Prospective associations between alcohol consumption and psychological well-being in midlife

Marie Grønkjær1,2,3*, Cathrine Lawaetz Wimmelmann2,3, Erik Lykke Mortensen2,3 and Trine Flensborg-Madsen2,3

Abstract

Background: Alcohol consumption potentially influences psychological well-being in beneficial and harmful ways, but prospective studies on the association show mixed results. Our main purpose was to examine prospective associations between alcohol consumption and psychological well-being in middle-aged men and women.

Methods: The study sample included 4148 middle-aged individuals (80% men) from the Copenhagen Aging and Midlife Biobank who reported their alcohol consumption (average weekly consumption and frequency of binge drinking) at baseline in 2004 or 2006 and reported their psychological well-being (satisfaction with life and vitality) at follow-up in 2009–2011. Analyses were adjusted for sociodemographic factors, lifestyle, social relations, and morbidity.

Results: For satisfaction with life at follow-up, lower scores were observed in men and women who were alcohol abstinent at baseline as well as in men with heavy alcohol consumption compared with moderate alcohol consumption at baseline. Moreover, men with weekly binge drinking at baseline had lower satisfaction with life scores at follow-up than men with moderate frequency of binge drinking (1–3 times/month). In relation to vitality at follow-up, alcohol abstinence at baseline in men and women and heavy alcohol consumption at baseline in men were associated with lower scores compared with moderate alcohol consumption (yet in men these findings were not robust to adjustment for covariates).

Conclusions: Alcohol abstinence seems to be prospectively associated with adverse psychological well-being (vitality and life satisfaction) in men and women, while heavy alcohol consumption seems to be prospectively associated with adverse satisfaction with life in men. Finally, a prospective association between weekly binge drinking and lower life satisfaction was observed in men.

Keywords: Psychological well-being, Quality of life, Satisfaction with life, Vitality, Alcohol consumption, Binge drinking

Background

The influence of alcohol consumption on psychological well-being is complex and remains a debated topic. In the short-term, alcohol may be associated with pleasure and positive effects such as stress reduction, having fun and letting go of control. Nevertheless, alcohol may also lead to acute negative outcomes such as intoxication. In the long-term, studies have suggested that alcohol may have
both beneficial and harmful effects on psychological well-being. Cross-sectional studies have suggested inversely J-shaped associations between alcohol consumption and psychological well-being in terms of low psychological well-being with heavy alcohol consumption and frequent binge drinking [1–4] and alcohol abstinence [4–8]. Some prospective studies likewise suggest that heavy alcohol consumption and frequent binge drinking are associated with lower psychological well-being [9–11] and that alcohol abstinence is associated with lower psychological well-being than moderate consumption [10, 12–14]. However, some studies have also implied that alcohol consumption is not prospectively associated with psychological well-being [15–17]. One study has even suggested that larger alcohol consumption among university students was associated with higher subjective well-being two years later [18].

The conflicting evidence on the prospective association between alcohol consumption and psychological well-being may partly be caused by diverse study samples and differences in assessment of alcohol consumption and psychological well-being. For example, age and sex differences in the association have previously been suggested [10, 19]. Anticipated age differences underline the importance of investigating the association in different age groups, such as in middle-aged and older individuals [11–13, 16]. Since alcohol consumption may influence different aspects of psychological well-being in different ways, it is problematic that existing studies in middle-aged and older participants have primarily focused on health-related quality of life. Finally, the consumption pattern may be important in relation to psychological well-being but there is scarcity of studies examining binge drinking and psychological well-being in midlife and old age.

The purpose of the present study was to examine prospective associations between alcohol consumption and psychological well-being in middle-aged men and women in Denmark. More specifically, the influence of both average weekly alcohol consumption and frequency of binge drinking was investigated in relation to two aspects of psychological well-being comprising satisfaction with life and vitality.

Methods
Study participants
The study population consisted of participants from the Copenhagen Aging and Midlife Biobank (CAMB) [20]. CAMB is a follow-up study comprising participants from three established cohorts; in the present study, we included men from the Metropolit 1953 Danish male birth cohort (MP) [21] and men and women from the Danish Longitudinal Study on Work, Unemployment and Health (DALWUH) [22]. The MP cohort included all boys born in 1953 in the Copenhagen Metropolitan area (N=12,270) [21], and 6219 of these boys completed a questionnaire in 2004 [23]. The DALWUH cohort included a random sample of Danish men and women aged 40 or 50 in 1999 (N=11,082) [20], and 6151 of these individuals completed a questionnaire in 2006 [23].

From the original cohorts, 7750 from the MP cohort and 4906 from the DALWUH cohort were invited to participate in the CAMB study. Data were collected through a questionnaire on psychosocial, behavioral, health-related and social variables, as well as a clinical examination, blood samples and physical and cognitive tests [23]. All participants gave informed consent [20]. In total, 4160 individuals (2749 from MP and 1411 from DALWUH) completed the questionnaire both at baseline in 2004 (MP) or 2006 (DALWUH) and at follow-up in 2009–2011 (CAMB). However, 4148 individuals were included in the analyses because 12 individuals were excluded to avoid cells with less than three observations.

Alcohol consumption at baseline
Average alcohol consumption
MP cohort members self-reported the amount of alcohol consumed the past week in terms of bottles of regular and strong beer, glasses of red and white wine, glasses of fortified wine, and units of spirits. Using the same alcohol categories, DALWUH cohort members self-reported the amount of alcohol consumed on typical weekdays and in typical weekends.

This information was used to calculate average weekly units of alcohol consumed using the following equivalents: regular beer (bottle)=1 unit; strong beer (bottle)=2 units; red wine (glass)=1 unit; white wine (glass)=1½ units; and fortified wine (glass)=1 unit; fortified wine (glass)=1½ units; and spirits reported in units. In Denmark and in this study, one unit of alcohol corresponds to 12 g of pure alcohol.

Binge drinking
MP cohort members were asked to report the number of times that they had consumed ≥5 units of alcohol on the same occasion during the last 30 days. A categorical binge drinking variable was constructed with three categories: ‘less than once a month’; ‘1–3 times per month’; and ‘once per week or more’. DALWUH cohort members were not asked questions about binge drinking.

Psychological well-being at follow-up
Satisfaction with life
Participants’ life satisfaction was assessed by the Satisfaction With Life Scale (SWLS) [24] at follow-up (CAMB). SWLS was not assessed at the baseline assessment in 2004 (MP) and 2006 (DALWUH). Five general statements
related to the respondents’ life satisfaction are included in SWLS. The five general statements are answered using a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree), leading to a total sum-score ranging from 5 to 35. The psychometric properties of SWLS in terms of both reliability and validity have shown to be satisfactory [24, 25]. In the present study sample, Cronbach’s alpha for the five SWLS items was 0.91.

Vitality
Participants’ vitality was assessed by the vitality scale of the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) [26] at baseline in 2004 (MP) and 2006 (DALWUH) and at follow-up in 2009–2011 (CAMB). Four items are included in SF-36 to evaluate participants’ vitality by referring to feelings of energy and fatigue within the past month, for example “How much of the time during the past 4 weeks did you have a lot of energy?”. Scores were transformed to a continuous scale ranging from 0 to 100 with higher scores indicating higher vitality [27]. Investigation of the psychometric properties of the Danish translation of the vitality scale has indicated that both the reliability and validity is satisfactory [28, 29]. In the present study sample, Cronbach’s alpha for the four SF-36 vitality items was 0.88 at both baseline and follow-up.

Covariates
Information on covariates was obtained from the questionnaires completed at baseline and from the Danish National Patient Register [30] using the unique personal identification number.

Sociodemographic factors
Participants’ reported the level of vocational training ranging from ‘no vocational training’ to ‘higher level education >4 years’ and this information was used to construct a variable indicating whether the participant’s educational level was low, medium, or high. Moreover, dichotomous information on current employment was included.

Other lifestyle factors
Smoking was included in three categories: never-smoker; ex-smoker; and current smoker. Information on leisure time physical activity (assessed differently in the two cohorts) was used to construct three groups: moderate/heavy activity (moderate or heavy exercise ≥4 h/week or ≥7 h of physical activity); light activity (light exercise ≥4 h/week or 2–6 h of physical activity); and sedentary (sedentary leisure activities or <2 h of physical activity/week). Body Mass Index (BMI) was grouped into <30 vs. ≥30 kg/m².

Social relations
Three dichotomized variables on social relations were included: children (yes/no; including biological, adopted, and foster children); living alone (yes/no); and a variable, which indicated whether participants rarely/never had someone to talk well with (yes/no) (neither family, friends, partner, children nor colleagues).

Morbidity
Self-rated health was reported on a 5-point scale from 1 (poor) to 5 (excellent) and grouped into low (1), medium (2–3) and high (4–5). Charlson Comorbidity Index (CCI) was calculated using information from the Danish National Patient Register from 1977 to 2003. CCI is a method of measuring somatic comorbidity by weighting different diseases based on the influence on mortality [31]. The updated weights suggested by Quan et al. [32] were used and three groups were constructed based on the scores: 0, 1, and ≥2. Using information from the Danish National Patient Register on hospital registrations from psychiatric wards from 1994 to 2003, a dichotomous variable was generated to indicate whether participants had psychiatric hospital diagnoses (using the 10th revision of the International Statistical Classification of Diseases and Related Health Problems [ICD-10] diagnostic codes: F10-F99).

Statistical methods
Characteristics of the study sample split on weekly units of alcohol at baseline were examined and between-group differences were analyzed using χ² test for categorical and one-way analysis of variance (ANOVA) for continuous variables (Table 1). The missing data frequency was ≤3% for all variables, except for weekly alcohol consumption (3.5%), and SF-36 vitality scores from both baseline (5.5%) and follow-up (3.8%). Cross-sectional associations between alcohol consumption and vitality scores at baseline were investigated and tested using one-way ANOVA (Table 2). Separate associations between the two alcohol consumption variables—average weekly consumption and frequency of binge drinking—at baseline and psychological well-being at follow-up were examined by Full Information Maximum Likelihood (FIML) models in Stata’s structural equation modeling (SEM) package to handle missing data. Results from unadjusted analyses and from four adjusted models were presented. The first adjusted model included adjustment for sociodemographic factors including age, cohort, education, and employment (Model 1). These adjustment factors were also included in the remainder of the adjusted models that included further adjustment for 2. other lifestyle factors, 3. social
Table 1  Characteristics of the study sample (N = 4148)

|                                | Total     | Weekly units of alcohol at baseline |              |              |              | \( p \)-value \(^a\) |
|--------------------------------|-----------|-------------------------------------|--------------|--------------|--------------|----------------------|
|                                | Total     | 0 units 1-14 units 15-21 units \( \geq \) 22 units |              |              |              |                      |
| Total                          | N = 4003  | 280 (7.0) 2136 (53.4) 670 (16.7) 917 (22.9) |              |              |              |                      |
| **Sociodemographic factors**   |           |                                     |              |              |              |                      |
| Age (mean [SD])                | 51.7 (3.0)| 51.5 (3.5) 51.6 (3.3) 51.6 (2.6) 51.6 (2.5) | 0.821        |              |              |                      |
| Sex (N [%])                    |           | < 0.001                              |              |              |              |                      |
| Male                           | 3336 (80.4)| 183 (65.4) 1592 (74.5) 594 (88.7) 860 (93.8) |              |              |              |                      |
| Female                         | 812 (19.6)| 97 (34.6) 544 (25.5) 76 (11.3) 57 (6.2)  |              |              |              |                      |
| Cohort (N [%])                 |           | < 0.001                              |              |              |              |                      |
| MP cohort                      | 2746 (66.2)| 148 (52.9) 1282 (60.0) 512 (76.4) 727 (79.3) |              |              |              |                      |
| DALWUH cohort                  | 1402 (33.8)| 132 (47.1) 854 (40.0) 158 (23.6) 190 (20.7) |              |              |              |                      |
| Educational level (N [%])      |           | < 0.001                              |              |              |              |                      |
| Low                            | 527 (12.8)| 67 (23.9) 234 (11.0) 73 (10.9) 115 (12.6) |              |              |              |                      |
| Medium                         | 1949 (47.3)| 127 (45.4) 1006 (47.5) 306 (45.7) 441 (48.2) |              |              |              |                      |
| High                           | 1643 (39.9)| 86 (30.7) 879 (41.5) 291 (43.4) 358 (39.2) |              |              |              |                      |
| Currently employed (N [%])     |           | < 0.001                              |              |              |              |                      |
| Yes                            | 3782 (91.5)| 214 (76.4) 1994 (93.7) 634 (94.6) 835 (91.1) |              |              |              |                      |
| No                             | 353 (8.5)| 66 (23.6) 134 (6.3) 36 (5.4) 82 (8.9) |              |              |              |                      |
| **Other lifestyle factors**    |           |                                     |              |              |              |                      |
| Smoking (N [%])                |           | < 0.001                              |              |              |              |                      |
| Current smoker                 | 1282 (31.4)| 112 (40.0) 534 (25.0) 188 (28.1) 403 (44.1) |              |              |              |                      |
| Ex-smoker                      | 1438 (35.1)| 88 (31.4) 750 (35.2) 274 (40.9) 302 (33.0) |              |              |              |                      |
| Never-smoker                   | 1370 (33.5)| 80 (28.6) 848 (39.8) 208 (31.0) 209 (22.9) |              |              |              |                      |
| Leisure time physical activity (N [%]) |           | < 0.001                              |              |              |              |                      |
| Heavy/moderate exercise        | 1219 (29.9)| 81 (28.9) 671 (31.6) 211 (31.5) 231 (25.3) |              |              |              |                      |
| Light exercise                 | 2343 (57.4)| 146 (52.1) 1202 (56.6) 384 (57.3) 559 (61.2) |              |              |              |                      |
| Sedentary activities           | 521 (12.8)| 53 (18.9) 250 (11.8) 75 (11.2) 124 (13.6) |              |              |              |                      |
| Body Mass Index (N [%])        |           | 0.002                                |              |              |              |                      |
| \(< 30 \text{kg/m}^2\)         | 3641 (89.4)| 227 (84.1) 1890 (89.8) 606 (92.4) 805 (89.2) |              |              |              |                      |
| \(\geq 30 \text{kg/m}^2\)      | 431 (10.6)| 43 (15.9) 214 (10.2) 50 (7.6) 97 (10.8) |              |              |              |                      |
| **Social relations**           |           |                                     |              |              |              |                      |
| Children (N [%])               |           | < 0.001                              |              |              |              |                      |
| Yes                            | 3504 (84.8)| 225 (80.4) 1860 (87.5) 559 (83.4) 752 (82.0) |              |              |              |                      |
| No                             | 626 (15.2)| 55 (19.6) 265 (12.5) 111 (16.6) 165 (18.0) |              |              |              |                      |
| Living alone (N [%])           |           | < 0.001                              |              |              |              |                      |
| Yes                            | 640 (15.5)| 79 (28.2) 278 (13.1) 74 (11.1) 161 (17.7) |              |              |              |                      |
| No                             | 3478 (84.5)| 201 (71.8) 1844 (86.9) 591 (88.9) 750 (82.3) |              |              |              |                      |
| Rarely have someone to talk well (N [%]) |           | 0.062                                |              |              |              |                      |
| Yes                            | 35 (0.9)| 6 (2.1) 15 (0.7) 4 (0.6) 6 (0.7) |              |              |              |                      |
| No                             | 4081 (99.2)| 274 (97.9) 2108 (99.3) 662 (99.4) 903 (99.3) |              |              |              |                      |
| **Morbidity**                  |           |                                     |              |              |              |                      |
| Self-rated health (N [%])      |           | < 0.001                              |              |              |              |                      |
| Low                            | 399 (9.7)| 67 (24.2) 159 (7.5) 42 (6.3) 87 (9.6) |              |              |              |                      |
| Medium                         | 3180 (77.6)| 184 (66.4) 1668 (79.0) 532 (80.2) 718 (79.2) |              |              |              |                      |
| High                           | 518 (12.6)| 26 (9.4) 285 (13.5) 89 (13.4) 101 (11.1) |              |              |              |                      |
| Charlson Comorbidity Index score (N [%]) |           | 0.005                                |              |              |              |                      |
| 0                              | 3880 (93.5)| 252 (90.0) 2017 (94.4) 640 (95.5) 853 (93.0) |              |              |              |                      |
| 1                              | 136 (3.3)| 14 (5.0) 54 (2.5) 17 (2.5) 40 (4.4) |              |              |              |                      |
| \(\geq 2\)                    | 132 (3.2)| 14 (5.0) 65 (3.0) 13 (1.9) 24 (2.6) |              |              |              |                      |
### Results

#### Description of the study sample

Approximately half of the participants had a weekly consumption of 1–14 units of alcohol (53.4%), whereas few participants reported alcohol abstinence (7.0%) (Table 1). The majority of participants were men (as the MP cohort only included men) and a tendency of women reporting lower alcohol consumption than men was observed. In Denmark, the high-risk drinking limits for men and women are 21 units and 14 units of alcohol per week, respectively, and 27% of the men and 17% of the women in the current study sample exceeded these limits. Concerning binge drinking, participants were almost equally distributed across the categories with binge drinking ‘less than once per month’ (26.7%), ‘1–3 times per month’ (41.1%) and ‘once per week or more’ (32.2%).

All investigated characteristics, except for age and rarely having someone to talk well with, were significantly associated with weekly alcohol consumption (Table 1). Individuals in the abstinent group were more likely to be characterized by low education, current unemployment, current smoking, sedentary leisure activities, BMI $\geq 30$ kg/m$^2$, not having children, living alone, low self-rated health, and psychiatric and somatic morbidity. Moreover, individuals in the heavy alcohol consumption group ($\geq 22$ units) were more likely to be characterized by current smoking and not having children.

### Cross-sectional associations between alcohol consumption and vitality

Weekly units of alcohol consumed at baseline was significantly associated with vitality scores at baseline in both men ($p<0.001$) and women ($p=0.004$) (Table 2). In both sexes, the lowest vitality score was observed in the abstinent group, whereas the highest score was observed...
Table 3  FIML analyses on associations between alcohol consumption at baseline and SWLS score at follow‑up in unadjusted and adjusted SEM models in men (N = 3336) and women (N = 812)

|                       |          | Model 1 (age, cohort, education, employment) | Model 1 + other lifestyle factors | Model 1 + social relations | Model 1 + morbidity |
|-----------------------|----------|-----------------------------------------------|----------------------------------|---------------------------|---------------------|
|                       | Unadjusted a | Model 1 |          |          | P-value |          |          |          |          |
| Men (N = 3336)        |          |        | Model 1 |          |          |          |          |          |          |
| Weekly units of alcohol consumed |          |        |          |          |          |          |          |          |          |
| 0 units               | -3.27 (-4.11; -2.44) | < 0.001 | -1.83 (-2.64; -1.02) | < 0.001 | -1.61 (-2.41; -0.80) | < 0.001 | 1.44 (-2.24; -0.65) | < 0.001 | -1.27 (-2.06; -0.49) | 0.001 |
| 1-14 units            | Ref      |        | Ref      |          |          |          |          |          |          |          |
| 15-21 units           | 0.10 (-0.41; 0.62) | 0.693   | 0.05 (-0.43; 0.54) | 0.828   | 0.05 (-0.44; 0.51) | 0.855   | 0.03 (-0.44; 0.51) | 0.887   | 0.09 (-0.38; 0.56) | 0.713 |
| 22+ units             | -0.99 (-1.45; -0.54) | < 0.001 | -0.79 (-1.23; -0.36) | < 0.001 | -0.59 (-1.03; -0.16) | 0.007   | -0.67 (-1.09; -0.25) | 0.002   | 0.63 (-1.04; -0.22) | 0.003 |
| Binge drinking past 30 days b |          |        |          |          |          |          |          |          |          |
| < once per month      | -0.97 (-1.49; -0.45) | < 0.001 | -0.64 (-1.13; -0.15) | 0.010   | -0.66 (-1.15; -0.17) | 0.008   | -0.46 (-0.94; 0.02) | 0.060   | -0.43 (-0.91; 0.04) | 0.074 |
| 1-3 times per month   | Ref      |        | Ref      |          |          |          |          |          |          |          |
| 4 or more per week    | -0.98 (-1.47; -0.49) | < 0.001 | -0.76 (-1.22; -0.30) | 0.001   | -0.62 (-1.08; -0.16) | 0.009   | -0.60 (-1.05; -0.14) | 0.010   | -0.72 (1.16; -0.27) | 0.002 |
| Women (N = 812)       |          |        | Model 1 |          |          |          |          |          |          |
| Weekly units of alcohol consumed |          |        |          |          |          |          |          |          |          |
| 0 units               | -2.48 (-3.60; -1.36) | < 0.001 | -1.89 (-2.98; -0.81) | 0.001   | -1.64 (-2.72; -0.55) | 0.003   | -1.64 (-2.71; -0.57) | 0.003   | -1.45 (-2.50; -0.39) | 0.007 |
| 1-14 units            | Ref      |        | Ref      |          |          |          |          |          |          |          |
| 15-21 units           | 0.35 (-0.89; 1.59) | 0.577   | 0.12 (-1.07; 1.32) | 0.838   | 0.18 (-1.00; 1.36) | 0.766   | 0.11 (-1.06; 1.28) | 0.851   | 0.08 (-1.07; 1.22) | 0.897 |
| 22+ units             | -0.11 (-1.54; 1.33) | 0.885   | -0.24 (-1.61; 1.14) | 0.737   | -0.12 (-1.49; 1.25) | 0.862   | 0.01 (-1.37; 1.38) | 0.992   | 0.05 (-1.29; 1.39) | 0.941 |

1 unit corresponds to 12 g of pure alcohol

a six observations were excluded in the unadjusted analyses on weekly consumption in men and five observations in the unadjusted analyses in women due to missing observations on all variables

b These analyses are based on men from the Metropolit 1953 Danish male birth cohort (N = 2746) as information on binge drinking was not available in the Danish Longitudinal Study on Work, Unemployment and Health cohort
Table 4  FIML analyses on associations between alcohol consumption at baseline and SF-36 vitality score at follow-up in unadjusted and adjusted SEM models in men (N = 3336) and women (N = 812)

|                      | Unadjusted a | Model 1 (age, cohort, education, employment) | Model 1 + other lifestyle factors | Model 1 + social relations | Model 1 + morbidity |
|----------------------|--------------|---------------------------------------------|----------------------------------|---------------------------|---------------------|
| **Men (N = 3336)**   |              |                                             |                                  |                           |                     |
| Weekly units of alcohol consumed |              |                                             |                                  |                           |                     |
| 0 units              | -8.06 (-11.10; -5.03) | < 0.001                                  | -46.3 (-76.1; -1.65)              | 0.002                     | -3.09 (5.99; 0.18)  |
| 1-14 units           | Ref          | -6.35 (-10.44; -2.26)                      | 0.002                            | -3.25 (-9.29; -1.21)      | 0.011               |
| 15-21 units          | 0.86 (-1.00; 2.72)  | 0.363                                     | 0.424                            | 0.76 (-0.99; 2.51)        | 0.393               |
| ≥ 22 units           | -2.77 (-4.40; -1.14) | 0.001| -2.25 (-3.83; -0.67) | 0.005                     | -0.90 (-2.46; 0.65)      | 0.255               |
| Binge drinking past 30 days b |              |                                             |                                  |                           |                     |
| < once per month     | -0.95 (-2.80; 0.90)  | 0.315                                     | -0.21 (-2.01; 1.58)              | 0.814                     | -0.32 (-2.06; 1.42) |
| ≥ once per week      | -2.08 (-3.83; -0.34) | 0.019| -1.47 (3.16; 0.22)   | -0.80 (-2.24; 1.05)      | 0.478               |
| **Women (N = 812)**  |              |                                             |                                  |                           |                     |
| Weekly units of alcohol consumed |              |                                             |                                  |                           |                     |
| 0 units              | -7.80 (-11.94; -3.67) | < 0.001                                  | -6.35 (-10.44; -2.26)            | 0.002                     | -5.25 (-9.29; -1.21) |
| 1-14 units           | Ref          | -8.35 (-13.04; -3.65)                     | 0.002                            | -5.25 (-9.29; -1.21)      | 0.011               |
| 15-21 units          | 3.20 (-1.32; 7.71)  | 0.165                                     | 2.50 (-1.92; 6.92)               | 0.268                     | 2.45 (-1.87; 6.87)  |
| ≥ 22 units           | -0.30 (-5.56; 4.97)  | 0.912                                     | 0.94 (6.09; 4.22)                | 0.722                     | -0.52 (-5.57; 4.52) |

1 unit corresponds to 12 g of pure alcohol

a 10 observations were excluded in the unadjusted analyses on weekly consumption in men, seven observations in the unadjusted analyses on binge drinking in men and five observations in the unadjusted analyses in women due to missing observations on all variables

b These analyses are based on men from the Metropolit 1953 Danish male birth cohort (N = 2746) as information on binge drinking was not available in the Danish Longitudinal Study on Work, Unemployment and Health cohort
in the group consuming 15–21 units per week. Binge drinking at baseline in men was also significantly associated with vitality at baseline ($p = 0.002$); the highest vitality score was observed in men with binge drinking ‘1–3 times per month’, whereas the scores were fairly similar in men with binge drinking ‘less than once per month’ and ‘once per week or more’.

**Prospective associations between alcohol consumption and satisfaction with life**

**Men**

Unadjusted analyses suggested that the SWLS score at follow-up was 3.3 points lower in men with alcohol abstinence at baseline (0 units/week; $p < 0.001$) and 1.0 points lower in men with heavy alcohol consumption at baseline ($\geq 22$ units/week; $p < 0.001$) than in men with moderate alcohol consumption (1–14 units/week) at baseline (Table 3). These differences attenuated after adjustment for sociodemographic factors, but the differences remained statistically significant. Similarly, differences attenuated but remained statistically significant after further adjustment.

With regard to binge drinking at baseline, the SWLS scores at follow-up were 1.0 points lower in men binge drinking ‘less than once per month’ ($p < 0.001$) and in men binge drinking ‘once per week or more’ ($p < 0.001$) compared with men binge drinking ‘1–3 times per month’ (Table 3). These differences attenuated but remained statistically significant after adjustment for sociodemographic factors. The lower SWLS scores with binge drinking ‘once per week or more’ was robust to adjustment for further covariates.

**Women**

In women, unadjusted analyses suggested a 2.5 points lower SWLS score at follow-up in the abstinent group at baseline (0 units/week; $p < 0.001$) compared with the group consuming 1–14 units per week (Table 3). These differences attenuated but remained statistically significant after adjustment for sociodemographic factors and after further adjustment for other lifestyle factors, social relations, and morbidity.

**Prospective associations between alcohol consumption and vitality**

**Men**

Compared with men with moderate alcohol consumption (1–14 units/week) at baseline, unadjusted analyses suggested that the vitality score at follow-up was 8.1 points lower in men with alcohol abstinence (0 units/week; $p < 0.001$) and 2.8 points lower in men with heavy alcohol consumption ($\geq 22$ units/week; $p < 0.001$) (Table 3). These differences attenuated after adjustment for sociodemographic factors but remained statistically significant. Nevertheless, differences became statistically non-significant after further adjustment for other lifestyle factors (only heavy drinking) and morbidity.

In relation to binge drinking at baseline, men with binge drinking ‘once per week or more’ had a 2.1 points lower vitality score at follow-up than men with binge drinking ‘1–3 times per month’ in the unadjusted analyses ($p = 0.019$) (Table 4). Nevertheless, this difference became statistically non-significant after adjustment for sociodemographic factors and other covariates.

**Women**

In the unadjusted analyses, the vitality scores at follow-up were 7.8 points lower in women who were abstinent at baseline (0 units/week) compared with women who consumed 1–14 units per week ($p < 0.001$) (Table 4). These differences attenuated but remained statistically significant after adjustment for sociodemographic factors and after further adjustment for other lifestyle factors, social relations, and morbidity.

**Discussion**

**Main results**

In this large study sample of Danish men and women, results suggested that alcohol abstinence compared with moderate alcohol consumption was associated with lower SWLS scores three to seven years later in both men and women even after adjustment for covariates. Moreover, men with heavy alcohol consumption at baseline had a lower SWLS score at follow-up than men with moderate alcohol consumption. Finally, men with moderate frequency of binge drinking (1 to 3 times per month) at baseline had higher SWLS scores at follow-up than men with higher frequency and men with lower frequency of binge drinking. Concerning vitality, results suggested that alcohol abstinence at baseline in both men and women and heavy alcohol consumption at baseline in men were associated with lower vitality scores at follow-up than moderate alcohol consumption.

**Comparison with previous research**

Our findings on alcohol consumption and satisfaction with life are partly consistent with previous findings from large prospective studies on middle-aged individuals and the general population. In relation to alcohol abstinence at baseline, Lang et al. [13] likewise observed lower subjective well-being three years later in this group compared with moderate alcohol consumption (up to two drinks/day) in middle-aged men and women. In addition, our findings of lower life satisfaction at follow-up with heavy alcohol consumption at baseline corroborate the findings of two
The present study, the association was robust to adjust-
alcohol consumption at baseline and lower life satisfac-
tion at follow-up in men, even though the analyses included a large number of
women (N = 3877). Finally, in relation to binge drink-
ing, a previous population-based Finish study found
that binge drinking at least once per month at base-
line increased the risk of life dissatisfaction 15 years
later [9]. This result is not consistent with our find-
ings, which indicate an inverse u-shaped association
with highest satisfaction with life in men with moder-
ate frequency of binge drinking (1 to 3 times/month).
Hence, our findings extend previous findings by sug-
gest that the highest satisfaction with life—at least in
middle-aged Danish men—is observed with binge
drinking one to three times per month.

In relation to alcohol consumption and vitality, our
findings of lower vitality scores at follow-up in women
with alcohol abstinence as opposed to moderate alco-
hol consumption at baseline are to some extent in line
with previous findings. Schrieks et al. [14] observed
that greater alcohol consumption (up to one daily
serving) at baseline was associated with better health-
related quality of life two years later in women aged
25–42 years from the Nurses’ Health Study II. Like in
the present study, the association was robust to adjust-
ment for several covariates. Likewise, in a study on
women aged 70 or older, Byles et al. [12] found that
alcohol abstinence at baseline was associated with
poorer health-related quality of life at follow-up. How-
ever, alcohol abstinence was only associated with the
general health, physical functioning, mental health
social functioning subscales, and hence not with the
vitality subscale. To our knowledge, no previous
study that included men has observed a prospective
association between alcohol abstinence and health-
related quality of life. Hence, our findings of lower
vitality scores at follow-up in men who were alcohol
abstinent at baseline (findings that were not robust to
adjustment for covariates) should be interpreted with
cautions. Finally, our results of lower vitality scores at
follow-up with heavy alcohol consumption at baseline
in men are in line with the findings from a previous
male study [11]. In that study, alcohol consumption
and health-related quality of life were assessed in 1974
and 2000, respectively, and only death-adjusted analy-

Interpretations
The observed prospective associations between alco-
hol consumption (weekly and binge drinking) and psy-
chological well-being may be explained in several ways.
First, alcohol may have a direct effect on psychological
well-being. Since moderate consumption of alcohol is
often associated with pleasure and positive effects such
as stress reduction and letting go of control and heavy
consumption is associated with negative effects such as
intoxication and hangover, it is likely that alcohol affects
psychological well-being directly in terms of higher psy-
chological well-being in individuals with moderate alco-
hol consumption.

Second, several indirect pathways between alcohol
consumption and psychological well-being may be antici-
pated. For example, alcohol consumption may influence
the social relations of the individual that in turn influence
psychological well-being. Due to the cultural acceptance
and expectations of Danes to consume alcohol but also
expectations about being in control of the alcohol con-
sumption [33], it is likely that both alcohol abstinence
and heavy alcohol consumption as well as infrequent
and very frequent binge drinking adversely influence
the social relationships of the individual; a factor that is
highly central to psychological well-being [34, 35].

Third, it is also possible that underlying factors that
influence both alcohol consumption and psychological
well-being explain the observed associations. In par-
cular in relation to the alcohol abstinent group—which
in Denmark is a rather small group [36] with an alcohol
behavior that fall outside the cultural norm [33]—several
underlying factors may explain the observed lower psy-
chological well-being. For example, some individuals may
be non-drinkers due to illness or chronic diseases and
even though we adjusted for comorbidity using Charlson
Comorbidity Index, all diseases that potentially influence
both alcohol consumption and psychological well-being
are not necessarily included.

The observed sex differences in the association between
heavy alcohol consumption at baseline and psychological
well-being at follow-up could be explained by lack
of power in the analyses among women, although suffi-
cient power was present to observe cross-sectional asso-
ciations among women. Another perhaps more plausible
explanation—supported by data—is that the amount of
alcohol consumed in the heavy alcohol consumption
group is larger among men than among woman.

Our results suggested that alcohol consumption may
be more strongly associated with satisfaction with life
than vitality, since frequency of binge drinking was only
was included as a covariate in all the adjusted analyses. These observations could reflect that overall satisfaction with life over a three to seven-year period to a larger extent is influenced by the social consequences of alcohol consumption than the vitality of the individual, primarily reflecting current feelings of energy and fatigue.

Methodological considerations
The main advantage of the present study is the prospective design, large study sample including both men and women, inclusion of two alcohol consumption variables—average weekly consumption and binge drinking—as well as two aspects of psychological well-being in terms of both satisfaction with life and vitality. The study particularly strikes by addressing the knowledge gap on the association between alcohol consumption and satisfaction with life in middle-aged individuals and the association between binge drinking and psychological well-being in the same age group. Moreover, the study sample and included measures enabled us to investigate the association between alcohol consumption and psychological well-being according to sex, alcohol consumption pattern, and different aspects of psychological well-being. Finally, we had information on a broad range of possible confounding factors—including both self-reported and register-based information—which allowed to present the results adjusted for these factors.

The study also has some limitations. First, analyses were restricted to include individuals who participated in the Copenhagen Aging and Midlife Biobank (CAMB) study. We did not have data to investigate non-participation, but a previous study on the entire CAMB sample found that participants did not differ substantially from non-participants regarding educational level and number of contacts with general practitioner, but a larger proportion of participants than non-participants were employed [20]. Hence, participants represent a somewhat socially selected group, which nevertheless appears to be comparable to non-participants in relation to overall health. In relation to alcohol consumption, we did not have information on binge drinking in women, limiting the conclusions on alcohol consumption patterns to men. Moreover, underreporting of amount of alcohol consumed is a well-known problem [37] and alcohol consumption was assessed slightly different in the two included cohorts (past-week consumption in the MP cohort and usual consumption on weekends and week-ends in the DALWUH cohort). However, the latter is assumed to be a minor problem as cohort membership was included as a covariate in all the adjusted analyses.

In relation to psychological well-being, only the vitality subscale from SF-36 was included in the assessment of participants, complicating comparison with previous studies that usually report results on the physical and mental component summary. Finally, even though we included several covariates in the analyses, residual confounding should still be considered. For example, confounders with incomplete assessment, e.g. social relations assessed using three single-item questions on children, whether living alone, and having someone to talk well with, may still confound the associations. Therefore, assessments of confounders could be improved in future studies; e.g. social relations assessed with scales summarizing several questions [38] and reflecting both structural (quantitative) and functional (qualitative) aspects of social relations [39]. Moreover, unmeasured factors such as personality may influence both alcohol consumption and psychological well-being.

Conclusions
In conclusion, we found that alcohol abstinence was prospectively associated with lower psychological well-being compared with moderate alcohol consumption in both men and women. Additionally, heavy weekly alcohol consumption was prospectively associated with lower psychological well-being in men. With regard to binge drinking, an inverse u-shaped association was found in men between binge drinking at baseline and satisfaction with life (but not vitality) at follow-up. Thus, the results of the study suggest that middle-aged Danes with a culturally ‘normal’ alcohol consumption have the highest psychological well-being several years later. The mechanisms behind these findings are, however, yet to be discovered and more research is warranted in this area.

Abbreviations
CAMB: Copenhagen Aging and Midlife Biobank; MP: Metropolit 1953 Danish male birth cohort; DALWUH: Danish Longitudinal Study on Work, Unemployment and Health; SWLS: Satisfaction With Life Scale; SF-36: 36-item Short-Form Health Survey; BMI: Body mass index; CCI: Charlson Comorbidity Index; ICD-10: 10th revision of the International Statistical Classification of Diseases and Related Health Problems; ANOVA: Analysis of variance; FIML: Full Information Maximum Likelihood; SEM: Structural equation modeling.

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Authors’ contributions
MG, CLW, ELM and TFM contributed to the study conception and design. Data analysis was performed by MG. The first draft of the manuscript was written...
by MG and CLW, ELM and TFM revised it critically for important intellectual content. MG, CLW, ELM and TFM approved the submitted version of the manuscript and have agreed both to be personally accountable for the author’s own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature. All authors read and approved the final manuscript.

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Competing interests
Consent for publication
The participants included in the study. The study is covered by permissions from the Danish Data Protection Agency to the authors. Informed consent was obtained from all individual participants included in the study.

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Competing interests
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Author details
1 Center for Clinical Research and Prevention, Bispebjerg and Frederiksberg Hospital, Nordre Fasanvej 57, 2000 Frederiksberg, Denmark. 2 Unit of Medical Psychology, Section of Environmental Health, Department of Public Health, University of Copenhagen, Copenhagen, Denmark. 3 Center for Healthy Aging, University of Copenhagen, Copenhagen, Denmark.

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