161.
- Traub S, Dodder R. Intergenerational conflict of values and norms: a theoretical model. *Adolescence*. 1988; 23(92):975–989.
- Urbano-Marquez A, Estruch R, et al. The greater risk of alcoholic cardiomyopathy and myopathy in women compared with men. *JAMA*. 1995; 274(2):149–154. [PubMed: 7596003]
- van Heerden MS, Grimsrud AT, et al. Patterns of substance use in South Africa: results from the South African Stress and Health study. *S Afr Med J*. 2009; 99(5 Pt 2):358–366. [PubMed: 19588799]
- WHO. Global status report on alcohol and health. WHO Press, World Health Organization; 2011. World Health Organization. Available at:
http://www.who.int/substance_abuse/publications/global_alcohol_report/msbgsruprofiles.pdf
- Wilsnack RW, Wilsnack SC, et al. Gender and alcohol consumption: patterns from the multinational GENACIS project. *Addiction*. 2009; 104(9):1487–1500. [PubMed: 19686518]
- [Last accessed September 6, 2009] World Health Organization: alcohol control database.
“<http://data.euro.who.int/alcohol/>.”
- Zhang Y, Guo X, et al. Secular trends in alcohol consumption over 50 years: the Framingham Study. *Am J Med*. 2008; 121(8):695–701. [PubMed: 18691483]

Figure 1.
Search strategy and method of article selection for review

Population-based studies published between 1989 and 2009 assessing cohort effects in currently prevalent alcohol consumption (N=14)

Table 1

Authors, date	Study design	Population location	Years of data coverage	Age range	Outcome(s)**	Methodology level	Found any cohort effect	Risk greatest in latest-born cohort	Cohort with highest risk	Gender convergence	
Aristei, Perali, Pieroni, 2008	Repeated cross-sections	Italy	1997–2002	20–80+	Household expenditure on alcohol	1	Yes	Yes	1972–1976	n/a	n/a
Bjork, Thygesen, Vinther-Larsen et al., 2008	Repeated cross-sections	Denmark	1987–2005	50–74	Heavy drinking (>3/day (m) or >2/day (w), or >21/week (m), >14/wk (w)) at the time of the survey	1	Yes	Yes (women)	1940–1949 (men); 1950–1955 (women)	Yes	Increase in weekly drinking among women; no increase among men
Kemm, 2003	Repeated cross-sections	Great Britain	1978–1998	15+	Past-year quantity, heavy episodic (>21/week (m), >14/wk (w))	1	Yes	Yes	1972–1976	Yes	Male: female ratio approaching 1:1 in percentage of heavy past-month quantity
Kerr, Greenfield, Bond et al., 2004	Repeated cross-sections	US (NAS)*	1979–2000	18+	Past-month quantity by beverage type	1	Yes	No	1976–1965 (men); pre-1940 (women)	n/a	n/a
Kerr, Greenfield, Bond et al., 2009	Repeated cross-sections	US (NAS)*	1979–2005	18+	Past-month quantity, past-month heavy episodic (5+or 8+)	1	Yes	Yes	post-1975	Yes	Convergence for heavy episodic (increases for both men and women, but more increase for women) but not mean monthly drinking
Kariamangla, Zhou, Reuben et al., 2006	Longitudinal cohort	US (NHANES)*	1971–1992	1–74 at baseline	Past-year heavy episodic (5+/4+***)	2	No	No	n/a	No	Cohort by gender tested; coefficient not significant
Menard & Huizinga, 1989	Longitudinal cohort	US (NSY)*	1976–1983	11–17 at baseline	Past-year frequency	2	Yes	No	n/a	n/a	n/a
Moore, Gould, Reuben et al., 2005	Longitudinal cohort	US (NHANES)*	1982–1992	25–74	Mean weekly volume	2	Yes	No	1905	No	Cohort by gender tested; coefficient not significant
Zhang, Guo, Saitz et al., 2008	Longitudinal cohort	US (Framingham study)	1948–2003	28–62 at baseline	Avg daily volume, heavy episodic (5+/4+***)	2	Yes	No	1900–1919	n/a	n/a
Bachman, Feedman-Doan, O'Malley et al., 1999	Panel design	US (MTF)*	1976–1995	12th grade at baseline	Past-two week heavy episodic (5+)	3	Yes	No	1972–1975	n/a	n/a
Black & Markides, 1994	Cross-sectional	US (HHNES)*	1982–1984	0–75	Past-year frequency	3	Yes	Yes (Cubans only)	>1950	n/a	n/a

Authors, date	Study design	Population location	Years of data coverage	Age range	Outcome(s)**	Methodology level	Found any cohort effect	Risk greatest in latest-born cohort	Cohort with highest risk	Gender convergence	
Gilthooly, 2005	Cross-sectional	Scotland	1998	16–74	Past-year quantity	3	Yes	Yes (women)	1974–1982	Yes	Decreasing drinking among men; no decrease among women
Levenson, Aldwin, and Spiro, 1998	Longitudinal cohort	US	1973–1991	46–72	Mean yearly volume	3	Yes	Yes	1928–1936	n/a	n/a
Neve, Drop, Lemmens et al., 1993	Repeated cross-sections	Netherlands	1958–1989	21–50	Mean weekly volume, heavy drinking (>21/wk (m), >14/wk (w))	3	No	No	n/a	Yes	Male: female ratios in heavy drinking decreased from 5.5 to 2.5

* For studies conducted in the U.S. we provide greater detail about the sample. NHANES = National Health and Nutrition Examination Survey, NSY = National Survey of Youth, MTF = Monitoring the Future, NAS = National Alcohol Survey, HHNES = Hispanic Health and Nutrition Examination Survey

** see Table 4 for specific measures of alcohol consumption across studies

*** 5+/4+ = 5+ drinks for men and 4+ drinks for women

† Studies were ranked in terms of the methodological rigor of the study design and statistical analysis. Those studies given a (1) are the most rigorous levels of evidence. These include studies with repeated cross-sections of individuals over time, and formal statistical modeling to decompose variance in trends over time into components that can be attributed to age, period, and cohort. Those studies given a (2) are intermediate levels of evidence. These include longitudinal studies with and without statistical age-period-cohort models. Those studies given a (3) are those for which the most caution should be taken during synthesis and inference. Cross-sectional studies make up the largest majority of this category.

Table 2
Population-based studies published between 1989 and 2009 assessing cohort effects in alcohol problems (N=12)

Authors, date	Study design	Population location	Years of data coverage	Age range	Outcome(s)	Methodology level	Any cohort effect	Risk greatest in the youngest born cohort	Cohort with highest risk	Gender convergence
Grucza, Bucholz, Rice et al., 2008	Repeated cross-sections	US (NLAES & NESARC) *	1991–2002	18+	DSM-IV dependence	2	Yes	Yes (women)	1944–1953	Yes Significant increases for women, no significant differences over time for men
Heath, Bucholz, Madden et al., 1997	Twin/family, longitudinal	Australia	1978–1993	0+	DSM-III-R abuse/dependence	2	Yes	Yes	1960–1964	n/a
Kendler, Prescott, Neale et al., 1997	Twin/family, longitudinal	Sweden	1929–1974	Range not reported	Temperance board registration	2	No	No	n/a	n/a
Levenson, Aldwin, and Spiro, 1998	Longitudinal cohort	US	1973–1991	46–72	Alcohol problems scale	2	Yes	Yes	1928–1936	n/a
Zhang, Guo, Satz et al., 2008	Longitudinal cohort	US (Framingham cohort)	1948–1974 (baseline interviews)	18+	Chart-review for alcohol problems	2	Yes	Yes	1920–1939	No Risk increased more between men in oldest and youngest bom cohort compared to women in oldest and youngest bom cohort
Burke, Burke, Rae et al., 1991	Cross-sectional	US (ECA) *	1980–1985	18+	DSM-III abuse/dependence	3	Yes	Yes	1953–1966	n/a
Dube, Felitti, Dong et al., 2003	Cross-sectional	US (Kaiser plan members)	1995–1997	18+	Self-report of alcoholism	3	No	No	n/a	n/a
Grant, 1997	Cross-sectional	US (NL/AES) *	1991–1992	18+	DSM-IV dependence	3	Yes	Yes	1968–1974	Yes Male: female ratio decreased from 4.4 in

Authors, date	Study design	Population location	Years of data coverage	Age range	Outcome(s)	Methodology level	Any cohort effect	Risk greatest in the youngest born cohort	Cohort with highest risk	Gender convergence	
											oldest cohort to 1.8 in youngest
Holdcraft & Iacono, 2002	Twin/family, longitudinal	US (MTFS) *	Not reported	Range not reported	DSM-III-R dependence	3	Yes	Yes	> 1950	Yes	Statistically significant gender by cohort interaction terms
Keyes, Grant, Hasin, 2008	Cross-sectional	US (NESARC) *	2001–2002	18+	DSM-IV abuse/dependence	3	Yes	No	1968–1984	Yes	Statistically significant gender by cohort interaction terms
Rice, Neuman, Saccone et al., 2003	Twin/family, cross-sectional	US (COGA) *	1991–1998	18+	DSM-III-R dependence	3	Yes	Yes	> 1960	Yes	Male: female ratio decreased from 7.9 in oldest cohort to 1.8 in youngest
Seedat, Scott, Angermeyer et al., 2009	Cross-sectional	Cross-national (WHO-WMH) *	2001–2005	18+	DSM-IV abuse/dependence	3	Yes	Yes	1966–1982	Yes	Statistically significant gender by cohort interaction terms; effect strongest in countries with changing normative gender roles

* For studies conducted in the U.S. we provide greater detail about the sample. ECA = Epidemiologic Catchment Area Study, COGA = Collaborative Studies on the Genetics of Alcoholism, WHO-WMH = World Health Organization World Mental Health, MTFS = Minnesota Twin Family Study, NLAES = National Longitudinal Alcohol Epidemiologic Survey, NESARC = National Epidemiologic Survey on Alcohol and Related Conditions

+ Studies were ranked in terms of the methodological rigor of the study design and statistical analysis. Those studies given a (1) are the most rigorous levels of evidence. These include studies with repeated cross-sections of individuals over time, and formal statistical modeling to decompose variance in trends over time into components that can be attributed to age, period, and cohort. Those studies given a (2) are intermediate levels of evidence. These include longitudinal studies with and without statistical age-period-cohort models. Those studies given a (3) are those for which the most caution should be taken during synthesis and inference. Cross-sectional studies make up the largest majority of this category.