

Title

Change in the relationship between drinking alcohol and risk of violence among adolescents and young adults: A nationally representative longitudinal study

Running Title

Alcohol and violence

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Keywords

Violence, alcohol, epidemiology, adolescence, gender

Short Summary

We have analysed data from a large longitudinal, nationally representative sample to investigate the longitudinal relationship between alcohol and violence.

We found that alcohol is more strongly linked to violence among adolescents than in adults, and particularly males rather than females who binge-drink.

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44 **Abstract**

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46 **Aims:** To quantify the relationship between alcohol and violence with increasing age.

47 **Methods:** Data were from The National Longitudinal Study of Adolescent to Adult

48 Health (ADD Health) of 20,386 people representative of the US population. Mean

49 age at the first wave of interviews was 16.2 years, with subsequent interviews mean

50 of 1, 6.3 and 12.9 years later. We used randomised effects models and predictive

51 marginal effects of the association between varying quantities of alcohol consumption

52 and violence while controlling for possible confounders

53 **Results:** Violence was reported by 19.1% of participants at wave I, but just 2.1% at

54 wave IV. The random-effects model showed that consuming 1-4 drinks on each

55 occasion was associated with a modest increase in risk of violence in males and

56 females (OR 1.36 (1.13-1.63) and 1.33 (1.03-1.72) respectively). For consumption of

57 5 or more drinks on each occasion the risk remained similar for females (OR 1.40

58 (0.99-1.97)), but increased considerably for males (OR 2.41 (1.96-2.95)). Predictive

59 marginal effects models confirmed that violence rates decreased with age.

60 **Conclusions:** Alcohol is most strongly linked to violence among adolescents, so

61 programmes for primary prevention of alcohol-related violence are best targeted

62 towards this age group, and particularly males who engage in heavy episodic

63 drinking.

64

65

66 **Short Summary**

67

68 We have analysed data from a large longitudinal, nationally representative sample to
69 investigate the longitudinal relationship between alcohol and violence.

70

71 We found that alcohol is more strongly linked to violence among adolescents than in
72 adults, and particularly males rather than females who engage in heavy episodic
73 drinking.

74

75 **Introduction**

76 Violence is responsible for high global rates of morbidity and mortality, with
77 homicide representing the 4th leading cause of death for 15-29 year olds (World
78 Health Organisation, 2010). Rates of criminal injury that require hospital treatment
79 are 30-40 times higher among this age group (World Health Organisation, 2005). The
80 direct and indirect costs to the individual and society are high (Organization, 2008),
81 with the economic burden of violence estimated to be approximately 3% of GDP in
82 both the USA (World Health Organisation, 2004) and the UK (Dubourg et al., 2005)
83 annually.

84 Although the causes of violence are complex and multifactorial, one of the most
85 common risk factors for violent behaviour is alcohol use. Violence is commonly
86 carried out by people who had consumed alcohol prior to the offence(CSEW, 2013),
87 and about half of victims of assault believe that their attacker was under the influence
88 of alcohol at the time of the assault (Steen and Hunskaar, 2004).

89 It is known that alcohol consumption in Western countries tends to increase markedly
90 from adolescence into adulthood. In the USA, around 4% of 12-14 year olds report
91 drinking in the last month (Health and Social Care Information Centre, 2014), while
92 20% of 12-20 year olds, and up to 56% of those aged over 20 report drinking alcohol
93 (Substance Abuse and Mental Health Services Administration (SAMHSA), 2015b).
94 The rate of heavy episodic drinking (often defined as 5 or more drinks for men and 4
95 or more drinks for women on a single drinking occasion(Wechsler and Nelson, 2001))
96 also rises sharply during early adulthood from 5.8% of 12-17 year olds to
97 approximately 38% of 18-34 year olds (Substance Abuse and Mental Health Services
98 Administration (SAMHSA), 2015a). In contrast however, rates of violence in the
99 general population tend to peak in adolescence and decline thereafter (Flatley et al.,
100 2010; Nash and Kim, 2006). Thus, although a common explanation for violence is
101 alcohol consumption, rates of alcohol consumption rises while rates of violence fall in
102 the general population in Western countries during the period from adolescence to
103 adulthood.

104 Several longitudinal studies have found evidence for a relationship between alcohol
105 and violence. Two studies that used data from the Longitudinal Study of Adolescent

106 Health (Add Health) found evidence of a significant relationship between alcohol and
107 violence. Using data from waves I and II among a subgroup of adolescents who
108 reported drinking alcohol, the initiation of violence was associated with high volume
109 or frequent alcohol use (Swahn and Donovan, 2004, 2005). Similarly, an analysis
110 of data from the Christchurch birth cohort found a significant relationship between
111 alcohol and violence in 15-21 year olds after adjusting for a wide range of covariates
112 (Boden et al., 2012; Fergusson and Horwood, 2000). Other longitudinal studies have
113 similarly found a positive relationship between alcohol and violence (Blitstein et al.,
114 2005; Duncan et al., 1997; Ellickson et al., 2003; Xue et al., 2009).

115 Several longitudinal studies however have found a positive relationship between
116 alcohol and violence at some time points and not others. A latent class analysis of the
117 Christchurch data (Wells et al., 2004) identified 4 latent classes, representing
118 increasing levels of severity of alcohol problems. The severity of alcohol problems
119 predicted violence at age 16-21, but not at age 21-25. Two papers arising from the
120 Pittsburgh Youth Study reached differing conclusions. Data from 506 boys aged 13
121 who were interviewed annually until age 18 showed significant association
122 between alcohol at age 13, and violence at any time between age 14 and 18 (White et
123 al., 1999). However in a subsequent analysis, the relationship between alcohol use at
124 each age and violence the following year was significant only among those drinking
125 at age 13 (Wei et al., 2004). In a study from Australia, (Scholes-Balog et al., 2013),
126 alcohol consumption at age 13 was found to be associated with violence at age 15,
127 however alcohol consumption at age 15 was not associated with violence at age 17.
128 Another study which involved structural equation analysis of over 808 students over 4
129 waves found only weak evidence of a relationship between alcohol and aggression in
130 one out of the three paths tested (Huang et al., 2001).

131 There are several reasons why some studies and not others have found a significant
132 relationship between alcohol and violence. First, the age of the participants both at
133 inception and at follow up varies between the studies. Some studies recruited
134 children aged 10 or younger, while others recruited older children and young adults.
135 The age at which violence was measured as the outcome variable also varied
136 considerably between studies, while some investigated overall trajectories of violence
137 It is possible therefore that the relationship between alcohol and violence is not

138 constant, and may vary with age. Second, many studies have not controlled for the
139 breadth of potentially relevant confounders, or have studied highly selected groups
140 such as from schools in high crime areas. Third, many studies have been relatively
141 small (less than 500 participants) and few have included a comprehensive set of
142 variables that have been identified as being associated with both violence and alcohol
143 use. Finally, few studies have incorporated changes in level of alcohol use during the
144 course of the study, and have relied on baseline alcohol use and subsequent violence.

145 Our aim was therefore to examine whether the risk of violence associated with
146 alcohol use varies by age, in a large nationally representative cohort of adolescents,
147 over a 13 year period, while adjusting for potential confounders. Our null hypothesis
148 was that there was no change in the relationship between alcohol and violence with
149 increasing age.

150

151 **Methods**

152

153 **Design and setting**

154 We used data from the National Longitudinal Study of Adolescent Health (Add
155 Health (Harris et al., 2009), a study of nationally representative adolescents in the
156 United States of America (USA), which commenced in 1994-95. Interviews took
157 place in four waves which were carried out in 1994/5, 1995/6, 2001/2 and 2007/8. At
158 baseline (wave I), the participants were between age 11 and 21 (mean age 16).
159 Participants were selected from 80 high schools and 52 middle schools in numbers
160 proportional to the size of each school. The design also ensured that the sample was
161 representative of US school attenders with respect to country of origin, school size,
162 school type, urbanicity, and ethnicity(Harris, 1995).

163 Participants were interviewed in their homes using audio-computer assisted self
164 interview (ACASI). A parent of each participant also completed an interviewer-
165 assisted questionnaire at wave I. Nationally collected social, demographic, and
166 criminological data from the US Census Bureau at the level of census block group
167 (consisting on average of 452 housing units or 1,100 people (1990) were linked to
168 participants in the study for use as covariates in the analyses. Participants were
169 interviewed on three further occasions, (wave II in 1996, wave III in 2001/2002, and
170 wave IV in 2008).

171 *Exposure Data*

172 At each of the four waves, participants were asked the same two questions about their
173 alcohol exposure: “Think of all the times you have had a drink during the past 12
174 months. How many did you usually have each time? - A ‘drink’ is a glass of wine, a
175 can of beer, wine cooler, a shot glass of liquor, or a mixed drink.” Responses were
176 categorised as 0, 1-4 and 5 or more. Participants were also asked, “Over the past 12
177 months on how many days did you drink 5 or more drinks in a row?” Responses were:
178 “1 or 2 days”, “Once a month”, “2 or 3 days month”, “1 or 2 days a week”, “3 to 5
179 days a week” or “Every/almost every day”.

180

181 *Outcome variables*

182 *Violence*

183 Violence was ascertained at each of the 4 waves by asking, “*In the past 12 months,*
184 *how often did you hurt someone badly enough to need bandages or care from a*
185 *doctor or nurse?*” Participants responded either “Never”, “*1 or 2 times*”, “*3 or 4*
186 *times*”, or “*5 or more times*”, and responses were converted to a binary variable for
187 this study to indicate whether or not they reported engaging in violence. Two
188 secondary outcome measures were also examined –the frequency of physical fighting
189 “physical fighting” (asked at wave I, II and IV), and whether the respondent had been
190 involved with fighting in a group against another group, “group fighting” (asked at all
191 4 waves).

192

193 **Co-variates**

194 Individual-level time-variant covariates which were gathered by self-reported
195 questionnaires at every wave were cigarette smoking (which we categorised as 0, 1-60
196 and 60 or more cigarettes per month), cannabis use (used versus not used cannabis in
197 the past 12 months), and age. Covariates analysed as time-invariant were gathered at
198 wave I, which were ethnicity (categorised as White, Black, Asian or other), gender
199 (male or female), IQ (measured using The Adolescent Health Picture Vocabulary Test
200 adapted from the Peabody Picture Vocabulary Test, Revised (Dunn and Dunn, 1981)),
201 temper (parent report as to whether the child has a bad temper (“Yes/No”)),
202 depression (measured on a 19-item scale at wave I adapted from the Center for
203 Epidemiologic Studies of Depression Scale (CES-D) (Radloff, 1977)), parental
204 conflict (parent report as to how much they “fight or argue” with their spouse, on a
205 scale 0-3, those without a spouse were coded as 0), peer substance abuse (of their
206 three closest friends, how many who drink alcohol, smoke cigarettes or use marijuana
207 at least once a month, total score 0-9), and delinquency (sum of 11 questions
208 regarding frequency of behaviours including stealing, damage to property, entering
209 buildings without permission, running away and selling drugs).

210

211 We used two neighbourhood measures, assumed to be time-invariant, measured at
212 wave I, which were neighbourhood disadvantage, and neighbourhood violent crime
213 rate. Neighbourhood disadvantage is a composite variable derived from US Census
214 Bureau statistics comprised of: (a) proportion of single parent families, (b) proportion

215 of households with income less than \$15,000; (c) proportion of people with high
216 school diploma; and (d) unemployment in the neighbourhood in which each
217 participant was located, defined as a US Census Bureau census block group which
218 had, on average, 452 housing units or 1100 people. We used principal component
219 factor analysis to obtain the composite neighbourhood disadvantage variable. The
220 variables loaded strongly onto a single factor, with loadings of 0.76, 0.88, 0.81 and
221 0.83 for the proportion of single parent families, proportion of households with
222 income less than \$15,000, proportion of people with high school diploma; and
223 unemployment respectively.

224 **Statistical analysis**

225 We first fitted random effects models using the entire cohort to investigate the effect
226 of levels of exposure to alcohol on violence over the 4 waves. We estimated the
227 marginal effect using the delta method (the difference in probability of the outcome
228 when the exposure is present versus not present) for ages between 12 and 30 years by
229 gender. We then repeated the analysis on an incident violence cohort, in which all
230 those who reported violence at wave I were excluded in order to further investigate
231 causality. Stata 12 was used for all analyses (StataCorp, 2012).

232 For calculations of proportions of those violent we present in tables, we used inverse
233 probability weighting (IPW) to take into account the sampling design and non-
234 response at preceding waves.

235 Sensitivity analyses

236 We carried out 2 sensitivity analyses. First, it could be considered that delinquency is
237 on the causal pathway between alcohol and violence, and therefore adjusting for it
238 may have introduced bias, and reduced the estimate of the effect size. We therefore
239 repeated the analyses excluding delinquency as a co-variate. Secondly, we used
240 alternative measures of violence as the outcome measure (serious fighting, and
241 fighting in a group).

242 Results

243 There were 20,542 individual at wave I, 49.4% were males. The mean age was 16.2
244 (sd=1.71, range 11.4-21.4). There were 14,712 individual at wave II (48.7% males,

245 mean age 16.7, sd=1.61), 14,948 at wave III (47.1% males, mean age 22.5, sd=1.75),
246 and 15,699 at wave IV (46.8% males, mean age 30.0, sd=1.75).

247 Alcohol use

248 Table 1 shows the characteristics of the participants by alcohol use at wave 1), with
249 frequencies and weighted proportions of those endorsing each response used in
250 calculating associations between alcohol use and violence.

251 Table 1 about here

252 **Violence**

253 The weighted proportion of people reporting violence at wave I was 19.1% . At wave
254 II, the weighted proportion was just over 8%, and was 6.4% at waves III and 2.1% at
255 wave IV.

256 *Relationships between alcohol consumption and violence*

257 The random-effects model of the effect of change in alcohol exposure on violence,
258 while adjusting simultaneously for time-variant and time-invariant confounders
259 showed that, overall, drinking 1-4 drinks on each occasion was associated with an
260 increase in risk of violence in males and females (OR 1.36 and 1.33 respectively) (see
261 table 2). Heavier drinking, (more than 5 drinks on each occasion) was associated with
262 a further increase in the odds of violence among males (OR 2.41, 95% CI 1.96-2.95,
263 $p<0.001$) compared with non-drinkers, whilst the elevation remained similar for
264 females (OR 1.40, 95% CI 0.99-1.97, $p=0.055$).

265

266 Table 2 about here

267

268 Figure 1 shows the predictive marginal effect of alcohol (plotted by categories of no
269 alcohol, 1-4 drinks and 5 or more) on the probability of violence from age 12-30 for
270 males and females separately. The probability of violence is greater in males than in
271 females, however the pattern is similar in both sexes; drinking 5 or more drinks each

272 occasion is associated with a higher probability of violence from age 12, continuing
273 into mid 20s and beyond, whereas consuming 1-4 drinks is not associated with a
274 significantly higher probability of violence compared with non-drinkers.

275 Drinking 1-4 drinks or 5 or more drinks on each occasion is associated with a
276 significantly higher probability of violence between age 12 and approximately age 18.
277 Thereafter, there is no additional risk of violence among those who drank 1-4 drinks
278 each occasion compared with those who drank no alcohol in either gender. Those who
279 reported usually having 5 or more drinks on a single occasion had a significantly
280 higher probability of violence than non- drinkers throughout the period of observation,
281 but the trajectories tended to converge with increasing age, and more so for females
282 than males.

283 Figure 1 about here

284

285 Sensitivity analyses

286 We carried out a repeat of the analyses without adjustment for delinquency as
287 it is possible that adjusting for delinquency may have reduced the estimate of the
288 effect size if it is on the causal pathway between alcohol and violence. The
289 association between heavy drinking (drinking 5 or more drinks) and violence
290 remained almost the same in these analyses both for males (OR 2.24, 1.93-2.61,
291 $p < 0.001$), and females (OR 1.64, 1.30-2.07, $p < 0.001$). However, the model with no
292 adjustment for delinquency did show evidence for association between drinking 1-4
293 drinks and violence in males (OR 1.32, 1.14-1.51, $p < 0.001$) and females (OR 1.41,
294 1.17-1.69, $p < 0.001$).

295 We also investigated other categories of violence, namely physical fighting and
296 fighting in a group. Similar findings were found for at least one reported episode of
297 physical fighting. Among men, drinking between 1-4 drinks was associated with such
298 violence (OR 1.28, 1.09-1.51, $p = 0.003$), as was consuming 5 or more drinks (OR 1.91,
299 1.57-2.33, $p < 0.003$). Among females, 5 or more drinks was associated with violence
300 (OR 1.36, 1.03-1.79, $p = 0.028$) but consuming 1-4 drinks was not (OR 1.15, 0.94-1.41,
301 $p = 0.163$). Rates of self-reported fighting in a group were also higher at any level of

302 reported drinking in both sexes. Males who consumed 1-4 drinks had increased rates
303 of violence (OR= 1.89 (1.59-2.25, p<0.001), as did males who consumed 5 or more
304 drinks had OR= 3.0 (2.46-3.65, p<0.001). Females who consumed 1-4 drinks also had
305 increased rates of violence (OR 1.5, 1.24-1.89, p<0.001), as did females who
306 consumed 5 or more drinks (OR 1.81, 1.38-2.39, p<0.001).

307

308

309 **Discussion**

310

311 We carried out a longitudinal study of nationally representative adolescents and
312 young adults to investigate the dynamic association between alcohol and violence
313 while controlling for a comprehensive set of individual and social-contextual
314 confounders. We found that those who consumed, 1-4 drinks each occasion had a
315 36% higher risk of violence, and those who consumed 5 or more drinks had 214%
316 higher risk compared with those who did not drink alcohol. Moreover, we found that
317 both violence rates and the effect of alcohol on violence apparently diminished with
318 increasing age in both males and females. Those who drank 1-4 drinks had an
319 elevated risk of violence only during adolescence (not adulthood) compared with
320 those who did not drink. Furthermore, for those who drank 5 or more drinks each
321 occasion, the risk was apparently highest amongst adolescents, but the relative risk
322 gradually reduced and seemed to converge by the 4th decade. Similar patterns were
323 found for both males and females. This finding was confirmed when other measures
324 of violence (serious physical fighting and fighting in a group) were examined,
325 however, there were differences in the association between alcohol and fighting in a
326 group. The effect of heavy drinking on fighting in a group was greater than for non-
327 group fighting, and this effect, continued to be evident until the 4th decade.

328 Overall, the prevalence of alcohol use and misuse in this study is similar to that found
329 in other national surveys in the USA (Chen et al., 2013). Our findings are also
330 consistent with the studies suggesting that the association between alcohol and
331 violence is present only in younger cohorts (Wells et al., 2004) (Scholes-Balog et al.,
332 2013).

333 Confounding

334 The association between alcohol use and violence was adjusted for several factors that
335 were, *a priori*, known to be associated with alcohol misuse and violence. An
336 extensive set of factors including individual, family, and neighbourhood
337 characteristics were adjusted for. An additional strength was the ability to control for
338 official rates of violent crime in the local community, as well as official indicators of
339 deprivation. Two variables were responsible for large confounding effects; they were
340 peer drug use, and delinquency which both reduced the apparent association by over
341 70% in preliminary univariate analyses. It is possible that violence and substance
342 misuse are part of a problem behaviour syndrome, and that each of these behaviours
343 may be expressions of a common underlying phenotype, however, there is some prior
344 evidence that a single common factor cannot adequately explain both substance use
345 and delinquency (LeBlanc and Loeber, 1998; Osgood et al., 1988; Paradise and Cauce,
346 2003; Tremblay et al., 2004; White and Labouvie, 1994). That there remained a
347 significant association between alcohol and violence even after controlling for other
348 substances as well as non-violent delinquency indicates that an underlying propensity
349 for risk-taking, addictive or general problem behaviours does not adequately explain
350 the observed association between alcohol and violence in this study.

351 Association with drug using peers also explained a large proportion of the apparent
352 relationship, indicating that young people who drank and who were violent were
353 significantly more likely to associate with substance using peers. It is possible that
354 some of the violence occurred because violent provocation may be more likely to
355 occur among peer groups whose members become intoxicated, disinhibited or are in
356 states of withdrawal, or who use violence in the acquisition of substances or the
357 means to acquire them. The association remained significant between alcohol and
358 violence even after controlling for peer substance use in our study. Adjustment for
359 gender, ethnicity, IQ, depression, temper, neighbourhood violent crime and
360 neighbourhood disadvantage resulted in small changes in the crude relationship.
361 Although a fairly comprehensive set of potential confounders were selected, the list
362 was not exhaustive and there are other potential confounders that were not used in this
363 analysis.

364 Causality

365 Although we have found a relationship between alcohol and violence, we are unable
366 to ascertain whether this is a causal relationship. We consider causality with respect
367 to the Bradford-Hill criteria(Bradford-Hill, 1965).

368 *Temporality.* In this study, the measurement of alcohol use preceded the observation
369 of violence by virtue of the prospective longitudinal design and the use of statistical
370 methods appropriate to the design. Given that questions relating to the exposure and
371 outcome were ascertained repeatedly over 4 waves, there are multiple opportunities to
372 assess the temporal relationship within individuals, however there remains a difficulty
373 in ascertaining the temporal sequence of alcohol and violence when both arise
374 between waves of data collection as would have happened with some individuals in
375 this study. *Dose-response relationship and strength of association.* Analysis of
376 the entire cohort showed that those who regularly consumed 1-4 alcoholic drinks had
377 and an increased odds of violence of 1.36 and those who regularly drank 5 or more
378 drinks on each occasion the odds of violence was 2.4 Using the method described by
379 Chen (Chen et al., 2010) odds ratios of 1.7, 3.5 and 6.7 are estimated to be equivalent
380 to Cohen's d effect sizes of small, medium and large respectively. We observed some
381 evidence of a dose-response effect, however the observed association between alcohol
382 consumption and later violence in our study is overall small.

383 *Consistency* A causal interpretation is strengthened when the association is
384 consistently found after multiple replications. In our study, we found the association
385 held across several different measures of violence, including measures of violence,
386 fighting, and group violence. *Biological Plausibility* There is evidence from
387 previous research that alcohol has differential effects on the adolescent compared with
388 the adult brain; for example adolescents have more memory impairment during acute
389 intoxication than adults(Acheson et al., 1998). It is possible therefore that younger
390 people are more susceptible to the detrimental effects of alcohol. Adolescence is a
391 time of major development of the human brain, and particularly of the prefrontal
392 cortex that is important for impulse control, and this be a factor contributing towards
393 adolescents' propensity for risk-taking, sensation seeking and impulsivity (Alfonso-
394 Loeches and Guerri, 2011). Alcohol may therefore have a disproportionately greater

395 impact on the adolescent brain in contributing to disinhibition and aggression as
396 important self-regulatory functions are still in the process of development and
397 maturation.

398 Strengths and limitation

399 There are a number of limitations with our study. It was not possible to correct for all
400 time-dynamic confounders and it is therefore possible that changes in the strength of
401 the relationship over time can be explained by changes in confounders that varied
402 over time, such as exposure to stress or trauma. Also, attrition in this study could
403 have resulted in an over-estimation of the association between alcohol and violence if
404 drinkers who became violent were less likely to drop out than drinkers who did not
405 become violent, or if those who were non-drinkers who did not become violent were
406 more likely to drop out. It is more likely however that those who were violent, and
407 drinking alcohol were more likely to engage in other problematic or chaotic
408 behaviours, and thus less likely to be traced or to participate in follow-up. It is
409 possible therefore that, if anything, the extent of the relationships may be
410 underestimated. In addition, all individuals who participated in two or more, not
411 necessarily consecutive, waves of data collection were included in the study to
412 maximise the information available, thus mitigating against non-participation in one
413 or two waves.

414 We noted the sharp decline in reported violence between wave I and II which might
415 be due to misclassification of violence at wave I (over reporting). However, similar
416 findings were observed in the other measures of violence, fighting and fighting in a
417 group, and neither were other forms of antisocial behaviour such as drug or alcohol
418 use elevated among the first wave respondents as might be expected if there was a
419 general tendency to over report deviant behaviours. It is unlikely therefore that there
420 was substantial misclassification of violence at wave I. It is possible however that that
421 the perception of violence changed as participants got older, such that there was an
422 under-reporting of violence as participants got older. Although the questions used to
423 enquire about violence were identical at each wave, the perception of, or reporting of
424 violence at different ages may have varied. For example the perpetration of violence
425 as an adolescent categorised as *“hurting someone badly enough to need bandages or*

426 *care from a doctor or nurse*” may be more readily endorsed if both perpetrator and
427 victim are young, for example if the victim receives medical attention from a school
428 nurse, but at a later age, victims may not readily seek medical attention, such as in
429 intimate partner violence. It is possible therefore that the relationship between alcohol
430 and violence does not change with age, but the type of violence or perception of
431 violence from the perspective of either perpetrator or victim changes. In addition, our
432 focus was explicitly on physical violence, and our findings may not generalise to
433 other forms of aggression such as sexual violence or aggression towards property.
434 Nevertheless, our findings are in keeping with other longitudinal studies that indicate
435 that the relationship between alcohol and violence holds for younger but not older age
436 groups.

437 The main strengths of the study are the large size of the sample, which was
438 representative of the US general population, the variation in age within the cohort, the
439 variation in time between data collection points which allowed the application of
440 appropriate statistical models to examine change, the long follow up period, good
441 study retention rate, and the use of comparable measure at each time point.

442 An additional strength was the ability to control for a comprehensive set of potential
443 confounders, including official rates of violent crime in the local community, and
444 social indicators of the local area.

445 Conclusions

446 Our study provides evidence to support the hypothesis that the effect of alcohol on
447 violence varies with quantity consumed on each occasion, and the effect of alcohol
448 and violence appears to reduce with age. These findings suggest that efforts towards
449 primary prevention of alcohol related violence reduction should be targeted on
450 reducing the amount individuals consume on each occasion, and would best be
451 focussed on adolescents.

452

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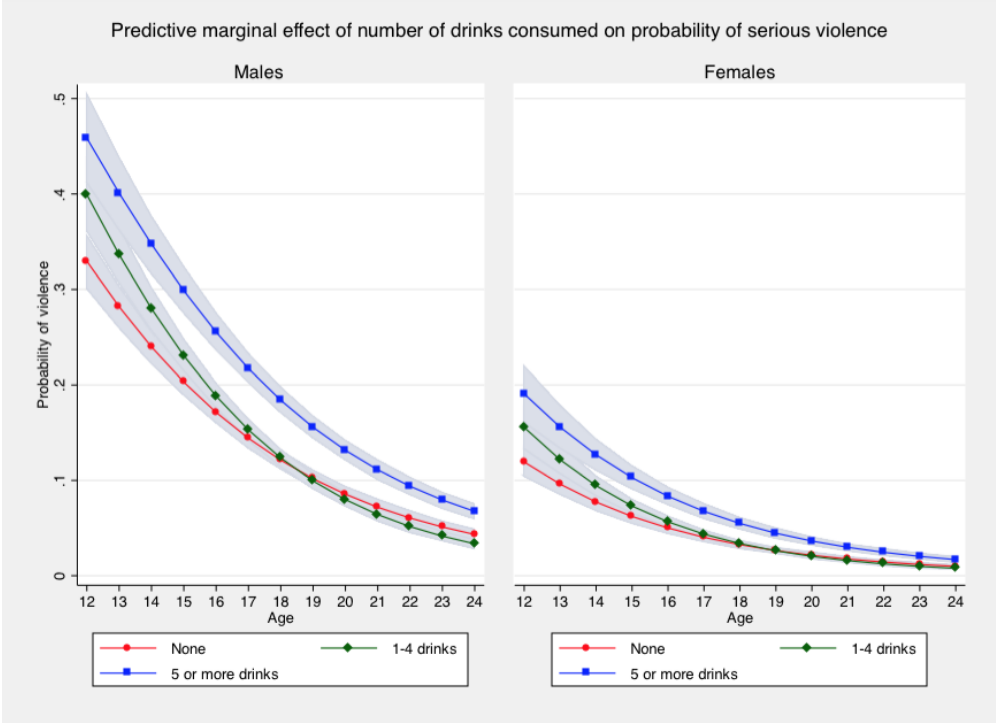
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Change in the relationship between drinking alcohol and risk of violence with increasing age: A nationally representative longitudinal study

Figure 1. Predictive marginal effects (with 95% CIs) of violence for number of drinks usually consumed each occasion, age 12-24, by gender



Change in the relationship between drinking alcohol and risk of violence among adolescents and young adults: A nationally representative longitudinal study

Table 1. Participant characteristics at wave 1 by number of alcoholic drinks usually consumed

	Frequency by number of drinks usually consumed on each occasion at baseline n=20,542 (Weighted %) ¹		
	0 Drinks	1-4 Drinks	5 or more Drinks
Violence			
No	9,345 (86.2)	4,725 (81.5)	2,488 (69.0)
Yes	1,599 (13.8)	1,099 (18.5)	1,130 (31.0)
Cigarettes			
No	9,844 (89.9)	3,677 (60.4)	1,498 (39.9)
Yes	1,037 (10.1)	2,124 (39.6)	2,100 (60.1)
Cannabis			
No	10,459 (96.9)	4,655 (80.7)	2,154 (60.9)
Yes	388 (3.1)	1,116 (19.3)	1,388 (39.1)
Ethnicity			
White	6,130 (69.4)	3,752 (75.5)	2,797 (74.0)
Black	3,071 (19.8)	1,235 (15.6)	373 (16.4)
Asian / Pacific Island	891 (4.3)	371 (2.0)	162 (3.6)
Other	844 (6.5)	464 (0.5)	286 (6.0)
Delinquency			
Lower tertile	4,040 (39.9)	891 (16.6)	362 (10.4)
Middle tertile	3,942 (35.1)	1,776 (31.3)	758 (22.3)
Upper tertile	2,992 (25.0)	3,130 (52.2)	2,477 (67.4)
IQ			
Lower tertile	3,835 (33.5)	1,596 (25.2)	868 (22.0)
Middle tertile	3,343 (33.8)	1,938 (35.7)	1,321 (38.4)
Upper tertile	3,184 (32.7)	2,026 (30.0)	1,281 (39.7)
Temper			
No	6,771 (71.9)	3,221 (66.9)	1,813 (68.6)
Yes	2,578 (28.1)	1,609 (33.1)	1,199 (31.4)
Depression			
Lower tertile	3,679 (36.6)	1,420 (26.4)	828 (31.4)
Middle tertile	3,730 (34.0)	1,986 (34.7)	1,129 (33.8)
Upper tertile	3,535 (29.4)	2,418 (38.9)	1,661 (43.8)
Parent conflict			
No	7,222 (77.3)	3,663 (75.9)	2,253 (76.6)
Yes	2,023 (22.7)	1,190 (24.1)	725 (23.4)
Peer substance use			
No	5,658 (54.3)	896 (15.4)	177 (4.6)
Yes	4,925 (45.7)	4,844 (84.7)	3,384 (95.4)
Neighbourhood Violent Crime			
Lower tertile	3,178 (33.3)	1,746 (33.4)	1,367 (39.5)
Middle tertile	3,383 (39.2)	1,920 (41.7)	1,157 (40.0)
Upper tertile	4,118 (27.6)	2,002 (25.0)	2,002 (20.5)
Neighbourhood disadvantage			
Lower tertile			
Middle tertile	3,361 (34.5)	1,932 (36.2)	1,248 (35.4)
Upper tertile	3,301 (28.7)	1,945 (32.0)	1,314 (30.7)
	3,946 (36.8)	1,782 (31.9)	957 (34.0)

¹ Inverse probability weighting (IPW) to account for sampling design and non-response at preceding waves

Change in the relationship between drinking alcohol and risk of violence among adolescents and young adults: A nationally representative longitudinal study

Table 2. Random-effects models of effects of quantity of alcohol, cigarette smoking and cannabis use (time variant) on violence, adjusted for time-invariant covariates including interaction terms by gender

Violence	Males			Females		
	OR	95% CI	p	OR	95%CI	p
Number of drinks usually consumed						
0						
1-4	1.34	1.11-1.60	0.002	1.33	1.03-1.72	0.030
5 or more	2.32	1.90-2.83	<0.001	1.40	0.99-1.97	0.055
Number of times smoked cigarettes in last month						
None	1					
1-60	1.03	0.83-1.28	0.806	0.97	0.70-1.35	0.870
61 or more	1.51	1.22-1.87	<0.001	1.61	1.13-2.29	0.008
Number of times used cannabis in last 30 days						
None		1				
1-10	1.45	1.19-1.76	<0.001	1.35	0.98-1.86	0.067
11 or more	1.63	1.28-2.09	<0.001	1.90	1.23-2.93	0.004
Age (centered at 16)	0.82	0.80-0.84	<0.001	0.74	0.68-0.75	<0.001
Age squared	1.00	1.00-1.00	0.137	1.01	1.01-1.01	<0.001
Number of drinks X age						
1-4						
5 or more	0.96	0.92-0.99	<0.001	0.94	0.89-0.99	0.021
	0.99	0.96-1.02	0.394	1.03	0.97-1.09	0.311
Ethnicity						
White	1					
Black	1.42	1.22-1.66	<0.001	2.21	1.78-2.74	<0.001
Asian	0.77	0.60-1.00	0.048	0.59	0.36-0.95	0.031
Other	1.07	0.87-1.32	0.514	1.58	1.18-2.11	0.002
Delinquency	1.16	1.14-1.18	<0.001	1.18	1.14-1.22	<0.001
IQ	0.99	0.99-0.99	<0.001	0.98	0.98-0.99	<0.001
Temper	1.45	1.30-1.63	<0.001	1.64	1.39-1.93	<0.001
Depression	1.01	1.01-1.02	0.001	1.01	1.00-1.02	0.010
Parents conflict	0.91	0.85-0.97	0.006	0.94	0.86-1.04	0.238
Peer substance use	1.08	1.05-1.10	<0.001	1.12	0.92-1.11	<0.001
Neighbourhood violent crime rate	1.02	1.01-1.03	<0.001	1.01	1.00-1.03	0.058
Neighbourhood disadvantage	1.07	1.01-1.14	0.030	1.14	1.05-1.23	0.001
Alcohol X delinquency						
0	1					
1-4	0.97	0.94-0.99	0.013	0.99	0.95-1.03	0.488
5 or more	0.96	0.94-0.99	0.003	0.99	0.95-1.03	0.646
Alcohol X age						
0	1					
1-4	0.95	0.92-0.98	0.004	0.99	0.95-1.03	0.488
5 or more	0.98	0.94-0.99	0.373	0.99	0.95-1.03	0.653
Cigarettes X delinquency						
None	1					
1-60	1.01	0.98-1.04	0.411	1.02	0.98-1.07	0.292
61 or more	0.97	0.95-1.00	0.042	0.96	0.92-1.00	0.068
Cannabis X delinquency						
No	1					
Yes	0.97	0.95-0.99	0.015	1.00	0.96-1.03	0.081