Influence of smoking and alcohol consumption on admissions and duration of hospitalization

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Background: Previous studies have linked smoking and alcohol consumption to a considerable disease burden and large healthcare expenditures. However, findings from studies based on individual level data are sparse and inconclusive. Our objective was to assess the association between alcohol consumption, smoking and patterns of hospitalization, defined as admission and duration of hospitalization. Methods: The study was based on 12,698 men and women, aged 20 years or more, enrolled in the Copenhagen City Heart Study. We related smoking and alcohol to hospital admission from any cause, smoking- and alcohol-related diseases and duration of hospitalization in a two-part random effects model. Results: Smoking status was strongly associated with admission and duration of hospitalization. For smoking-related admissions, odds ratios (OR) of 2.77 (95% CI 2.13–3.59) in men and 6.30 (95% CI 4.80–8.26) in women were observed among smokers of >20 g/day compared to never-smokers. For any admission (excl. smoking-related causes), corresponding ORs were 1.32 (95% CI 1.15–1.51) and 1.80 (95% CI 1.58–2.06), respectively. In men, a U-shaped association between alcohol consumption and risk of admission was found, both regarding any admission and admissions due to alcohol-related diseases. Alcohol was associated with alcohol-related admissions in women but not with duration of hospitalization. Conclusions: Smoking was associated with increased risk of hospital admission and duration of hospitalization. A U-shaped relation was observed for alcohol consumption and risk of hospitalization in men, but no effect on duration was observed. In women, however, alcohol consumption was only vaguely associated with admission and duration of hospitalization.

Keywords: alcohol consumption, epidemiology, hospitalization, length of stay, smoking.

Introduction

Smoking and alcohol consumption are modifiable risk factors for numerous diseases with major public health impacts, including cardio- and cerebrovascular diseases and cancers.1–7 Several studies have found both smoking and alcohol to be associated with a considerable disease burden and large healthcare expenditures,8–13 e.g. these risk factors each account for ~4% of the global burden of disease, placing them as the fourth and fifth leading risk factors of disease in the world.13 In the developed part of the world alone, tobacco is the leading cause of loss of healthy life years (12.2%), i.e. premature death and years of life lived with disability, mainly due to the effect on vascular and chronic respiratory diseases as well as cancers, whereas alcohol consumption is the third most influential risk factor, contributing to 9.2% of the years of healthy life lost, primarily due to neuropsychiatric diseases and injuries.13

It is reasonable to assume that lifestyle risk factors, such as smoking and alcohol, lead to increased use of healthcare services at the individual level. While several studies have found alcohol misuse and dependence to be associated with excessive health care use14–17 including injuries and use of emergency services,14,15,18,19 few studies have analysed the effect of moderate smoking and alcohol consumption at the individual level on the use of healthcare systems in general. Especially the influence on the duration of hospitalization is less well described.20–26

To address these issues, we analysed the association between smoking and alcohol consumption on risk of being admitted to a hospital and on duration of hospitalization among 12,698 men and women. This will contribute with useful information regarding the general impact of these important lifestyle factors on healthcare systems.

Methods

The study is based on data from the Copenhagen City Heart Study (CCHS), previously described in detail.27 In brief, the CCHS was initiated in 1976 primarily to study the impact of lifestyle factors on cardiovascular diseases. The population was an age-stratified sample of men and women, aged 20 years or more, randomly selected from a defined area of Copenhagen, Denmark. The present study employs data from the second wave of The Copenhagen City Heart Study conducted in 1981–83 in which a total of 12,698 persons participated (participation rate = 63%). Participants individually reported information on lifestyle factors in standardized self-administered questionnaires.

Exposures

Participants reported their smoking status as ‘never smokers’, ‘ex-smokers’ or ‘current smokers’. Current smokers reported amount and type (e.g. cigarettes, cheroots, cigars, pipe or mixed) of tobacco presently smoked, and we calculated the total daily tobacco consumption by equating a cigarette to 1 g, a cheroot to 3 g and a cigar to 5 g of tobacco. Smoking was categorized in five groups as: never-smokers, ex-smokers and smokers of ≤10, 11–20 or >20 g of tobacco per day.

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respectively. Participants gave information on consumption of beer (in bottles), wine (in glasses) and spirits (in units), with response categories of ‘never/almost never’, ‘monthly’, ‘weekly’ or ‘daily’ and the average number of drinks per week for each of these categories. We categorized participants according to their usual weekly consumption of alcohol as: 0, 1–13, 14–21 and >21 drinks. Because of the more limited range of consumption among women, their alcohol consumption was categorized as: 0, 1–6, 7–14 and >14 drinks per week. The highest cut-off values for men and women of 21 and 14, respectively, were based on the Danish sensible drinking limits as proposed by the National Board of Health. The educational level of participants was divided into three categories: <8 years of schooling, 8–11 years and more than 11 years of schooling. All analyses applied updated measures of smoking, alcohol and educational level based on the subsequent third wave of the CCHS among participants with available information (n = 6939).

Outcomes

Hospital admissions were identified from the Danish National Hospital Discharge Register. This register holds information on all Danish hospital admissions from 1977 and onwards, individually identifiable through personal identification numbers. This study focused on full-day admissions. If a person was admitted to a hospital and discharged the same day, this counted as a 1-day admission. We studied any admission excepting admissions related to pregnancies [International Classification of Diseases 8th revision (ICD8): 630–676 and 760–779; ICD10: O00–O99 and Z30–Z39]. In addition, we studied the relation between smoking and smoking-related diseases as well as the relation between alcohol consumption and alcohol-related diseases.

Diagnoses of smoking-related and alcohol-related diseases were identified according to the ICD8 up until 1993. From 1994 to 2003, the corresponding codes of the 10th revision of the ICD were used. Smoking-related diseases were defined as: cancers of larynx (ICD8: 161; ICD10: C32), cancers of trachea, bronchus and lung (ICD8: 162; ICD10: C33–C34), chronic obstructive pulmonary diseases and emphysema (ICD8: 490–492; ICD10: J40–J44), essential hypertension (ICD8: 401; ICD10: I10), ischaemic heart diseases (ICD8: 410–414; ICD10: I20–I25; I48; I50), cerebral ischaemia (ICD8: 432–433, 435–438; ICD10: I63–I66; I69.3–4; I69.8) and atherosclerosis (ICD8: 440; ICD10: I70). Alcohol-related diseases were defined as: psychiatric diseases following alcohol abuse (ICD8: 291, 303, N980, E860; ICD10: F10), cancers of the lip, mouth, pharynx, larynx, oesophagus, rectum, liver and breast (ICD8: 140–150, 153–55, 161, 174; ICD10: C00–C15, C18–C22, C32, C50), essential hypertension (ICD8: 401; ICD10: I10), haemorrhagic stroke (ICD8: 430–31; ICD10: I60–I62), diseases of the liver (ICD8: 570–73, 456, 785.3; ICD10: K70–K77, I85, R18, C22) and pancreatitis (ICD8: 577; ICD10: K85-K86).

We excluded participants admitted with chronic disease 1 year before baseline to reduce bias associated with reverse causality. Chronic diseases were defined as chronic heart diseases (ICD8: 393–458), lung (ICD8: 490–493), gastrointestinal (ICD8: 530–537; 560–69), endocrine (ICD8: 240–279) and infectious diseases (ICD8: 040–046; 079–083; 570; 993–095), diseases in the muscular and skeletal system (ICD8: 710–738), cancers (ICD8: 140–172; 174–209), diseases of the nervous system (ICD8: 340–358), diseases of the blood and blood-forming organs (ICD8: 280–289), stroke (ICD8: 430–438), urogenital diseases (ICD8: 580–584) and alcohol-related chronic diseases (ICD8: 571–573; 577). In the analysis of admissions due to smoking-related and alcohol-related diseases, respectively, participants with any of these diagnoses one year before baseline were excluded as well.

Statistical analysis

Data were analysed in a double-outcome (two-part) model. This model enabled us to address two questions simultaneously: One equation estimated the risk of being admitted to a hospital given the smoking status or alcohol consumption of the individual and other covariates by logistic regression, while a second equation estimated the influence of risk factors on the duration of admission (conditional on whether the participant was admitted or not) by Poisson regression. For every successive year from baseline, we assessed whether participants where admitted during this particular year (yes/no), and if so, the total number of days of hospitalization in this year. The observation time of each person after baseline was included in the model (modelled with an offset). In the conventional regression analysis, it is assumed that the observations are independent. Since each participant in this analysis contributed with up to 20 observations each (one for each year after baseline), the observations were obviously not independent. We therefore applied a random effect coefficient, taking into account the dependency between the observations of the individuals over time and between the two outcomes. This approach provides more conservative estimates (wider confidence bounds) than conventional analyses.

Results

Baseline characteristics

The study population consisted of 6664 women and 5292 men, who provided information on smoking habits, average weekly alcohol consumption and educational level and who were free of chronic diseases during the year before baseline.

At baseline, 54% of the women and 65% of the men reported current smoking, with a mean tobacco consumption of 13.8 g/day among women and 18.2 g/day among men (Table 1). Approximately 43% of the women and 15% of the men were abstainers. The average weekly alcohol consumption was 4.3 drinks in women and 13.7 drinks per week in men. In addition, 8% of the women had an excessive alcohol intake (more than 14 drinks per week) while this applied to 22% of the men (more than 21 drinks per week). Furthermore,

<table>
<thead>
<tr>
<th>Table 1 Baseline characteristics of the participants of the second wave of the Copenhagen City Heart Study (1981–83)</th>
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<tr>
<td><strong>Women</strong></td>
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<tr>
<td>Number (%)</td>
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<tr>
<td>Age, mean (SD)</td>
</tr>
<tr>
<td>Smoking</td>
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<tr>
<td>Never, n (%)</td>
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<tr>
<td>Ex-smokers, n (%)</td>
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<td>Current, n (%)</td>
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<td>g/day*, mean (SD)</td>
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<tr>
<td>Alcohol consumption</td>
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<tr>
<td>0 drinks/week</td>
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<tr>
<td>1–13 drinks/week</td>
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<tr>
<td>&gt;14 drinks/week</td>
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<tr>
<td>&gt; 21 drinks/week</td>
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<tr>
<td>Educational level</td>
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<tr>
<td>&lt;8 years (%)</td>
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<td>8–11 years</td>
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<td>&gt;11 years</td>
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a: Among current smokers  
b: Defined as years of schooling
nearly 50% the women and men had a low educational level (<8 years of schooling).

During 20 years of follow-up, the women experienced a total of 32,689 admissions and the men a total of 25,998 with a mean duration of hospitalization of 11.5 days (median 6 days) in women and 10.4 days (median 5 days) in men. The total number of admissions due to smoking-related diseases was 6990 in women and 7443 in men, with a mean duration of 13.5 (median 7 days) and 12.3 days (median 7 days), respectively. The total number of alcohol-related admissions was 3195 in women and 2625 in men, and the mean duration was 12.6 (median 7 days) and 12.3 days (median 7 days), respectively.

**Smoking and hospitalizations**

Table 2 shows the effect of smoking on risk of being admitted to a hospital. In both men and women, a positive dose–response relation between current smoking and risk of any admission was found, the highest odds ratio (OR) being 1.44 [95% confidence interval (CI), 1.26–1.65] in men and 1.95 in women (95% CI, 1.72–2.22) for the groups smoking >20 g of tobacco per day compared to never-smokers. A statistically significant elevated risk was also observed among ex-smokers compared to never smokers in both men and women. The association was even more evident with regard to admissions due to smoking-related diseases. A considerable higher risk of admission was observed in female smokers of >20 g/day [OR, 6.30 (95% CI, 4.80–8.26)] compared to never smokers. The corresponding OR in male smokers was 2.77 (95% CI, 2.13–3.59).

Likewise, a statistically significant association between smoking and duration of hospitalization was observed in both women and men (Table 3). The duration of any hospitalization was elevated by 1.25 (95% CI, 1.14–1.37) in both women and men with the highest tobacco consumption compared to never-smokers. The corresponding estimates for duration of hospitalizations due to smoking-related diseases were 1.33 (95% CI, 1.13–1.58) in women, and 1.14 (95% CI, 0.96–1.36) in men. However, ex-smokers did not have more hospital days during a year than never-smokers.

**Alcohol consumption and hospitalization**

Table 4 summarizes the risk of admission according to alcohol consumption. A slightly elevated risk of any admission was observed among women with an average intake of more than 14 drinks per week [OR, 1.12 (95% CI, 1.01–1.24)], and a dose–response relationship with regard to admissions due to alcohol-related diseases. Compared to women with a moderate intake of 1–6 drinks per week, an OR of 1.41 (95% CI, 1.15–1.73) was found in women with an alcohol
consumption of 7–14 drinks per week and correspondingly an elevated risk of 1.45 (95% CI, 1.10–1.91) was observed in women with a weekly consumption of 15 drinks or more. In men, a U-shaped association between alcohol consumption and risk of any admission as well as alcohol-related admissions was observed, with the lowest risk found in the reference category of 1–13 drinks per week. The highest risk of any admissions was 1.15 (95% CI, 1.06–1.25) in men with a weekly consumption of 22 drinks or more compared to men with an intake of 1–13 drinks per week. The OR of admissions due to alcohol-related diseases was 2.21 (95% CI, 1.79–2.73) for men within this alcohol group.

As summarized in Table 5, female abstainers were found to have a statistically significant longer duration of hospitalization in general, compared to women with an average weekly alcohol consumption of 1–6 drinks [risk ratio (RR), 1.10 (95% CI, 1.06–1.16)], but no effect on the duration of alcohol-related admissions was observed. In men, no association was found in either duration of any hospitalization or alcohol-related hospitalizations.

Figure 1 illustrates the combined effects of smoking, alcohol consumption and age on risk of hospitalization. In women, similar risk patterns were observed for alcohol groups according to age and smoking status, indicating a J-shaped relation between alcohol and admissions. However, the additional effect of increasing age and smoking shifts the curves upwards, e.g. an OR of 2.2 (95% CI, 1.8–2.6) was observed among ‘elderly’ (65+ years), light-drinking (1–13 drinks/week) never-smokers compared to ‘younger’ (<50 years), light-drinking never-smokers. Correspondingly, an OR of 1.3 (95% CI, 1.1–1.6) was found among younger, light-drinking smokers and an OR of 3.2 (95% CI, 2.6–3.8) was found among elderly, light-drinking smokers compared to younger, light-drinking never-smokers. Similar associations were observed in men, yet with much stronger effects of age and smoking.

### Discussion

In the present study, smoking status was found to be strongly (positively) associated with risk of admissions and duration of hospitalization in both men and women. In men, a U-shaped association between alcohol consumption and risk of admission was found, both regarding any admission and admissions due to alcohol-related diseases. However, our results imply that the average weekly alcohol consumption of women is only vaguely associated with risk of admission and duration of hospitalization. This finding was evident in both analyses of any admission and analyses of admissions due to alcohol-related diseases.

Only few previous studies have addressed the impact of these two major lifestyle risk factors on the healthcare system at the individual level, and findings are inconsistent. In correspondence with our findings, a Finnish study has found smokers to have more hospital days than non-smokers. A similar study of a Spanish population equally found smoking to be associated with an increased utilization of hospital services, while a large study on American Health
Associations between smoking, alcohol and hospital admissions are biologically plausible, as both factors are considered important risk factors for many diseases requiring admission to a hospital. With regard to smoking, multiple studies have documented negative health consequences, including cancers of the upper digestive tract, lung, liver, pancreas and urinary tract\(^1\) in addition to chronic obstructive pulmonary disorder,\(^34\) and cardio- and cerebrovascular diseases.\(^35\) Likewise, alcohol consumption is an established risk factor for liver cirrhosis, chronic pancreatitis, haemorrhagic stroke, hypertension, injuries and violence, as well as cancers of the oral cavity, pharynx, oesophagus, larynx, stomach, colon, rectum, liver and breast.\(^4,7,36\) The effect of smoking and alcohol consumption on the duration of hospitalization may be mediated by decrease in tissue blood flow and healing rate, immunosuppression, and haemostatic imbalance for instance following surgical procedures.\(^33,37\)

Since an excessive alcohol intake is considered a considerable risk factor of morbidity in both men and women, it is surprising that we did not find the highest group of alcohol consumption in women to be associated with patterns of hospitalizations in general, and that only a small effect was observed regarding alcohol-related diseases. As mentioned earlier, this could result from women reducing their intake after the first hospital admissions, leading to an increased risk at the beginning of the follow-up period, but a reduced risk later on as a result of lowering their intake. Subdividing the follow-up period into two periods of 10 years in succession did reveal a difference in estimates for women in the highest alcohol category compared to women with an intake of 1–6 drinks per week during the first 10 years of follow-up. This finding suggests that the effect estimates may be attenuated by changes in exposure during the follow-up period.

To our knowledge, no previous studies have addressed effects of smoking and alcohol on patterns of hospitalization by means of a two-part random-effects model. This method enabled us to illuminate the effect of the lifestyle risk factors on two components of the pattern of hospitalization: First, the likelihood that a participant will be admitted to the hospital and second the extent of the hospitalization. However, some limitations of the study warrant consideration. Results of the present study could be influenced by differences between participants in factors other than smoking status and alcohol consumption for which we did not control (physical activity, other dietary factors, etc.). Moreover, information on smoking status and consumption of alcohol was obtained through self-administered questionnaires, which could imply significant underreporting. However, the measures used to estimate alcohol consumption have been validated showing good agreement with more thorough dietary interviews in Danish populations.\(^38\) Moreover, the outcome categories of the study are broad which may have diluted some of the effect of smoking and alcohol consumption, and we did not consider the pattern of smoking habits or alcohol consumption. Future studies should address these perspectives. In addition, smoking rates and patterns of alcohol consumption have changed considerably over the 20 years studied, why the baseline measurements may not reflect a constant exposure throughout the period. Unfortunately, we were not able to include information on changes in exposure for every year; however, the inclusion of a 10-year update from the third wave of CCHS does minimize part of this shortcoming. Information on hospitalization was obtained from the Danish National Discharge Register. The validity of this register is high,\(^39\) why we do not consider misclassification of outcome a problem in this study.
In addition, most of the Danish hospitals are public, and costs are therefore not likely to have an effect on the number or duration of hospitalizations. The response rate of the second wave of the Copenhagen City Heart Study is high (63%), but the sample consists almost entirely of white, native-born Danes, why results from this study should be generalized to other populations with caution.

In conclusion, our findings support previous evidence of negative consequences of tobacco consumption on health, implying significant excess use of hospital services among smokers compared to never-smokers—especially within the group of smoking-related diseases. The elevated risk of admission also applied to male abstainers and both male and female consumers of 15 drinks or more per week. Alcohol consumption was not related to duration of hospitalization in either men or women.

Thus, receiving large numbers of patients with adverse lifestyle habits, such as alcohol drinking and smoking, hospitals may impact on health not only through treatment but also by promoting lifestyle behaviour changes. The concept of health-promoting hospitals is therefore highly relevant in this context and standard procedures should be incorporated at the hospital level in order to improve disease prevention.

Conflicts of interest: None declared.

Key points
- Previous studies have linked smoking and alcohol consumption to a considerable disease burden and large healthcare expenditures. This study contributes with similar findings based on individual level data.
- Strong associations were observed between smoking and patterns of hospitalization, but only vague associations were observed between alcohol consumption and duration of hospitalization.
- One public health policy implication of our findings is that lowering tobacco and alcohol consumption in the population could considerably reduce healthcare expenditures.

References


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