ALCOHOL CONSUMPTION AND MIDLIFE COGNITIVE CHANGE IN THE BRITISH 1946 BIRTH COHORT STUDY

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(Received 9 July 2004; first review notified 31 August 2004; in revised form 29 October 2004; accepted 30 October 2004)

Abstract — Aims: Cross-sectional studies suggest that alcohol consumption benefits cognitive function. However, more longitudinal studies are required to confirm that alcohol has an effect on cognitive change and to rule out the possibility that those of higher ability engage in a lifestyle that protects against cognitive decline. Methods: We investigated the association between self-reported alcohol consumption and change in memory, speed and concentration in midlife, in 903 men and 861 women enrolled in the MRC National Survey of Health and Development (the British 1946 birth cohort). Results: After controlling for educational attainment, occupational social class and general cognitive ability, it was found that alcohol consumption was associated with a slower memory decline from 43 to 53 years in men, but a more rapid decline in visual search speed for the same interval in women. These effects were not explained by a further control for health status (body water weight, smoking, exercise, cardio-respiratory disease and affective state). Conclusions: Our data suggest that alcohol consumption is associated with a slower memory decline. However, the negative association between alcohol and psychomotor function in women is a potential cause for concern.

INTRODUCTION

Population-based studies suggest that alcohol consumption can benefit cognitive function in non-demented older people, although the pattern of this association is unclear. Some studies have found a higher cognitive performance in moderate drinkers than in abstainers or heavier drinkers (Hebert et al., 1993; Hendrie et al., 1996; Orgogozo et al., 1997; Kalmijn et al., 2002), whereas others have reported a positive association between alcohol consumption and cognitive function of a more linear nature, particularly in women (Dufouil et al., 1997; Elias et al., 1999; Kalmijn et al., 2002). Several factors may explain these trends, including the association between moderate social drinking and cardiovascular health (Rimm et al., 1996; Rehm et al., 1997; Murray et al., 2002), mental well-being (Delin and Lee, 1992; Mortensen et al., 2001), healthy lifestyle (Barefoot et al., 2002), and socio-economic advantage (Goodwin et al., 1987).

One limitation is that most of these studies are cross-sectional, making it difficult to rule out the possibility that those of higher ability have an advantageous lifestyle that protects against cognitive decline, which happens to include moderate social drinking. Available longitudinal evidence suggests weak or null associations between alcohol consumption and cognitive change, although these studies used either a brief follow-up interval (Dufouil et al., 1997), or a cognitive outcome (Mini-Mental State Examination, MMSE) that is relatively insensitive to change in younger people (Leroy et al., 2002). In this study, we investigated the association between self-reported alcohol consumption and change in memory, speed and concentration between 43 and 53 years in the British 1946 birth cohort study, controlling for general ability, socio-economic status (social advantage), physical function and mental health.

An additional advantage of this cohort is that all participants are of identical age, which may reduce the risk of confounding from poorer health and function associated with the age-related increase in alcohol abstention (Adams et al., 1990).

METHODS

Study population

Participants comprised the study sample of the MRC National Survey of Health and Development (NSHD), also known as the British 1946 birth cohort, that initially consisted of 5362 children. It included all births to non-manual and agricultural workers and a random sample of one in four of manual workers selected from all single and legitimate births that occurred in England, Scotland and Wales during one week in March, 1946. Information about socio-demographic factors and medical, cognitive and psychological function has been obtained regularly over the years by interview and examination, most recently in 1999, when 3035 study members at the age of 53 years underwent interview and examination by research nurses, who received standardized training. At this age the cohort was shown to be a representative sample, in most aspects, of the UK population born in the immediate post-war era. The exceptions were the over-representation among non-responders of the never married and the least advantaged in terms of cognitive ability, educational attainment and social class (Wadsworth et al., 2003).

Of the 3035 participants interviewed at 53 years of age, 1764 had complete data for alcohol consumption, the cognitive outcome measures, general cognitive ability, educational attainment and adult occupational social class. These 1764 participants comprised the study sample. Those with any missing cognitive scores had a lower educational attainment than those with complete outcome data (P < 0.001). There was no difference at 5% significance in the level of alcohol consumption at 43 years between those with and without data for cognitive test scores at 53 years.
Information on alcohol consumption over the previous 7 days was obtained by a self-completed questionnaire when the participants were at 43 years of age. Questions were asked about (i) spirits or liqueurs (number of measures), (ii) wine, sherry, martini or port (number of glasses), and (iii) beer, lager, cider or stout (number of half-pints). Responses to these three items were totalled and divided by seven to provide an approximate measure of drinks per day, where a drink (or unit in UK terminology) contains ~9.0 g of alcohol. Based on criteria used in the Framingham Heart Study (Elias et al., 1999), this was coded into 0 drinks/day (abstainers), 0.1–1.0 drinks/day (very light drinkers), 1.1–2.0 drinks/day (light drinkers), 2.1–4.0 drinks/day (moderate drinkers) and >4.1 drinks/day (heavy drinkers). Moderate and heavy categories were merged for females because few women fell into the heavy drinking category.

Cognitive outcome variables at 43 and 53 years

Verbal memory was assessed by a 15 item word learning task devised by the NSHD. Each word was shown for 2 s. When all 15 words had been shown, the cohort member was asked to write down as many of the words as possible. The total number of words correctly recalled over three identical trials was summed to provide an overall score for short-term verbal memory (maximum score = 45). After a delay of approximately 2 min, while participants were engaged in another task, they were asked to recall the words again, without warning. The total number of words recalled correctly during this trial provided a score for delayed verbal memory (maximum score = 15). A different word list was given to each half of the cohort at 43 years and these lists were reversed when they were at 53 years of age, to minimize any practice effects.

Speed and concentration was assessed by a visual search task, wherein participants were required to cross out the letters P and W, randomly embedded within a page of other letters, as quickly and accurately as possible within 1 min. The score comprised the total number of letters searched (maximum score = 600). Target letters were in different positions on the page at 43 and 53 years.

Potential confounding variables

Potential confounding variables consisted of educational attainment, occupational social class, general cognitive ability and a range of health indicators.

The highest educational or training qualification achieved by 26 years was classified by the Burnham scale (Department of Education and Science, 1972) and grouped into no qualifications, below ordinary secondary qualifications, ordinary secondary qualifications (‘O’ levels and their training equivalents), advanced secondary education (‘A’ levels and their equivalents) or higher education (degree level or equivalent). The occupational social class of the participants at 43 years of age (or earlier if this was unavailable) was coded according to the Registrar General classification (OPCS, 1970), and classified as professional, managerial, intermediate, skilled manual, semi-skilled manual or unskilled.

General ability was measured by a test of word pronunciation, using the National adult reading test (NART; Nelson and Willison, 1991) at 53 years.

The following health indicators were used as potential confounders when the participants were at 43 years of age:

(i) Body water weight, which is associated with blood alcohol level for any given dose of alcohol (Graham et al., 1998), derived from body mass index (BMI) by the method recommended by the Royal College of Physicians (Williams et al., 1983; Ely et al., 1999).

(ii) Smoking, which is associated with alcohol consumption (Istvan and Matarazzo, 1984; Launer et al., 1996) and with memory decline in this cohort (Richards et al., 2003a), classified as 0, 1–20 or >20 cigarettes per day.

(iii) Physical exercise (none vs any during the last 4 weeks, or no exertion vs any strenuous exercise during this interval), which provided a more functional index of general health and is protective of cognitive decline in this cohort (Richards et al., 2003b).

(iv) Cardio-respiratory disease, represented by recurring bronchitis, hypertension, heart disease, stroke or diabetes over the past 12 months, treated as a potential confounder in view of the suggested cardioprotective effect of alcohol (Rimm et al., 1996; Rehm et al., 1997; Murray et al., 2002) and the association between cardiovascular risk and cognitive function (Elias et al., 1993).

(v) Affective state, assessed by the Psychiatric symptom frequency scale (PSF; Lindelow et al., 1997), an interview-based scale for symptoms of anxiety and depression.

(vi) Speed and dexterity, measured at 43 years by timed peg placement (overall mean of three trials for each hand, subjected to a log transformation to improve distribution).

Statistical methods

Analysis of covariance was used to test the association between alcohol consumption and change in verbal memory and visual search speed between 43 and 53 years of age, separately for men and women. Conditional models of change were employed, adjusting for the memory and search speed scores at 53 years for their corresponding scores at 43 years, because different versions of the cognitive tests were used at the different ages. Multiple regression was then used to obtain regression coefficients and to adjust the associations for educational attainment, occupational social class and general ability and then for each health indicator in turn.

RESULTS

Socio-economic status, general ability and alcohol consumption

Tables 1 and 2 show educational attainment, occupational social class and mean cognitive test scores by the level of alcohol consumption at 43 years, separately for men and women.

There was a J-shaped or inverted U-shaped trend in men, with those consuming light to moderate levels of alcohol showing a higher socio-economic status and higher cognitive test scores than abstainers or heavy drinkers. The scores for socio-economic status and cognitive tests were higher in women who consumed alcohol, irrespective of the amount taken, compared with abstainers. The striking exception was for visual search speed, where scores were lower (i.e. slower) in all alcohol consumption categories, compared with abstainers.
Table 3 shows the results of the multiple regression analyses for memory, separately for men and women. Regression coefficients represent mean difference in memory at 53 years for a given memory score at 43 years, for each alcohol category compared with abstainers (reference group). Hence, these coefficients can also be interpreted as a change in memory score between 43 and 53 years for a given score at 43 years. Since there is a decline in scores between the two ages, positive coefficients represent a slower decline. All coefficients are shown before and after adjustment for educational attainment, occupational social class and general cognitive ability.

Alcohol consumption was associated with a slower memory decline ($F_{(2.35)} = 2.35$, $P = 0.05$) in men.
although there was no trend towards increasing memory score at 43 years with increasing alcohol consumption ($P$ for trend $= 0.10$), in the adjusted model. It can be seen that controlling for education, social class and general ability had a modest attenuating effect on the association, which nevertheless remained significant at the 5% level. Alcohol was significantly associated with a slower memory decline in women, although coefficients were strongly reduced after adjustment for education, social class and general ability. Inspection of Table 2 suggests that the unadjusted association was largely explained by education and social class. Sex $\times$ alcohol consumption interactions were not significant at the 10% level in the adjusted model.

**Alcohol consumption and visual search speed**

Table 4 summarizes the regression analyses for visual search speed. There was little evidence of an association between alcohol consumption and change in search speed in men, before or after adjustment for education, social class and general ability. However, alcohol was associated with a more rapid decline in search speed from 43 to 53 years in women ($F = 2.94$, $P = 0.03$), and a faster decline with increasing alcohol consumption ($P$ for trend $= 0.008$). Adjustment for education, social class and general ability had little effect on this association and the sex $\times$ alcohol consumption interaction was not significant at the 10% level.

**Controlling for health indicators**

With education, social class and prior cognitive ability controlled, none of the health indicators (body weight, cigarette smoking, physical exercise, cardio-respiratory disease and affective state) explained the associations between alcohol consumption and the rate of cognitive decline. The association between alcohol and search speed decline in women was not explained by manual speed and dexterity at 43 years (timed peg placement).

**Alcohol abstinence and past potential alcohol abuse**

Ten (2.1%) of the abstainers (six males and four females) reported that they had scored positive, at some time in their life, on at least two items in the CAGE screen, the recommended threshold with this measure for potential alcohol abuse (Ewing, 1984). Results of the regression analyses were almost identical when these participants were excluded from the analyses.

**DISCUSSION**

In this population-based birth cohort study, we found that alcohol consumption at 43 years was associated with a change in cognitive function from 43 to 53 years, after controlling for socio-economic status (educational and occupational attainment) and general cognitive ability. Alcohol consumption was associated with a slower decline in memory in men, but a more rapid decline in psychomotor speed in women. The protective effect on memory decline in men was observed at all levels of alcohol consumption, with no difference between light and heavy drinkers, whereas in women there was evidence of a more rapid decline in psychomotor speed with increasing alcohol consumption. These associations were not explained by an additional control for indicators of health and physical function (body water weight, smoking, exercise, FEV$_1$, resting pulse and blood pressure), and affective state. Furthermore, the association between alcohol and search speed decline in women was not accounted for by a more basic measure of manual speed and dexterity at 43 years (timed peg placement).

We should note several potential limitations of this study. First, measures of alcohol consumption were self-reported, which raises the question of inaccurate or biased recall. Although self-report measures do not give a precise estimate of actual consumption, they are useful for classifying people into broad consumption bands (Eren, 1995). Second, the questions about alcohol consumption applied only to the previous 7 days, and can only be assumed to represent typical weekly alcohol consumption. There is some justification for this, since most studies report temporal stability in patterns of alcohol use (Glynn et al., 1985; Temple and Leino, 1989; Adams et al., 1990). Third, these measures of alcohol

**Table 4. Mean differences in conditional visual search speed decline from 43 to 53 years per alcohol consumption category, compared with abstainers**

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted$^a$</th>
<th></th>
<th>Adjusted$^b$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Change in search speed from 43 to 53 years</td>
<td>$P$</td>
<td>Change in search speed from 43 to 53 years</td>
<td>$P$</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None (reference)</td>
<td>0</td>
<td><strong>0.40$^c$</strong></td>
<td>0</td>
<td><strong>0.23$^c$</strong></td>
</tr>
<tr>
<td>Very light</td>
<td>0.05 ($-0.12$, 0.22)</td>
<td>0.55</td>
<td>0.01 ($-0.15$, 0.18)</td>
<td>0.88</td>
</tr>
<tr>
<td>Light</td>
<td>$-0.07$ ($-0.24$, 0.10)</td>
<td>0.42</td>
<td>$-0.12$ ($-0.29$, 0.05)</td>
<td>0.17</td>
</tr>
<tr>
<td>Moderate</td>
<td>$-0.08$ ($-0.26$, 0.10)</td>
<td>0.37</td>
<td>$-0.14$ ($-0.32$, 0.05)</td>
<td>0.14</td>
</tr>
<tr>
<td>Heavy</td>
<td>0.02 ($-0.18$, 0.21)</td>
<td>0.86</td>
<td>$-0.02$ ($-0.22$, 0.17)</td>
<td>0.81</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None (reference)</td>
<td>0</td>
<td><strong>0.03$^c$</strong></td>
<td>0</td>
<td><strong>0.03$^c$</strong></td>
</tr>
<tr>
<td>Very light</td>
<td>$-0.03$ ($-0.16$, 0.09)</td>
<td>0.61</td>
<td>$-0.06$ ($-0.19$, 0.08)</td>
<td>0.40</td>
</tr>
<tr>
<td>Light</td>
<td>$-0.26$ ($-0.45$, $-0.01$)</td>
<td>0.005</td>
<td>$-0.26$ ($-0.45$, $-0.07$)</td>
<td>0.006</td>
</tr>
<tr>
<td>Moderate/heavy</td>
<td>$-0.18$ ($-0.44$, 0.08)</td>
<td>0.16</td>
<td>$-0.21$ ($-0.47$, 0.05)</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Positive coefficients represent a slower decline and negative coefficients represent a faster decline compared with abstainers.

$^a$Analysis of covariance with the score at 43 years as a covariate.

$^b$Adjusted for education, social class and general cognitive ability (NART).

$^c$F for equality of means.
use did not provide information on the pattern of alcohol consumption within the 7 days. Thus, we were unable to identify binge drinking, which is known to have adverse effects on health (Murray et al., 2002). Fourth, since cognition was only part of a wide range of functions measured in this study, our test battery was necessarily of limited range, and to date, repeat measures have only been obtained for one measure each of memory and search speed. It would therefore be important to extend this investigation using a wider range of repeated cognitive measures. Finally, there was a disproportionate loss to follow-up of those with a lower cognitive ability. This is a common problem with studies of cognitive ageing, and may have led to an underestimation of the negative effects of alcohol on cognitive function, although we have no reason to believe that this loss influenced the pattern of associations.

Against these limitations, two advantages of the 1946 birth cohort can be highlighted. First, we were able to adjust for general cognitive ability, which, along with educational and occupational attainment, increased the rigour of control against confounding from social position. Second, all participants were of identical age, which reduces the risk of uncontrolled confounding from an age-associated decline in health and function.

With these methodological issues in mind, what accounts for the protective effect of alcohol consumption on memory decline? Since moderate drinking is associated with a healthy lifestyle and general well-being, it is possible that the underlying aspects of health were responsible. The inability of cardiovascular risk to explain this association raises doubts over whether it was mediated by the cardioprotective effects of alcohol. There is population-based evidence that moderate drinkers have fewer white matter abnormalities in later life than abstainers or heavy drinkers (Mukamal et al., 2001), raising the possibility of a neuroprotective effect of moderate alcohol consumption, via direct benefit to cerebral blood flow (Golomb et al., 1995). However, only a small proportion of people are likely to have white matter disease in middle age.

Moreover, it is unclear whether a healthy lifestyle explains the positive association between alcohol and memory in men. We did not find that physical exercise or smoking had a confounding effect. To date, however, nutrition is an unexplored confounding factor, which may have led to an underestimation of the negative effects of alcohol on cognitive function, although we have no reason to believe that this loss influenced the pattern of associations.

An unexpected finding was the negative association between alcohol consumption and visual search speed in older women. Yet their study was based on a random sample of the community, and may have led to an underestimation of the negative effects of alcohol on cognitive function, although we have no reason to believe that this loss influenced the pattern of associations.

Acknowledgements — Funding for the National Survey of Health and Development is provided by the Medical Research Council. Data collection at 53 years was carried out by the National Centre for Social Research.

REFERENCES


