Scandinavian Journal of Public Health, 2019; 47: 408–416

ORIGINAL ARTICLE

Alcohol and type 2 diabetes: The role of socioeconomic, lifestyle and psychosocial factors

EMILIE E. AGARDH[1], ANDREAS LUNDIN[1], ANTON LAGER[1,2], PETER ALLEBECK[1], ILONA KOUPIL[1,3], SVEN ANDREASSON[1,4], CLAES-GÖRAN ÖSTENSON[5] & ANNA-KARIN DANIELSSON[1]

[1]Department of Public Health Sciences, Karolinska Institutet, Sweden, [2]Centre for Epidemiology and Community Medicine, Sweden, [3]Stockholm University/Karolinska Institutet, Centre for Health Equity Studies (CHESS), Sweden, [4]Center for Psychiatric Research, Sweden, and [5]Department of Molecular Medicine and Surgery, Karolinska Institutet, Sweden

Abstract

Aims: We investigate (a) alcohol consumption in association with type 2 diabetes, taking heavy episodic drinking (HED), socioeconomic, health and lifestyle, and psychosocial factors into account, and (b) whether a seemingly protective effect of moderate alcohol consumption on type 2 diabetes persists when stratified by occupational position. *Methods:* This population-based longitudinal cohort study comprises 16,223 Swedes aged 18–84 years who answered questionnaires about lifestyle, including alcohol consumption in 2002, and who were followed-up for self-reported or register-based diabetes in 2003–2011. Odds ratios (ORs) with 95% confidence intervals (CIs) were estimated in a multivariable-adjusted logistic regression model for all participants and stratified by high and low occupational position. We adjusted for HED, socioeconomic (occupational position, cohabiting status and unemployment), health and lifestyle (body mass index (BMI), blood pressure, smoking, physical inactivity, poor general health, anxiety/depression and psychosocial (low job control and poor social support) characteristics one by one, and the sets of these factors. *Results:* Moderate consumption was inversely associated with type 2 diabetes after controlling for health and lifestyle (OR=0.47; 95% CI: 0.29–0.79) and psychosocial factors (OR=0.40; 95% CI: 0.22–0.79) when compared to non-drinkers. When adjusting for socioeconomic factors, there was still an inverse but non-significant association (OR=0.59; 95% CI: 0.35–1.00). In those with high occupational position, there was no significant association between moderate consumption and type 2 diabetes after adjusting for socioeconomic (OR=0.67; 95% CI: 0.3–1.52), health and lifestyle (OR=0.70; 95% CI: 0.32–1.5), and psychosocial factors (OR=0.75; 95% CI: 0.23–2.46). On the contrary, in those with low occupational position, ORs decreased from 0.55 (95% CI: 0.28-1.1) to 0.35 (95% CI: 0.15–0.82) when adjusting for psychosocial factors, a decrease that was solely due to low job control. HED did not influence any of these associations. ***Conclusions:*** **Moderate alcohol consumption is associated with a lower risk of type 2 diabetes, after adjusting for HED, health and lifestyle, and psychosocial characteristics. The association was inverse but non-significant after adjusting for socioeconomic factors. When stratified by occupational position, there was an inverse association only in those with low occupational position and after adjusting for low job control.**

Keywords: *Alcohol, type 2 diabetes, socioeconomic, health, lifestyle, psychosocial, epidemiology*

Introduction

Despite numerous observational studies showing that moderate alcohol consumption is associated with a reduced risk of type 2 diabetes [1–3], and plausible biological mechanisms enhancing insulin sensitivity [4,5] and/or reducing the inflammatory process [6], scepticism regarding bias and uncontrolled confounding has been pointed out [7–9]. While a meta-analysis from 2009 concluded moderate

Correspondence: Emilie E. Agardh, Department of Public Health Sciences (PHS), Karolinska Institutet, SE-171 77 Stockholm, Sweden.
E-mail: Emilie.agardh@ki.se

Date received 15 August 2017; reviewed 16 March 2018; accepted 3 April 2018

DOI: 10.1177/1403494818774192
journals.sagepub.com/home/sjp
SAGE

alcohol consumption to be protective for type 2 diabetes [3], the latest and most comprehensive meta-analyses showed no reduction in type 2 diabetes risk at any level of alcohol consumption among men, regardless of reference group. Instead, reductions in risk appeared to be specific to women, who exhibited a peak risk reduction of 34% at 31–37 g/day, relative to combined abstainers (current non-drinkers and never drinkers) [10]. However, these analyses concerned average volume intake over a given time and therefore did not capture the possible effect of heavy episodic drinking (HED) behaviours. Thus, this may partly explain the inconsistent results in previous studies. To date there are not enough epidemiological studies to settle this question [9].

Another well-known issue concerns the sick-quitter-effect as people may reduce or give up drinking because they are unwell, which in turn would explain the protective associations found in moderate drinkers. Non-drinkers have been shown to be older [11], more obese [12,13], less physically active [13], have a higher prevalence of pre-diabetes [11], and have lower education [11–13] compared to moderate drinkers. These factors are also closely related to the development of type 2 diabetes and have been accounted for in previous studies to a varying extent [1].

It has also been suggested that moderate drinkers have beneficial life circumstances compared to non-drinkers that has not been adequately taken into account. Increased attention is being paid to socioeconomic and psychosocial factors such as, for example, education, occupational position, employment status, marital status and social relationships [8,14,15]. Type 2 diabetes is less prevalent in those with higher socioeconomic position in western societies [16] and even if socioeconomic position has been adjusted for in many studies [1], there is to our knowledge no prior study that has assessed the alcohol and diabetes association in separate socioeconomic groups. Moreover, psychosocial factors as risks or buffers in the aetiology of type 2 diabetes also seem important [17,18]. While studies have shown that non-drinkers have less favourable psychosocial characteristics compared to moderate drinkers [15], the role of psychosocial factors in the alcohol–diabetes association has not yet been examined.

Consequently, in this study, we investigate: (a) the association between alcohol consumption and type 2 diabetes taking into account HED, socioeconomic (occupational position, unemployment and cohabiting status), health and lifestyle (body mass index (BMI), blood pressure, smoking, physical inactivity, poor general health and anxiety/depression) and psychosocial factors (low job control and poor social support); and (b) whether a seemingly protective effect of moderate alcohol consumption on type 2 diabetes can be found in both high and low occupational groups after adjusting for these potential confounding variables.

Methods

Study population

The study population is from the longitudinal Stockholm Public Health Cohort (SPHC), which has been described in detail previously [19]. Briefly, in 2002 a health questionnaire was sent to approximately 50,000 randomly sampled (stratified by sex and residential area) individuals aged 18 to 84 years living in Stockholm County in Sweden. Those who responded (n=31,182; 63%) answered detailed questions about somatic (including diabetes) and psychological health, demographics, family situation, housing, work environment, socioeconomic position and lifestyle factors (including alcohol use). These participants were followed up by questionnaire in 2010 (n=19,327; 62% participated, 8290 men and 11,037 women).

Those without information about alcohol at baseline (n=1745) and those who reported diabetes at baseline (2002) in the SPHC questionnaire or with a confirmed diagnosis in medical registers between 1993 and 2002 (n=1359) were excluded. Thus, the final study cohort included 16,223 participants (7006 men and 9217 women).

Data collection

Participants of the SPHC cohort were linked by their unique personal identification numbers to the National Patient Register (PR), which includes both in-and outpatient visits and the regional primary health care register (VAL). VAL captures all health care appointments at primary care centres and house physicians in Stockholm County. Diagnoses in PR and VAL are coded according to the International Classification of Disease (ICD), and VAL is here a complement to PR since many patients with diabetes in Sweden are diagnosed in primary health care.

Exposure: alcohol consumption

Information on alcohol consumption was obtained from the baseline (2002) questionnaire. Participants were asked questions about the total quantity of beer, wine and spirits they drank during an average week in the past year. We estimated the amount of 100% pure alcohol in grams per week, and from the distributions of grams among all respondents, cut-off groups were created from the upper (≥145.2 grams per week, or

12 drinks or more), median (41.6–145.2 grams per week, or 3.5–12 drinks) and lower tertile (≥0–41.6 grams per week or >0–3.5 drinks). In addition, subjects who reported that they did not consume alcohol were categorized as non-drinkers. We defined >0–3.5 drinks per week as *light consumption*, 3.5–12 drinks per week as *moderate consumption* and ≥12 drinks as *high consumption*. HED was defined as drinking at least a half bottle of spirit, two bottles of wine, 6 cans/8 bottles of strong beer or 12 bottles of medium strong beer, during the same occasion once per month or more often.

Outcome: type 2 diabetes

People with type 2 diabetes during follow-up (2003–2011) were identified by self-report (SPHC in 2010) and by their ICD codes (E10-E14) recorded in VAL and PR (2003–2011). The self-reported data were obtained by survey response to the question 'Have you ever been diagnosed with diabetes by a medical doctor?' ('Yes' or 'No'). A total of 565 diabetes cases were identified during follow-up (321 in men and 244 in women). Among the 565 cases, 98 appeared only in the registers, 261 only in the questionnaire and 206 cases in both registers and questionnaire.

Potential confounders

Socioeconomic factors. All analyses were controlled for age (18–44, 45–64 and 65–84 years) and sex. *Occupational position* on the labour market was based on self-reported current or previous occupational titles and classified according to the standard system elaborated by Statistics Sweden [20]. We divided these into three groups: high (high- and medium-level non-manual employees and self-employed), middle (low-level non-manual employees) and low (unskilled and skilled workers). There were also some persons who did not report any occupation; these were students, retired, housewives, unemployed or disability pensioners, the majority being students, and these were excluded from further analysis. *Unemployment* was based on a question of having been unemployed any time during the 2 past years, with two responding alternatives, yes or no. *Cohabiting status* was based on sharing accommodation during the majority of the week and was dichotomized as (living alone) versus (cohabiting).

Health and lifestyle factors. BMI (kg/m^2) was measured by self-reported weight and height and categorized into three groups, normal (≤25), overweight (25–28) and obesity (≥28). *Blood pressure* was based on a question of currently receiving treatment for high blood pressure with three responding alternatives, 'no', 'yes, but only advice about changed diets' and 'yes, medication against high blood pressure'. Positive answers were combined as an indication of high blood pressure. *Physical inactivity* was measured by how physically active the person had been at leisure time during the previous year. There were four responding alternatives including low exercise activity, moderate exercise, moderate regular exercise and regular exercise and training. In the analysis, low exercise activity was regarded as physical inactivity. *Smoking* was based on the question 'do you smoke on a daily basis', with two responding alternatives, 'yes' or 'no'. We also assessed *self-rated general health*, by the question 'How do you judge your general health condition?' There were five responding options 'very good', 'good', 'fairly good', 'poor' and 'very poor'. We categorized general health into 'good general health' (very good and good) and poor general health (fairly good, poor and very poor). *Feelings of anxiety/depression* was defined as (yes, to a certain extent, and highly) versus (no, I am not) and based on a question about health today.

Psychosocial factors. Evaluation of *low job control* was based on two questions from the well-established Karasek & Theorell demand–job control questionnaire [21], that is: (a) 'Do you have the freedom to decide what work should be done'?; and (b) 'Do you have the possibility to learn new things and develop through your work'? These had four responding alternatives that each were categorized as (most of the time and always) versus (almost never and never). *Social support* was based on a question of having any persons who can provide personal support to handle personal problems or crisis' in life. The question had four responding alternatives, 'yes', always', 'yes, most of the time', 'no, mostly not', and 'no, never'. In the analysis 'no, mostly not' and 'no, never' were combined and regarded as poor social support.

Analyses

Baseline characteristics, presented by numbers (*n*) and proportions (%) by alcohol use in SPHC 2002 for all participants and participants with diabetes at follow-up (2003–2011) are presented in Table I.

First, age- and sex-adjusted odds ratios (ORs) with 95% confidence intervals (CIs) for alcohol consumption at baseline and type 2 diabetes (1–9 years later) were estimated in a multivariable-adjusted logistic regression analysis, with dummy variables representing potential socioeconomic, health and lifestyle, and psychosocial confounders. The effect of each potential confounder was controlled for one at a

Table I. Baseline characteristics (2002) of participants in the SPHC cohort according to alcohol consumption.

	Alcohol consumption for an average week during the past year							
	All participants				Type 2 diabetes at follow-up			
	Non-drinker	Light (0–3.5 drinks/ week)	Moderate (≥3.5–12 drinks/week)	High (≥12 drinks/week)	Non-drinker	Light (0–3.5 drinks/week)	Moderate (≥3.5–12 drinks/week)	High (≥12 drinks/ week)
Total *n* (%)	974 (6.0)	3358 (20.7)	7838 (48.3)	4053 (25.0)	51 (9.0)	124 (22.0)	225 (39.8)	165 (29.2)
Men	310 (31.8)	977 (29.1)	3059 (39.0)	2660 (65.6)	22 (6.9)	51 (15.9)	118 (36.8)	130 (40.5)
Women	664 (68.2)	2381 (70.9)	4779 (61.0)	1393 (34.4)	29 (11.9)	73 (29.9)	107 (43.9)	35 (14.3)
Heavy episodic drinking	28 (2.9)	159 (4.8)	770 (9.9)	1498 (37.2)	2 (4.1)	8 (6.6)	22 (9.9)	62 (38.3)
Socioeconomic factors								
Occupational position								
High	349 (38.5)	1595 (49.6)	4425 (58.6)	2299 (58.8)	11 (25.0)	39 (33.0)	111 (50.0)	85 (51.8)
Middle	158 (17.4)	577 (17.9)	1274 (16.9)	533 (13.6)	10 (22.7)	30 (25.6)	41 (18.5)	30 (18.3)
Low	399 (44.0)	1046 (32.5)	1854 (24.6)	1078 (27.6)	23 (52.3)	48 (41.3)	70 (31.5)	49 (29.9)
Unemployed	127 (14.2)	310 (9.7)	689 (9.1)	459 (11.6)	5 (12.2)	10 (8.9)	10 (4.6)	16 (9.8)
Living alone	267 (27.5)	652 (19.5)	1271 (16.3)	789 (19.5)	18 (35.3)	28 (22.6)	46 (20.4)	40 (24.4)
Health and lifestyle								
Age, years (mean)	49.7	47.5	47.4	47.1	56.9	56.8	57.8	55.0
BMI (mean)	25.2	24.6	24.4	25.1	28.0	28.8	28.4	28.3
High blood pressure	113 (11.7)	357 (10.7)	762 (9.8)	460 (11.4)	14 (28.0)	41 (33.0)	82 (36.8)	55 (33.3)
Physically inactive	202 (21.5)	439 (13.4)	795 (10.3)	542 (13.5)	11 (22.9)	26 (21.3)	33 (15.1)	29 (17.9)
Smoking (daily)	166 (17.7)	429 (12.8)	968 (12.4)	772 (19.1)	7 (14.0)	24 (19.5)	48 (21.3)	38 (23.2)
Poor general health	79 (8.2)	150 (4.5)	201 (2.6)	123 (3.1)	6 (11.8)	10 (8.1)	11 (4.9)	10 (6.1)
Anxiety/depression	395 (41.0)	1166 (35.1)	2624 (33.7)	1232 (32.9)	25 (49.0)	50 (40.3)	72 (32.3)	57 (34.6)
Psychosocial factors								
Low job control								
Low freedom	293 (49.0)	1101 (45.5)	2493 (40.8)	1124 (35.1)	13 (46.4)	31 (39.2)	56 (36.4)	34 (28.8)
Low possibilities to develop	188 (31.4)	609 (25.2)	1244 (20.4)	646 (20.2)	7 (25.0)	28 (35.4)	38 (24.8)	28 (23.7)
Poor social support	146 (15.2)	332 (10.0)	583 (7.5)	326 (8.1)	13 (25.5)	18 (14.8)	23 (10.3)	22 (13.3)

Data are given as numbers (*n*) and percent (%).

time. We then looked at the set of health and lifestyle variables and the set of psychosocial variables, respectively, in the same model.

Second, we stratified the participants into high (high and middle) and low occupational groups. Also, in this analysis we estimated age- and sex-adjusted ORs with 95% CIs for alcohol consumption at baseline and type 2 diabetes at follow-up, and adjusted for socioeconomic, health and lifestyle, and psychosocial variables one at a time and then the set of health and lifestyle, and psychosocial variables simultaneously.

In all regression analyses we used a system of weights created for the SPHC to account for non-response and the stratified sampling procedure. These weights were constructed on the basis of available auxiliary variables from different national registers and their co-variation with survey data, such as age, sex, country of birth, marital status, income, education, sick-leave benefits and strata [19,22]. By including these weights, the overrepresentation of, for example, well-educated women in the data was taken into account. The analyses were computed with the SAS Statistical Program version 9.3.

Results

Out of 16,223 participants, 6% were non-drinkers, 21% light, 48% moderate and 25% had high consumption (Table I). In non-drinkers 2.9% reported HED, while 4.8% of light, 9.9% of moderate and 37.2% of high consumers reported HED. Non-drinkers were more likely to have low occupational position on the labour market (44%) compared to moderate consumers (25%), to be unemployed (14%

Table II. Odds ratios (ORs) and 95% confidence intervals (CIs) for alcohol consumption (2002) in association with subsequent type 2 diabetes (2003–2011).

	Non-drinker	Light (0–3.5 drinks/week)	Moderate (≥3.5–12 drinks/week)	High (≥12 drinks/week)
		OR (95% CI)	OR (95% CI)	OR (95% CI)
Crude (age- and sex-adjusted)	1	0.53 (0.33–0.85)	0.38 (0.24–0.59)	0.52 (0.32–0.86)
Adjusted for(one by one)				
Heavy episodic drinking	1	0.55 (0.34–0.89)	0.38 (0.24–0.61)	0.49 (0.30–0.82)
Socioeconomic factors				
Occupational position	1	0.68 (0.42–1.11)	0.53 (0.33–0.86)	0.75 (0.45–1.26)
Unemployed	1	0.60 (0.35–1.01)	0.45 (0.27–0.74)	0.63 (0.37–1.07)
Living alone	1	0.53 (0.33–0.85)	0.38 (0.24–0.60)	0.52 (0.32–0.86)
Adjusted for all socioeconomic	1	0.74 (0.43–1.27)	0.59 (0.35–1.00)	0.86 (0.49–1.49)
Health and lifestyle				
BMI	1	0.58 (0.36–0.93)	0.44 (0.27–0.70)	0.55 (0.33–0.92)
High blood pressure	1	0.53 (0.33–0.86)	0.37 (0.24–0.59)	0.51 (0.31–0.85)
Physically inactive	1	0.60 (0.37–0.97)	0.41 (0.26–0.66)	0.59 (0.36–0.98)
Smoking (daily)	1	0.54 (0.33–0.86)	0.39 (0.24–0.61)	0.51 (0.31–0.84)
Poor general health	1	0.55 (0.34–0.88)	0.39 (0.25–0.63)	0.55 (0.33–0.90)
Anxiety/depression	1	0.55 (0.34–0.87)	0.38 (0.24–0.60)	0.53 (0.33–0.87)
Adjusted for all health and lifestyle	1	0.66 (0.40–1.10)	0.47 (0.29–0.79)	0.59 (0.34–1.00)
Psychosocial factors				
Low job control				
Low freedom	1	0.60 (0.32–1.14)	0.38 (0.21–0.71)	0.58 (0.31–1.10)
Low possibilities to develop	1	0.63 (0.33–1.20)	0.42 (0.22–0.77)	0.65 (0.33–1.25)
Poor social support	1	0.52 (0.33–0.84)	0.37 (0.24–0.59)	0.52 (0.32–0.86)
Adjusted for all psychosocial	1	0.61 (0.32–1.16)	0.40 (0.22–0.79)	0.62 (0.32–1.20)

All analyses are controlled for age (18–44, 45–64 and 65–84) and sex.

versus 9%), and to live alone (28% versus 16%). They also had slightly higher mean BMI (25.2 versus 24.4) and were older (mean age 49.7 versus 47.4). Non-drinkers were also more likely to have high blood pressure (12% versus 10%), to smoke (18% versus 12%), to be physically inactive (22% versus 10%),to report poor general health and have feelings of anxiety/depression (41% versus 34%) compared to moderate drinkers (8% versus 3%).

In terms of psychosocial circumstances, non-drinkers were more likely to experience low job control, for example, low freedom at work (49% versus 40.8%) and low possibilities to develop at work (31.4% versus 20.4%) and report poor social support (15% versus 8%), compared to moderate consumers. This implies that moderate drinkers in overall constitute a healthier group compared to non-drinkers.

On the contrary, when looking at baseline characteristics in those with type 2 diabetes at follow-up (before being aware of disease status), non-drinkers had slightly lower mean BMI, were less likely to have high blood pressure and were less likely to smoke compared to moderate drinkers (Table I). In addition, non-drinkers with type 2 diabetes were more likely to report poor health (12%) compared to moderate drinkers (5%).

Compared to non-drinkers, all levels of alcohol consumption (light, moderate and high) were inversely associated with subsequent type 2 diabetes, with the lowest ORs among moderate consumers (sex- and age-adjusted OR=0.38; 95% CI: 0.24–0.59) (Table II). Heavy episodic drinking (HED) did not influence this association. The inverse association among moderate consumers persisted also after adjusting for occupational position (OR=0.53; 95% CI: 0.33–0.86) and the set of health and lifestyle (OR=0.47; 95% CI: 0.29–0.79) and psychosocial factors (OR=0.40; 95% CI: 0.2–0.79). When adjusting for the set of socioeconomic factors, the association was still reverse but non-significant (OR=0.59; 95% CI: 0.35–1.0).

When stratified by high occupational position, the inverse association between moderate alcohol use and subsequent type 2 diabetes persisted when compared with non-drinkers (sex- and age-adjusted OR=0.47; 95% CI: 0.24–0.93) (Table III). However, although still inverse, this association was no longer significant after adjusting for socioeconomic (OR=0.67; 95% CI: 0.3–1.52), health and lifestyle (OR=0.7; 95% CI: 0.32–1.5) and psychosocial factors (OR=0.75; 95% CI: 0.23–2.46).

Also, in the low occupational group there was an inverse association between moderate consumption

Table III. Odds ratios (ORs) and 95% confidence intervals (CIs) for alcohol consumption (2002) in association with subsequent type 2 diabetes (2003–2011) in participants with *high* occupational position.[a]

	Non-drinker	Light 0–3.5 drinks/week	Moderate ≥3.5–12 drinks/week	High ≥12 drinks/week
		OR (95% CI)	OR (95% CI)	OR (95% CI)
Crude (age- and sex-adjusted)	1	0.64 (0.32–1.31)	0.47 (0.24–0.93)	0.64 (0.32–1.30)
Adjusted for(one by one)				
Heavy episodic drinking	1	0.64 (0.31–1.30)	0.47 (0.24–0.92)	0.60 (0.29–1.24)
Socioeconomic factors				
Unemployed	1	0.85 (0.36–1.99)	0.66 (0.29–1.48)	0.89 (0.38–2.07)
Living alone	1	0.66 (0.32–1.35)	0.49 (0.25–0.96)	0.65 (0.32–1.33)
Adjusted for all socioeconomic	1	0.86 (0.36–2.02)	0.67 (0.30–1.52)	0.90 (0.38–2.10)
Health and lifestyle				
BMI	1	0.61 (0.29–1.29)	0.51 (0.25–1.03)	0.63 (0.30–1.32)
High blood pressure	1	0.65 (0.31–1.34)	0.48 (0.24–0.94)	0.62 (0.30–1.28)
Physically inactive	1	0.84 (0.40–1.78)	0.62 (0.30–1.25)	0.82 (0.40–1.71)
Smoking (daily)	1	0.71 (0.34–1.50)	0.52 (0.26–1.03)	0.66 (0.32–1.35)
Poor general health	1	0.68 (0.34–1.38)	0.52 (0.26–1.01)	0.70 (0.35–1.40)
Anxiety/depression	1	0.66 (0.33–1.36)	0.48 (0.25–0.93)	0.65 (0.32–1.31)
Adjusted for all health and lifestyle	1	0.88 (0.39–1.97)	0.70 (0.32–1.49)	0.76 (0.35–1.67)
Psychosocial factors				
Low job control				
Low freedom	1	1.16 (0.34–3.92)	0.70 (0.22–2.25)	1.09 (0.32–3.64)
Low possibilities to develop	1	1.22 (0.35–4.19)	0.74 (0.23–2.44)	1.14 (0.33–3.90)
Poor social support	1	0.64 (0.31–1.30)	0.47 (0.24–0.93)	0.64 (0.31–1.30)
Adjusted for all psychosocial	1	1.21 (0.35–4.15)	0.75 (0.23–2.46)	1.15 (0.34–3.94)

All analyses are controlled for age (18–44, 45–64 and 65–84) and sex.
[a]High occupational position (high- and medium-level non-manual employees and self-employed, and low-level non-manual employees).

and subsequent type 2 diabetes when compared to non-drinkers; however, it was non-significant (sex- and age-adjusted OR=0.55; 95% CI: 0.28–1.10 (Table IV). When adjusting for the set of psychosocial factors, the results were virtually the same as when adjusting for low job control, that is, low freedom at work and low possibilities to develop: the OR decreased to 0.35 (95% CI: 0.15–0.82) and 0.39 (CI: 0.17–0.89), respectively.

Discussion

Our results support previous findings reporting that moderate alcohol consumption is associated with a reduced risk of type 2 diabetes [1,2,3] and extends the knowledge by testing the potential confounding by HED, socioeconomic and psychosocial factors. While HED did not influence any of the associations, the inverse association was less stable after adjusting for the set of socioeconomic factors. Also, when we stratified by occupational position, there was only a significant reverse association in those with low occupational position and when adjusting for low job control, while at the same time this was the most important factor to attenuate the protective effect from moderate alcohol intake in the high occupational group.

It has been suggested that moderate alcohol drinking is a general indicator of a well-integrated member of our society with optimal social status, and with better health and psychological characteristics compared to abstainers [8]. This implies that socioeconomic and psychosocial factors should be taken into account when estimating the association of moderate alcohol consumption and health outcomes. Still, most common confounders in studies of alcohol and diabetes only concern age, sex, BMI, smoking, pre-existing disease, blood pressure, physical inactivity and education [1]. Psychosocial stress is associated with the development of type 2 diabetes and may cause insulin resistance via psychoendocrine pathways [17,23,24]. Despite suspicion of residual confounding from psychosocial characteristics [8,15], there is to our knowledge only one previous study accounting for a range of stress factors, such as demands at work, decision latitude, job strain, sense of coherence and psychological distress, when analysing the possible protective effect of alcohol on type 2 diabetes [10]. Psychosocial stress did not explain the inverse associations in that study. In our study, psychosocial factors seemed important only when we stratified by occupational position. It is puzzling that the protective effects from moderate alcohol consumption is restricted to those with low occupational

Table IV. Odds ratios (ORs) and 95% confidence intervals (CIs) for alcohol consumption (2002) in association with subsequent type 2 diabetes (2003–2011) in participants with *low* occupational position.[a]

	Non-drinker	Light 0–3.5 drinks/week	Moderate ≥3.5–12 drinks/week	High ≥12 drinks/week
		OR (95% CI)	OR (95% CI)	OR (95% CI)
Crude (age- and sex-adjusted)	1	0.69 (0.36–1.36)	0.55 (0.28–1.10)	0.80 (0.38–1.68)
Adjusted for(one by one)				
Heavy episodic drinking	1	0.68 (0.35–1.33)	0.51 (0.26–1.00)	0.67 (0.32–1.39)
Socioeconomic factors				
Unemployed	1	0.65 (0.32–1.30)	0.52 (0.25–1.04)	0.79 (0.37–1.67)
Living alone	1	0.68 (0.35–1.34)	0.54 (0.27–1.07)	0.78 (0.37–1.65)
Adjusted for all socioeconomic	1	0.65 (0.32–1.30)	0.51 (0.25–1.04)	0.78 (0.37–1.67)
Health and lifestyle				
BMI	1	0.81 (0.41–1.61)	0.65 (0.32–1.31)	0.83 (0.39–1.81)
High blood pressure	1	0.70 (0.35–1.37)	0.54 (0.27–1.08)	0.79 (0.37–1.67)
Physically inactive	1	0.67 (0.33–1.33)	0.50 (0.24–1.02)	0.79 (0.38–1.66)
Smoking (daily)	1	0.69 (0.35–1.35)	0.55 (0.28–1.10)	0.78 (0.37–1.65)
Poor general health	1	0.71 (0.36–1.40)	0.57 (0.28–1.15)	0.82 (0.39–1.74)
Anxiety/depression	1	0.68 (0.35–1.35)	0.55 (0.27–1.11)	0.79 (0.38–1.65)
Adjusted for all health and lifestyle	1	0.78 (0.37–1.63)	0.59 (0.27–1.27)	0.82 (0.37–1.79)
Psychosocial factors				
Low job control				
Low freedom	1	0.43 (0.19–0.98)	0.35 (0.15–0.82)	0.51 (0.22–1.21)
Low possibilities to develop	1	0.48 (0.21–1.07)	0.39 (0.17–0.89)	0.61 (0.25–1.49)
Poor social support	1	0.68 (0.34–1.34)	0.55 (0.28–1.11)	0.81 (0.38–1.71)
Adjusted for all psychosocial	1	0.42 (0.18–0.96)	0.35 (0.15–0.83)	0.52 (0.22–1.24)

All analyses are controlled for age (18–44, 45–64 and 65–84) and sex.
[a]Low occupational position (unskilled and skilled workers).

position and only when taking low job control into account. It has been shown that psychosocial stress can explain a considerable part of the excess risk of type 2 diabetes in lower socioeconomic groups [25], and a biological explanation could be that moderate alcohol intake counteracts stress-induced insulin resistance in those with low occupational position.

With regard to the potential sick-quitter effect, this may be a concern in our study. Unfortunately, we do not have any information about lifetime abstainers, occasional drinkers or former drinkers in our study. Thus, the non-drinking group (those not drinking during the past year), may be a combination of lifetime abstainers as well as persons who gave up drinking because they were unwell. A recent meta-analysis showed that some beneficial effects disappeared when using lifetime abstainers as the reference group [10]. While moderate consumers in our study, among all respondents, were more likely to have high occupational position, and more favourable health and lifestyle and psychosocial circumstances compared to non-drinkers, non-drinking type 2 diabetic individuals at follow-up had slightly lower BMI and were less likely to have high blood pressure and smoke compared to moderate drinkers. This may also imply that some had given up drinking due to feelings of illness. However, the beneficial effects from moderate consumption remained when we adjusted for these factors. In addition, we checked our health registers for persons with a prior hospitalization due to alcohol-related diagnosis between 1972 and 2002, but we did not find any non-drinker with type 2 diabetes at follow-up.

Men tend to drink more than women, and it appeared that women's consumption was around one-third of that of men's in our study. Two meta-analyses have shown that moderate alcohol consumption is associated with a lower risk of type 2 diabetes primarily in women [1,10], although other studies have shown that it is limited to men [13]. In the latest and largest of those meta-analyses [10], where moderate consumption was associated with a lower risk primarily in women, it was suggested, although not measured, that a higher degree of HED in men could be one explanation for these observed sex-specific differences. It is also possible that biological pathways operate differently in men and women, such as the effect of alcohol on insulin sensitivity [26]. In our study we combined men and women since our study sample was not sufficient when stratifying by occupational position. However, when we checked the associations among all respondents based on the distribution of alcohol consumption in men and women respectively, moderate consumption

was associated with a reduced risk of type 2 diabetes in both sexes (data not shown). In addition, adjustment for HED did not influence our results as mentioned above.

There are some methodological issues that may influence our results. First, alcohol intake was based on self-reported data and studies have shown that people tend to underreport their consumption [27]. Since all respondents were diabetes free when filling in the questionnaire, this misclassification is non-differential and would, if anything, underestimate the protective effects of consumption at moderate levels. Furthermore, the potential confounders were also based on self-reported data and any mismeasurements in these may result in residual confounding.

A second issue is how well the two questions from the original Karasek & Theorell questionnaire capture low job control. The original questionnaire comprises five items on demands that refer to the load of work a person experiences, and six items on job control that describe a person's skills and ability to master his/her work activities [21]. The simplified way of asking in our study could put its usefulness in question. On the other hand, previous studies have underscored the importance of low job control in association with type 2 diabetes [17]. Hence, possible bias would be random misclassification of exposure to low job control and would most likely underestimate the confounding effect of low job control.

Third, type 2 diabetes is insidious and develops gradually through pre-diabetes, a stage referred to as impaired glucose tolerance (IGT), and may in the early stages not be severe enough to give symptoms of diabetes [28]. Studies have shown that alcohol is also protective for IGT [11,29], and it is reasonable to believe that not all participants were healthy at baseline. Hence, it is possible that some had IGT or even type 2 diabetes without knowing, and thus the protective effect may be underestimated. A total of 261 persons that reported diabetes in the questionnaire did not appear in the health registers. The reason is not known; however, some cases may have had pre-diabetes, who received advice from a medical doctor about lifestyle changes, or there may be incomplete registration about their disease. Moreover, we only measured alcohol use and other lifestyle factors at baseline, and many things can happen during a person's life during the nine years of follow-up, and we could not control for these changes.

Strengths of our study were that we were able to take HED as well as a number of socioeconomic, health and lifestyle and psychosocial factors into account. Moreover, all participants were free from diabetes at baseline, and new cases were identified and ascertained by questionnaire and by the national PR, with high coverage for most diseases, as well as the VAL at follow-up. We also performed Cox regression analyses on annual register-based diabetes cases, and although based on fewer cases, the results were similar to those when estimating ORs.

Conclusions

To conclude, the results of our study suggest that moderate alcohol consumption is associated with a lower risk of type 2 diabetes, after adjusting for HED, health and lifestyle, and psychosocial characteristics. However, the inverse association was less stable when accounting for socioeconomic factors, and the protective effect was, when stratified by high and low occupational position, restricted to those with low occupational position and after adjusting for low job control. The reason for this is not known but implies some influence of socioeconomic and psychosocial factors in the alcohol and diabetes association. From a public health and health care perspective, we suggest future studies that focus on socioeconomic subpopulations and take psychosocial factors into account when analysing this association. The consistently found protective effect of alcohol for diabetes is important to disentangle further, since it may bias estimates of the overall disease burden attributed to alcohol, stemming from, for example, neoplasms, injuries, alcohol use disorders and cirrhosis [30].

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by grants provided by the Research Council for Health Working Life and Welfare (Forte: 2016-07108).

References

[1] Li XH, Yu FF, Zhou YH, et al. Association between alcohol consumption and the risk of incident type 2 diabetes: a systematic review and dose-response meta-analysis. *Am J Clin Nutr* 2016;103:818–29.

[2] Koppes LLJ, Dekker JM, Hendriks HFJ, et al. Moderate alcohol consumption lowers the risk of type 2 diabetes. A meta-analysis of prospective observational studies. *Diabetes Care* 2005;28:719–25.

[3] Baliunas DO, Taylor BJ, Irving H, et al. Alcohol as a risk factor for type 2 diabetes: a systematic review and meta-analysis. *Diabetes Care* 2009;32:2123–32.

[4] Davies MJ, Baer DJ, Judd JT, et al. Effects of moderate alcohol intake on fasting insulin and glucose concentrations and

insulin sensitivity in postmenopausal women: a randomized controlled trial. *JAMA* 2002;287:2559–62.
[5] Mayer EJ, Newman B, Quesenberry CP, et al. Alcohol-consumption and insulin concentrations: role of insulin in associations of alcohol intake with high-density-lipoprotein cholesterol and triglycerides. *Circulation* 1993;88:2190–97.
[6] Shelmet JJ, Reichard GA, Skutches CL, et al. Ethanol causes acute inhibition of carbohydrate, fat, and protein oxidation and insulin resistance. *J Clin Invest* 1988;81:1137–45.
[7] Chktritzhs TST, Naimi T, Andreasson S, et al. Has the leaning tower of presumed health benefits from 'moderate' alcohol use finally collapsed? *Addiction* 2015;110:726–7.
[8] Fekjaer HO. Alcohol: a universal preventive agent? A critical analysis. *Addiction* 2013;108:2051–57.
[9] Rhem J, Gmel GE, Gmel G, et al. The relationship between different dimensions of alcohol use and the burden of disease: an update. *Addiction*. Epub ahead of print 20 February 2017. DOI: 10.1111/add.13757.
[10] Knott C, Bell S and Britton A. Alcohol consumption and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis of more than 1.9 million individuals from 38 observational studies. *Diabetes Care* 2015;38: 1804–12.
[11] Cullmann M, Hilding A and Östenson CG. Alcohol consumption and risk of pre-diabetes and type 2 diabetes development in a Swedish population. *Diabet Med* 2012;29: 441–52.
[12] Marques-Vidal P, Vollenweider P and Waeber G. Alcohol consumption and incidence of type 2 diabetes. Results from the CoLaus study. *Nutr Metab Cardiovasc Dis* 2015;25: 75–84.
[13] Rasouli B, Ahlbom A, Andersson T, et al. Alcohol consumption is associated with reduced risk of Type 2 diabetes and autoimmune diabetes in adults: results from the Nord-Trondelag health study. *Diabet Med* 2013;30:56–64.
[14] Hansel B, Thomas F, Pannier B, et al. Relationship between alcohol intake, health and social status and cardiovascular risk factors in the Urban Paris-Ile-de France cohort: is the cardioprotective action of alcohol a myth? *Eur J Clin Nutr* 2010;64:561–8.
[15] Camacho TC, Kaplan GA and Cohen RD. Alcohol consumption and mortality in Alameda County. *J Chronic Dis* 1987;40:229–36.
[16] Agardh EE, Allebeck P, Hallqvist J, et al. Type 2 diabetes incidence and socio-economic position: a systematic review and meta-analysis. *Int J Epidemiol* 2011;40:804–18.
[17] Agardh EE, Ahlbom A, Andersson T, et al. Work stress and low sense of coherence is associated with type 2 diabetes in middle-aged Swedish women. *Diabetes Care* 2003;26: 719–24.
[18] Heraclides A, Chandola T, Witte DR, et al. Psychosocial stress at work doubles the risk of type 2 diabetes in middle-aged women: evidence from the Whitehall II study. *Diabetes Care* 2009;32:2230–5.
[19] Svensson AC, Fredlund P, Laflamme L, et al. Cohort profile: The Stockholm Public Health Cohort. *Int J Epidemiol* 2013;42:1263–72.
[20] Statistics Sweden. *Swedish socioeconomic classification*. Stockholm Sweden: Statistics Sweden, 1984.
[21] Karasek RA, Baker D, Marxer F, et al. Job decision latitude, job demands and cardiovascular disease: a prospective study of Swedish men. *Am J Public Health* 1981;71:694–705.
[22] Lundstrom SSC. Calibration as a standard method for treatment of nonresponse. *J Offic Statist* 1999;15:305–27.
[23] Rosmond R and Björntorp B. The hypothalamic-pituitary-adrenal axis activity as a predictor of cardiovascular disease, type 2 diabetes and stroke. *J Intern Med* 2000;247: 188–97.
[24] Björntorp P, Holm G and Rosmond R. Hypothalamic arousal, insulin resistance and type 2 diabetes mellitus: *British Diabetic Association* 1999;16:373–83.
[25] Agardh EE, Ahlbom A, Andersson T, et al. Explanations of socioeconomic differences in excess risk of type 2 diabetes in Swedish men and women. *Diabetes Care* 2004;24: 716–21.
[26] Schrieks IC, Heil AL, Hendriks HF, et al. The effect of alcohol consumption on insulin sensitivity and glycemic status: a systematic review and meta-analysis of intervention studies. *Diabetes Care* 2015;38:723–32.
[27] Christensen AI, Ekholm O, Gray L, et al. What is wrong with non-response? Alcohol-, drug- and smoking-related mortality and morbidity in a 12-year follow-up study of respondents and non-respondents in the Danish health and morbidity survey. *Addiction* 2015;110:1505–12.
[28] The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Report of the Expert Committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care* 2003;26:S5-S20.
[29] Carlsson S, Hammar N, Efendic S, et al. Alcohol consumption, type 2 diabetes mellitus and impaired glucose tolerance in middle-aged Swedish men. *Diabetic Medicine* 2000;17:776–81.
[30] Agardh EE, Danielsson AK, Ramstedt M, et al. Alcohol-attributed disease burden in four Nordic countries: a comparison using the Global Burden of Disease, Injuries and Risk Factors 2013 study. *Addiction* 2016;11:1806–13.