EPIDEMIOLOGY

Subjective Measures of Binge Drinking, Suboptimal Subjective Health and Alcohol-Specific Hospitalizations Among Working-Aged Adults: A Prospective Cohort Study

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Abstract — Aims: The purpose of this prospective study was to determine how subjective measures of binge drinking predict suboptimal subjective health. In order to contribute to the understanding of potential causal mechanisms, we also aimed to determine the factors through which subjective health predicts alcohol-specific hospitalizations. Methods: A total of 16,111 alcohol-drinking men and women, aged 20–54 years, participated in the Health and Social Support baseline postal survey in 1998, and also responded to the repeated measurement 5 years later in 2003 (T2). Suboptimal subjective health was defined as self-reported overall health status being fair, rather poor or poor. Subjective measures of binge drinking were frequency of subjective intoxications/drunkenness, frequency of hangovers and frequency of alcohol-induced pass-outs. Results: Frequency of intoxications, hangovers and alcohol-induced pass-outs, all predicted suboptimal subjective health regardless of several potential confounders, including beverage-specific total intake. Those reporting suboptimal subjective health at baseline had a 5-fold odds ratio (5.08, 95% confidence interval: 3.43, 6.48) for alcohol-related hospitalizations, compared with those rating their health above fair, when gender and age were controlled. Binge drinking, together with concurrent symptoms of depression, explained over 50% of this relationship, and when additionally taking into account smoking, over two-thirds of this relation was explained. Conclusion: Mental health is an important mediating factor between binge drinking, suboptimal subjective health and alcohol-specific hospitalizations, and symptoms of depression should therefore be taken into account in prevention of alcohol-related adverse health outcomes.

INTRODUCTION

Subjective perception of one’s overall health status has been shown to predict objectively measured health outcomes (Kaplan et al., 1983, 1996; Idler and Benyamini, 1997; Heistaro et al., 2001; Heidrich et al., 2002; Benjamins et al., 2004; Idler et al., 2004; DeSalvo et al., 2006). However, despite the relatively large number of studies showing the ability of suboptimal subjective health to predict various objective health outcomes, little is known about how suboptimal subjective health potentially predicts alcohol-specific adverse health outcomes. Also, the mechanisms through which subjective health has its impact on clinical outcomes are still not fully understood (Machenbach et al., 2002; Benjamins et al., 2004; Singh-Manoux et al., 2006).

Current evidence, based solely on cross-sectional studies, suggests that alcohol consumption is associated with self-reported subjective health status. The evidence, however, is inconsistent in relation to the shape of the overall risk function, role of different beverage types and the contribution of binge-drinking patterns. While some studies have established a J-shaped association between total intake and poor subjective health (Poikolainen et al., 1996; Grønbæk et al., 1999; Theobald et al., 2003), others have suggested a negative graded relation (Guallar-Castillón et al., 2001; Valencia-Martin et al., 2009). Even levels of total intake exceeding limits of hazardous drinking have been associated with good subjective health (Guallar-Castillón et al., 2001; Valencia-Martin et al., 2009).

Most of the previous studies have focused on beverage preference for beer, wine or spirits, which seems to have an important role in explaining variation in subjective health (Poikolainen et al., 1996; Grønbæk et al., 1999; Guallar-Castillón et al., 2001; Theobald et al., 2003; Stranges et al., 2006; Valencia-Martin et al., 2009). Evidence on the predictive utility of binge drinking is scarcer and the results are inconsistent across studies (Volk et al., 1997; Poikolainen and Vartiainen, 1999; Okoro et al., 2004; Stranges et al., 2006; Valencia-Martin et al., 2009). Variation in the determinants of subjective health could explain some of these inconsistent findings. For example, it has been suggested that the negative effects of binge drinking would be mediated mainly through aspects of mental health and not so much by physical health (Okoro et al., 2004), although gender differences may exist (Stranges et al., 2006).

The purpose of this study is first to determine whether baseline subjective intoxications/drunkenness, hangovers and alcohol-induced pass-outs (i.e. subjective measures of binge drinking) predict incident suboptimal (fair/rather poor/poor) subjective health after controlling for various confounders and mediators. In order to contribute to the understanding of potential causal pathways linking suboptimal subjective health to adverse health outcomes, the second analysis builds upon the results of the first analysis. This analysis aims to identify the mediators that explain the potential relation between baseline suboptimal subjective health and future alcohol-specific hospitalizations. Understanding the mediators through which subjective health has its impact on clinical outcomes will potentially help developing targeted interventions for specific risk groups. This large prospective population-based study sample of working-aged adults with a comprehensive measurement of various behavioural and social determinants of health, and information linked from national hospital discharge register, enabled us to address many of the limitations of previous studies.
METHODS

Data and ethics approval
This study is part of the nation-wide Health and Social Support study of Finnish men and women of working-age: 20–24, 30–34, 40–44 and 50–54 years at baseline. The baseline (T1) postal survey in 1998 yielded a response proportion of 40% (n = 25,901). The same questionnaire was repeated after 5 years in 2003 (T2) for the baseline study participants. Between T1 and T2, 216 persons died, 234 emigrated and 969 were unreachable due to an unknown postal address. After excluding those, the response proportion of the T2 survey was 80% (n = 19,629). The original sample included over-representations of responders from one geographic area and from one minority language group. These oversamples (n = 3629) were included into the current analysis. A more detailed description of the study protocol and the baseline sample is available elsewhere (Korkeila et al., 2001).

According to Turku University Hospital ethics committee, the study did not require a formal ethics approval because the study used a general population sample and did not collect any biological specimens. A signed informed consent for linking information on hospitalizations was obtained from study participants. A detailed baseline non-response analysis (without the oversamples) showed that the T1 study population was representative of the Finnish general population, and there was no significant selection bias due to health-related factors (Korkeila et al., 2001). For the present analysis, we excluded those with missing information on measures of alcohol consumption (n = 483), and abstainers (n = 3035) because the reasons for abstaining are a likely source of unmeasured confounding (Fillmore et al., 1998; Grønbæk et al., 1999; Green and Polen, 2001). Thus, 16,111 responders were eligible for the present analysis.

Measurement and analysis
Subjective health was assessed with a single question asking ‘How would you describe your health status?’ Based on the response options on a five-point scale (ranging from ‘good’ to ‘poor’), we defined the subjective health as suboptimal for those rating their health as being either ‘fair’, ‘rather poor’ or ‘poor’. Incident suboptimal subjective health was defined as health status being ‘rather good’ or ‘good’ at T1, but ‘fair’ or below ‘fair’ at T2.

Measures of alcohol consumption were beverage-specific weekly intake, asked separately for beer, wine and spirits, and measures representing patterns of short-term high-intensity drinking i.e. binge drinking. Average beverage-specific weekly intake was converted to grams of absolute alcohol and summed up as total weekly intake. For each beverage, the weekly intake was converted to average number of standard drinks (one standard drink corresponding to 12 g of ethanol). Due to differences in the original format of the beverage-specific questions, only approximate equivalence in converted beverage-specific intake levels were possible. The following categories were used for the number of standard drinks of beer: none; less than one; 1–4; 5–12; ≥13 drinks/week, for wine: none; less than one; 1–4; 6–15; ≥16 drinks/week, and for spirits: none; less than two; 2–5; 7–12; ≥13 drinks/week. Total intake was first categorized into genderspecific quartiles and the upper quartile was further split into two, using a gender-specific limit for hazardous drinking according to Finnish guidelines (the corresponding categories in standard drinks for women 1–2; 3–4; 5–6; 7–15; ≥16 drinks/week, and for men 1–4; 5–7; 8–12; 13–23; ≥24 drinks/week) (Halme et al., 2008).

Binge-drinking pattern was estimated by asking the respondent to report their frequency of subjective intoxications/drunkenness, hangovers and alcohol-induced pass-outs during the past 12 months. The frequency of intoxications/drunkenness and the frequency of hangovers were categorized into: Never; 1–5; 6–11; 12–23; 24–51; 52+ times per year. For the frequency of alcohol-induced pass-outs, the original categorization was retained (Never; Once; 2–3; 4–6; 7+ times). All categorizations were based on the original response options, but some categories were collapsed. The original format and response options for the alcohol measures are available elsewhere (Paljärvi et al., 2009).

In multiple regression analyses, the following potential confounders were controlled from T1: gender, age (20–24; 30–34; 40–44; 50–54 years at baseline), educational level (University; College; Vocational School; No vocational education), whether the responder lived alone (Yes; No), unemployment (Yes; No), social support (High; Low), low physical activity (Less than 1 h of any type of physical exercise weekly vs. At least 1 h weekly), number of cigarettes smoked daily (None; 1–9; 10–19; >19), presence of alcohol problems in any family member from participant’s childhood (Yes; No; Uncertain) and years of alcohol exposure defined as age at T1 minus age when first started drinking alcohol (<10; 10–25; 26–35; 36+ years of alcohol exposure). Social support was measured by the Brief Social Support Questionnaire (Sarason et al., 1987). The sum score (range 0–36) was dichotomized using lowest decile of the distribution (score ≤5) as an indication of low social support (Korkeila et al., 2005). The presence of alcohol problems in any childhood family member was asked as ‘Did someone of your family member have problems because of alcohol?’ The original response options provided were ‘no’, ‘yes’ and ‘I don’t know or I cannot tell’.

Self-reported depressive symptoms were assessed with the 21-item Beck Depression Inventory scale (Beck et al., 1988). The sum score (range 0–63) of responses was categorized into three categories (0–9; 10–19; >19), describing different levels of symptoms (Paljärvi et al., 2009). In addition, from T2, we used information on self-reported use of psychotropic medicines during the last year. The use of medicines for treatment of depression, sleep problems or anxiety were asked separately, but the responses were combined for the purpose of the present study (No; Yes). We also linked information from the national hospital discharge register to identify responders who were treated for alcohol-specific conditions, depression, ischemic heart disease (IHD) or other cardiovascular diseases (OCVDs) after T1. The International Classification of Diseases tenth revision (ICD-10, Finnish modification) codes were used to identify hospitalizations for each of the selected outcomes/alcohol-specific causes: F10, G621, G4051, G312, G721, I421, K292, K70, K8600, T510, X45; depression: F32, F33, F341; IHD: I20-I25; OCVD: I00-I19, I26-I99.

All categorizations of the analysis variables were validated against the outcome measure to ensure that the new
categorizations did not change the overall relationships. We used binary logistic regression models to analyse the data. The results are shown as odds ratios (ORs) and their 95% confidence intervals (CIs). The percentage reduction in ORs after adjusting for potential confounders and mediators shown in Table 2, was calculated using a formula: Adjusted OR—Reference OR/Reference OR—1 (Bosma et al., 1999). Two-way interactions were tested between all alcohol consumption measures and gender, and age. Because gender or age did not have statistically significant interactions with any of the binge drinking measures, we do not present results separately according to gender.

RESULTS

Of the 16,111 baseline current drinkers, 22% rated their health as being suboptimal at T2. Of the responders who rated their health as being above average (rather good or good) at baseline, 10% rated their health as being suboptimal at T2 (i.e. incident cases). The prevalence of suboptimal health was higher at T2 than at T1 (22 vs. 18%, respectively). Seven percent of the responders exceeded the Finnish weekly limit for hazardous/heavy intake (for women ≥16 drinks; for men ≥24 drinks/week). At baseline, 82% reported at least occasional intoxications/drunkenness, 69% at least occasional hangovers and 16% at least occasional alcohol-induced pass-outs. Hazardous drinking, preference for beer, and binge drinking occasions were more common among men. Preference for wine was more common among women, and among older age groups. Preference for beer was more common among younger age groups. After T1, 3% of the participants became abstainers. At T2, abstaining was more common among women, but age or frequent binge drinking at T1 were not associated with T2 abstaining. During follow-up, 107 persons (0.7%) were hospitalized at least once for alcohol-specific diseases, 114 persons (0.7%) for depression, 171 persons (1.0%) for IHD and 942 persons (6.0%) for OCVDs. All included covariates were statistically significant predictors of T2 suboptimal health.

### Table 1. Baseline subjective measures of binge drinking predicting incident suboptimal subjective health after 5 years

<table>
<thead>
<tr>
<th>Intoxications</th>
<th>No. of subjects (n = 13,213)</th>
<th>No. of cases</th>
<th>Models 1–3</th>
<th>Models 4–6</th>
<th>Model 7</th>
<th>Models 8–10</th>
<th>Models 11–13</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>2317</td>
<td>304</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
</tr>
<tr>
<td>1–5 times</td>
<td>5282</td>
<td>631</td>
<td>1.16</td>
<td>1.00</td>
<td>1.18</td>
<td>1.01</td>
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</tr>
<tr>
<td>6–11 times</td>
<td>1338</td>
<td>137</td>
<td>1.23</td>
<td>0.98</td>
<td>1.54</td>
<td>0.97</td>
<td>1.54</td>
</tr>
<tr>
<td>12–23 times</td>
<td>1786</td>
<td>186</td>
<td>1.28</td>
<td>1.04</td>
<td>1.58</td>
<td>1.02</td>
<td>1.60</td>
</tr>
<tr>
<td>24–51 times</td>
<td>1552</td>
<td>186</td>
<td>1.59</td>
<td>1.28</td>
<td>1.97</td>
<td>1.32</td>
<td>1.95</td>
</tr>
<tr>
<td>52+ times</td>
<td>938</td>
<td>162</td>
<td>2.22</td>
<td>1.77</td>
<td>2.79</td>
<td>1.80</td>
<td>2.39</td>
</tr>
<tr>
<td>P for trend</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.302</td>
<td>0.002</td>
<td>0.004</td>
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<table>
<thead>
<tr>
<th>Hangovers</th>
<th>No. of subjects (n = 13,213)</th>
<th>No. of cases</th>
<th>Models 1–3</th>
<th>Models 4–6</th>
<th>Model 7</th>
<th>Models 8–10</th>
<th>Models 11–13</th>
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<tbody>
<tr>
<td>None</td>
<td>3964</td>
<td>507</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
</tr>
<tr>
<td>1–5 times</td>
<td>5848</td>
<td>669</td>
<td>1.16</td>
<td>1.02</td>
<td>1.32</td>
<td>1.19</td>
<td>1.36</td>
</tr>
<tr>
<td>6–11 times</td>
<td>981</td>
<td>103</td>
<td>1.30</td>
<td>1.03</td>
<td>1.64</td>
<td>1.27</td>
<td>1.62</td>
</tr>
<tr>
<td>12–23 times</td>
<td>1319</td>
<td>160</td>
<td>1.57</td>
<td>1.28</td>
<td>1.92</td>
<td>1.52</td>
<td>1.90</td>
</tr>
<tr>
<td>24–51 times</td>
<td>756</td>
<td>104</td>
<td>1.88</td>
<td>1.47</td>
<td>2.39</td>
<td>1.71</td>
<td>2.22</td>
</tr>
<tr>
<td>52+ times</td>
<td>345</td>
<td>63</td>
<td>2.43</td>
<td>1.79</td>
<td>3.30</td>
<td>1.78</td>
<td>2.53</td>
</tr>
<tr>
<td>P for trend</td>
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<td>&lt;0.001</td>
<td>0.065</td>
<td>&lt;0.001</td>
<td>0.003</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pass-outs</th>
<th>No. of subjects (n = 13,213)</th>
<th>No. of cases</th>
<th>Models 1–3</th>
<th>Models 4–6</th>
<th>Model 7</th>
<th>Models 8–10</th>
<th>Models 11–13</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>11,223</td>
<td>1282</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
<td>OR 1.00</td>
</tr>
<tr>
<td>Once</td>
<td>1096</td>
<td>153</td>
<td>1.55</td>
<td>1.29</td>
<td>1.87</td>
<td>1.49</td>
<td>1.80</td>
</tr>
<tr>
<td>2–3 times</td>
<td>622</td>
<td>104</td>
<td>1.87</td>
<td>1.49</td>
<td>2.34</td>
<td>1.66</td>
<td>2.11</td>
</tr>
<tr>
<td>4–6 times</td>
<td>177</td>
<td>42</td>
<td>2.70</td>
<td>1.88</td>
<td>3.88</td>
<td>2.15</td>
<td>3.14</td>
</tr>
<tr>
<td>7+ times</td>
<td>95</td>
<td>25</td>
<td>3.08</td>
<td>1.91</td>
<td>4.96</td>
<td>2.13</td>
<td>3.51</td>
</tr>
<tr>
<td>P for trend</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.003</td>
<td></td>
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</tr>
</tbody>
</table>

**Total intake**

Total intake suggested a J-shaped overall association with incident suboptimal subjective health, where those drinking moderate amounts (men 5–7 standard drinks/week; women 3–4 drinks/week) had a lower OR (0.81, 95% CI: 0.69, 0.94), and those who exceeded the Finnish hazardous drinking limit (women ≥16 standard drinks; men ≥24 standard drinks/week) had a higher OR (1.49, 95% CI: 1.20, 1.85) for...
suboptimal health, compared with the lowest intake category (men 1–4 standard drinks/week; women 1–2 drinks/week), when gender and age were adjusted for. When any of the binge drinking measures were adjusted for, the higher OR for hazardous drinking was no longer significant and attenuated close to one, whereas the lower OR among moderate drinkers retained significance, even when all binge drinking measures were simultaneously adjusted for (0.75, 95% CI: 0.64, 0.88).

**Binge drinking**

All binge drinking measures showed a strong linear trend (P for trend <0.001, for each of the three variables) in predicting incident suboptimal subjective health (Table 1, Models 1–3), and these associations were independent of beverage-specific total intake (Models 4–6). In other words, the connection between binge drinking and suboptimal subjective health is not merely due to the fact that binge drinkers, on average, have higher intake levels overall. When all three binge drinking variables were simultaneously in the model, together with gender, age and beverage-specific total intake, only the frequency of alcohol-induced pass-outs retained statistically significant point estimates (Model 7).

When adjusting for potential confounding effects of educational level, living alone, unemployment, low social support, low physical activity and smoking (Models 8–10), all point estimates attenuated considerably. Of these confounders, smoking had the largest individual effect. When adjusting for potential mediating factors (Models 11–13), the point estimates for frequency of intoxications/drunkenness and frequency of hangovers attenuated mainly due to adjusting for depression. The estimates for the frequency of alcohol-induced pass-outs were attenuated especially when additionally adjusting for alcohol-specific hospitalizations.

When modelling the above-described associations using all cases of suboptimal subjective health (i.e. not only T2 incident cases) adjusting for baseline suboptimal subjective health did not change the observed overall associations to any considerable extent. For example, when adjusting for gender, age and baseline suboptimal subjective health, the point estimates for all binge drinking measures were slightly lower throughout, compared with when modelling only incident cases (Models 1–3). In contrast with modelling T2 incident cases of suboptimal subjective health, a model that adjusted for gender, age, baseline suboptimal subjective health, depression and hospitalizations due to alcohol-specific causes, the only point estimates retaining significance were for alcohol-induced pass-outs.

**Subjective health and alcohol-specific hospitalizations**

Those reporting suboptimal health at baseline had a 5-fold OR (5.08, 95% CI: 3.76, 6.92) for future alcohol-specific hospitalizations, compared with those rating their health as optimal (rather good or good), when gender was adjusted for (Table 2, Model 1). When years of alcohol exposure, and all binge drinking measures were adjusted for, this OR decreased by 54% (Model 4). When additionally adjusting for symptoms of depression (Model 5), the OR was decreased by 79%. Adding smoking into this model, the OR decreased by 84%, compared with the model only adjusting for gender. Adding all the remaining baseline covariates (beverage-specific intake, educational level, living alone, unemployment, low social support, low physical activity, family history of alcohol problems and age) into the model, the OR attenuated by a further 5% (Model 8), and the point estimate fell out of statistical significance.

**T2 non-response**

Prevalence of baseline suboptimal subjective was slightly higher among T2 non-responders compared with T2 responders (20 vs. 18%, P-value for difference 0.032). T2 non-responders had over 2-fold OR (2.11; 95% CI: 1.64, 2.71) for alcohol-specific hospitalizations after baseline, compared with those who responded to both measurements, when gender and age were adjusted for. Those T2 non-responders who reported suboptimal subjective health at baseline had 79% excess odds (OR = 1.79; 95% CI:1.27, 2.54) to alcohol-specific hospitalizations, compared with T2 responders who reported their subjective health as suboptimal at baseline, when gender and age were adjusted for.

**DISCUSSION**

This first prospective population-based cohort study exploring the relation between binge drinking and incident suboptimal subjective health showed that among working-aged adults, frequency of intoxications/drunkenness, hangovers...
and alcohol-induced pass-outs, all predict suboptimal subjective health regardless of several potential confounders, including beverage-specific total intake. Of the binge drinking measures, alcohol-induced pass-outs in particular is an important predictor for incident suboptimal subjective health. The effects of binge drinking to suboptimal subjective health seem to be mediated, to a large extent, through depression and alcohol-specific conditions. We also showed that suboptimal subjective health predicts future alcohol-specific hospitalizations, and that over half of this relation is explained by gender, years of alcohol exposure and binge drinking. Over two-thirds of this relation is explained when additionally taking into account concurrent symptoms of depression. These results add to the current literature not only by showing that subjective health captures aspects of health which are associated with the risk of alcohol-specific adverse health outcomes, but in addition by showing that the mechanisms through which this relation is explained (i.e. depression and binge drinking) are, to a large extent, modifiable and can be addressed by existing interventions.

**Methodological considerations**

The strengths of this study were the prospective design with two measurement points, detailed measurement of binge drinking, potential confounders, mediating factors and the linkage of register-based information on hospitalizations. By restricting our analyses on T2 incident suboptimal subjective health (i.e. those with T1 suboptimal subjective health were not included), we have probably controlled many of the baseline comorbidities that could have confounded the relation between baseline binge drinking and suboptimal subjective health 5 years later.

Our sample was representative of the Finnish general population despite the low response proportion, and there was little selection due to health-related factors (Korkelia et al., 2001). It is, however, probable that the effects of non-response have diluted the observed ORs, because of the well-known fact that those with heavier drinking patterns and poorer health status are more likely not to participate in surveys (Gmel and Rehm, 2004). In line with previous studies assessing correlates of non-response in population surveys, T2 non-responders experienced alcohol-related adverse health effects more frequently compared with those who responded to both surveys. The probability of being admitted to hospital due to alcohol-specific causes was higher among T2 non-responders regardless of baseline subjective health status. The observed ORs are, therefore, likely to be underestimates due to the fact that T2 non-responders are, on average, less healthy and at higher risk for alcohol-related outcomes than those who participated in both surveys. Assuming that T2 non-responders are similar to T1 non-responders, also the observed associations between baseline measures and future alcohol-specific hospitalizations are underestimates rather than overestimates.

It is also known that those who participate in surveys tend to under-report their alcohol consumption (Gmel and Rehm, 2004). Total intake was calculated as average weekly intake and was based on questions of beverage-specific intake for beer, wine and spirits. For beer and wine, the provided reference period was ‘average’ week, and for spirits ‘average’ month. The reference period for binge drinking was 12 months, and the provided frequency categories ranged from ‘never’ to ‘at least twice a week’. For drinkers who drink less or more often, than the provided reference period, it could be challenging to convert intake to correspond a different time frame (e.g. responder’s typical frequency of drinking is once or twice a month, but the responder is asked to report the intake as weekly average intake). It is, however, not clear whether the responder would be more likely to under-report or over-report his or her intake, and therefore we can assume that the error/misclassification would be mainly random. In the worst case-scenario, however, the responder could potentially report his or her intake as ‘none’ if not realizing to convert his or her intake to fit the shorter or longer time frame (e.g. by dividing or multiplying with the appropriate factor). Those responders who systematically misclassified themselves as ‘none’-drinkers were here labelled as abstainers and therefore excluded. Those who drank beer, wine or spirits with the provided time frame ‘correctly’ estimated their intake for the given beverage, and under-reported their intake for those beverages that they drank with a different time frame than that provided. It is possible that some of the observed ‘independent’ effect of binge drinking could result from under-estimated total intake. If total intake would under-estimate heavy drinking occasions, but measures of binge drinking capture these drinking occasions (e.g. due to longer time frame asked), binge drinking would bring additional information to the models. However, regardless of potential bias introduced by differences in time frames asked, measures of binge drinking have been consistently shown to have explanatory power over average total intake on various health outcomes (e.g. Room et al., 2005; Rehm et al., 2010; Roerecke et al., 2010).

**Main results**

The prevalence of suboptimal health in our study population (22%) was much lower than previously found in Finland (44%) (Poikolainen et al., 1996), but very close to those found in other Scandinavian countries (28%, 23%) (Grønbæk et al., 1999; Theobald et al., 2003) and in Spain (31%, 20%) (Guallar-Castillón et al., 2001; Valencia-Martin et al., 2009). The difference between our study population and the previous Finnish study could be explained by the fact that the data (Poikolainen et al., 1996; Poikolainen and Vartiainen, 1999) used was restricted to a geographical part of Finland known to have significant health differences, particularly in cardiovascular diseases, compared with the rest of Finland (Vartiainen et al., 2010). We did not find significant gender differences in the associations between beverage-specific intake or binge drinking and subjective health. This is in contrast with a previous study using the Short Form-36 health survey questionnaire to assess subjective health (Stranges et al., 2006), but not with previous studies using the same global measure for subjective health as we did (Grønbæk et al., 1999; Theobald et al., 2003; Valencia-Martin, 2009).

A previous cross-sectional study among Finnish adult population showed no independent effect for frequency of intoxications/drunkenness when beverage-specific intake was controlled (Poikolainen and Vartiainen, 1999). Our data, however, showed that frequent intoxications/drunkenness predicted future suboptimal subjective health independently
of several confounders, including beverage-specific intake for beer, wine and spirits. This is in line with other cross-sectional studies showing association between frequent binge drinking and subjective health (Okoro et al., 2004; Stranges et al., 2006; Valencia-Martín et al., 2009). We were able to show that this relation is retained also prospectively.

In line with previous cross-sectional studies (Okoro et al., 2004; Stranges et al., 2006), alcohol abuse and mental health problems were found to be important mediating factors between binge drinking and incident suboptimal subjective health. The best explanatory power (attenuation of ORs) for the relation between binge drinking and suboptimal health was seen in a model that controlled, not only depression but alcohol-specific adverse health outcomes as well. Given the high co-morbidity between alcohol-dependence and depression (Merikangas et al., 1998; Gilman and Abraham, 2001), further research is needed to establish the actual causal pathways. Future studies should also compare these subjective measures of binge drinking against the commonly used measure of drinking 5+ drinks at a time.

CONCLUSIONS

Given the strong linear relationship between frequency on binge drinking and suboptimal subjective health, preventive measures should target the number of drinking occasions leading to intoxication. Clinical advice based on avoiding/cutting-down the number of drinking occasions leading to intoxication would be a quick and pragmatic approach to brief intervention, and this would not require potentially complicated estimation of standard drinks. Mental health is an important mediating factor between binge drinking, suboptimal subjective health, and alcohol-specific hospitalizations, and symptoms of depression should, therefore, be taken into account in prevention of alcohol-related adverse health outcomes. Future research should establish the potential utility of suboptimal subjective health status as a risk marker for alcohol-specific hospitalizations also in clinical contexts.

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