Alcohol consumption in very old age and its association with survival: A matter of health and physical function

Neda Agahi[a,*], Susanne Kelfve[a,b], Carin Lennartsson[a], Ingemar Kåreholt[a,c]

[a] *Aging Research Center, Karolinska Institutet/Stockholm University, Gävlegatan 16, 113 30 Stockholm, Sweden*
[b] *Department of Sociology, Stockholm University, 106 91 Stockholm, Sweden*
[c] *Institute for Gerontology, School of Health and Welfare, Jönköping University, Box 1026, 551 11 Jönköping, Sweden*

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A B S T R A C T

Background: Alcohol consumption in very old age is increasing; yet, little is known about the personal and health-related characteristics associated with different levels of alcohol consumption and the association between alcohol consumption and survival among the oldest old.
Methods: Nationally representative data from the Swedish Panel Study of Living Conditions of the Oldest Old (SWEOLD, ages 76–101; $n = 863$) collected in 2010/2011 were used. Mortality was analyzed until 2014. Alcohol consumption was measured with questions about frequency and amount. Drinks per month were calculated and categorized as abstainer, light-to-moderate drinker (0.5–30 drinks/month) and heavy drinker (>30 drinks/month). Multinomial logistic regressions and Laplace regressions were performed.
Results: Compared to light-to-moderate drinkers, abstainers had lower levels of education and more functional health problems, while heavy drinkers were more often men, had higher levels of education, and no serious health or functional problems. In models adjusted only for age and sex, abstainers died earlier than drinkers. Among light-to-moderate drinkers, each additional drink/month was associated with longer survival, while among heavy drinkers, each additional drink/month was associated with shorter survival. However, after adjusting for personal and health-related factors, estimates were lower and no longer statistically significant.
Conclusions: The association between alcohol consumption and survival in very old age seems to have an inverse J-shape; abstention and heavy use is associated with shorter survival compared to light-to-moderate drinking. To a large extent, differences in survival are due to differences in baseline health and physical function.

1. Introduction

Recent studies have shown that alcohol consumption is prevalent among the oldest old aged 80 years and above in Europe; between 30 and 60% in these ages drink alcohol (Hoeck and Van Hal, 2013; Immonen et al., 2011; Kelfve et al., 2014). In more recent cohorts of older adults there are fewer abstainers and more weekly drinkers (Ahacic et al., 2012; Kelfve et al., 2014; Waern et al., 2014). Yet, the circumstances surrounding alcohol consumption and alcohol's association with health/survival in this expanding segment of the population are largely unexplored. In this study, we will investigate personal and health-related characteristics associated with different levels of alcohol consumption among the oldest old as well as the association between alcohol consumption and survival.

The body's tolerance for alcohol decreases with age and so the equivalent amount of alcohol leads to a higher blood alcohol concentration in older individuals compared to younger (Novier et al., 2015; Vestal et al., 1977). In older adults, alcohol consumption can potentially harm health through increasing the risk of falls and accidents, interactions with medications, and complications related to various diseases (Heuberger, 2009; Immonen et al., 2011). To a certain extent then, maintained health and function, as well as the absence of certain chronic diseases, are central for continued alcohol consumption in old age. Older individuals that stop drinking often do so because of health problems (Moos et al., 2005). Impaired health and mobility can also hamper the ability to access alcohol.

Previous studies have suggested a U- or J-shaped association between the amount of alcohol consumption and mortality in other segments of the population, including middle aged and older

* Corresponding author. Tel.: +46 8 6905896.
E-mail address: neda.agahi@ki.se (N. Agahi).

people (Bellavia et al., 2014; Halme et al., 2010; Rehm and Sempos, 1995; White et al., 2002). A handful studies have investigated the association between alcohol consumption and survival among older adults and found varying results. In a study of 45–83-year-olds, 0.5 drinks/day for women and 1.5 drinks/day for men was associated with the longest survival time, while both lower and higher consumption was related to shorter survival (Bellavia et al., 2014). In a study of 65–79-year-olds, mortality risk was lowest in weekly consumers drinking 1–2 drinks/day (women) and 4 drinks/day (men) compared to non-weekly drinkers. Alcohol-free days during the week were related to an additional decrease in mortality risk among the weekly drinkers (McCaul et al., 2010). Two studies of individuals aged 65 years and older suggested higher mortality risks among abstainers and those consuming more than 2 drinks/day compared to those drinking less than 2 drinks/day (Halme et al., 2010; Lang et al., 2007). However, the association between alcohol consumption and survival is still largely unexplored among those aged 80 years and older. A study of nonagenarians (90+) did not find the J- or U-shaped association between alcohol and mortality, but results did indicate a higher mortality risk among abstainers compared to drinkers (Nybo et al., 2003). However, the health benefits of moderate alcohol consumption – at any age – is not uncontroversial (for a recent editorial, see Chikritzhs et al., 2015), and alcohol abstinence, particularly in old age, is often due to underlying health problems that constrain alcohol consumption.

Considering the increasing rates of drinking among the oldest old (80+), more information about the characteristics of abstainers and drinkers, as well as how alcohol consumption is related to survival in this age group is warranted. With nationally representative data of the oldest old aged 76–101, the present study investigated (1) personal and health-related characteristics in three alcohol consumption groups, to see if and how abstainers, moderate and heavy drinkers differ; and (2) the association between alcohol consumption and survival, to see if the inversely J- or U-shaped association can be found also among the oldest old.

2. Material and methods

2.1. Data

Data were from the Swedish Panel Study of Living Conditions of the Oldest Old (SWEOLD), a nationally representative survey of individuals aged 76 years and older conducted since 1992 in Sweden (Lennartsson et al., 2014). SWEOLD is based on probability samples and includes institutionalized individuals. The survey covers a wide range of topics, such as health and function, living conditions and health behaviors. The current study used data from the fourth wave of SWEOLD, conducted in 2010–2011. Men aged 85–99 and women aged 90–99 were oversampled to allow for more detailed analyses. In addition, questions about alcohol consumption were more detailed, including both frequency and amount of drinking.

More than half of the participants (64%) were interviewed face-to-face. Indirect/proxy interviews (20.1%) with a spouse, relative, or healthcare personnel were performed when the older person was too frail or cognitively impaired to participate. Telephone interviews (9.7%) were primarily used for the proxy interviews, but were also used when respondents refused a visit. A questionnaire was sent by mail to those who refused an interview (6.2%). The response-rate of the whole survey was 86.2%. The full sample consisted of 931 individuals. Due to item non-response related to items concerning alcohol consumption ($n = 14$), education ($n = 24$) and health/function ($n = 30$), the analytical sample consisted of 863 persons. The study has been approved by the Ethical Review Board in Stockholm, dnr 2010/403-31/4.

2.2. Variables

Frequency and amount of *alcohol consumption* were measured in the survey. Frequency was measured with the question "How often do you drink alcoholic beverages such as wine, beer, or spirits?" Response alternatives were Never, 1–6 times/year, 1 time/month, 2–3 times/month, 1–2 days/week, 3–4 days/week, and 5–7 days/week. Amount was measured with the question "How many drinks do you drink on a typical day when you consume alcohol?" Response alternatives were 1–2, 3–4, 5–6, 7–9, and >9 drinks.

The frequency and amount questions were combined to estimate the number of drinks consumed per month. For simplicity, yearly consumption was calculated first. The midpoint of the frequency answer (Never = 0, 1–6 times/year = 3.5, 1 time/month = 12, 2–3 times/month = 30, 1–2 days/week = 78, 3–4 days/week = 183, 5–7 days/week = 313) was multiplied by the midpoint of the volume answer (1–2 = 1.5, 3–4 = 3.5, 5–6 = 5.5, 7–9 = 8, >9 = 10). For instance, a person who reported consumption 2–3 times/month, with a consumption of 1–2 drinks on a typical day, will get an estimation of 45 drinks/year (30 days × 1.5 drinks). Yearly alcohol consumption was then divided by 12 to get monthly consumption.

Respondents were coded into three categories based on their drinking behavior. Those who did not drink alcohol were categorized as abstainers. Those who did drink alcohol were categorized as light-to-moderate drinkers and heavy drinkers. Light-to-moderate drinkers were persons drinking up to 30 drinks/month, regardless of consumption pattern. Heavy drinkers were those drinking more than 30 drinks/month.

Most countries do not have specific guidelines regarding alcohol consumption for older people. However, based on current research and guidelines it has been suggested that one drink per day, or up to seven drinks per week, can be considered safe for persons over the age of 65 (Crome et al., 2012; National Institute on Aging, 2012). The cutoffs used in this study focus on monthly consumption and consider more than 30 drinks/month as heavy drinking.

Survival was calculated in days from the baseline interview until death or censoring on June 30, 2014 and served as the outcome in the analyses. Mortality information was obtained from the Swedish National Cause of Death Registry.

Level of education was measured by highest attained level of education. The categories were primary, secondary (e.g., vocational education or upper secondary school), and university.

Living situation was categorized as living together with someone, living alone or living in an institution (nursing home, retirement home, or group living arrangement with service around the clock). In Sweden, older people move to an institution only after a needs assessment in the municipality where they reside. In this study, living situation was considered an indicator of how accessible alcohol was for the older person as well as an indicator of health.

Three other indicators of health were also included in the study, one measuring function and the ability to move around without problems, and two measuring chronic diseases that can interact negatively with alcohol consumption. *High blood pressure* and *diabetes* were measured with the question "Have you had any of the following diseases or symptoms during the last 12 months?" This was followed by a list of health problems, including high blood pressure and diabetes. For each item, the given answers were No, Yes, mild problems, and Yes, severe problems. *Mobility problems* included two items, difficulties walking 100 meters fairly briskly and walking up and down stairs. The index ranged 0–2, indicating the number of mobility problems.

Interview type was coded as direct, indirect or mixed interviews. Although this variable concerns the data collection, it is also an indirect measure of health as very frail or cognitively impaired persons can usually not be interviewed in person (Kelfve et al., 2013).

2.3. Statistical analyses

Chi square tests and multinomial logistic regressions were used to analyze differences between the three categories of alcohol consumers.

Laplace regression was used to analyze survival (Bottai and Orsini, 2013; Orsini et al., 2012). The Laplace regression assumes that the error term follows a type of asymmetric Laplace distribution. Like hazard regressions, the Laplace regression allows censoring even when censoring depends on covariates. Hazard regressions and Laplace regressions are equally appropriate for data like this, including censoring (Bottai and Zhang, 2010). A major difference between Laplace regressions and hazard regressions is that the Laplace regression estimates the results in terms of days of survival while the hazard regression estimates relative differences in mortality risk. We chose Laplace regressions mainly because results are easier to interpret. The outcome is the number of days until death has occurred for specific percentiles – in this study, the number of days until the first 10% and 30% of the sample have died. We chose these percentiles because those in the 10th percentile are the first to die and those in the 30th constitute the majority that die (in all, 36% of the sample died during follow-up).

We expected the association between alcohol consumption and survival to be non-linear. In order to determine what level of alcohol consumption that corresponded to the longest survival and to better represent the association in case of an inverse J- or U-shaped distribution, piecewise linear representation variables (splines) were used. Linear splines are a series of concatenated variables separated by pre-defined cut-points (knots). Within each interval, alcohol consumption (measured as drinks/month) is explored as a continuous variable. In this way, linearity is only assumed within each interval within the scale while at the same time retaining some of the statistical power of the original continuous variable. The first knot was chosen to distinguish between the abstainers and those that consumed any alcohol. The lowest amount of alcohol consumption recorded was 0.5 drinks/month and therefore we set the lower knot at 0.5. Within the group that consumed alcohol, knots at 10, 25, 30 and 38 drinks/month were explored. Among these, a knot at 30 drinks/month best captured the shape of the survival time. The results are presented as (1) differences in survival between abstainers and persons drinking any alcohol, (2) average difference in survival among persons drinking 0.5–30 drinks/month

Table 1
Personal and health-related characteristics (percentages, except for age and follow-up time) by amount of alcohol consumption among older Swedes aged 76 and older ($n = 863$). *P*-values (within parentheses) indicate differences between light-to-moderate drinkers and abstainers, and between light-to-moderate drinkers and heavy drinkers.

	Abstainers ($n = 269$)	Light-to-moderate drinkers ($n = 518$)	Heavy drinkers ($n = 76$)
Age			
Mean age	84.0 (0.001)	82.7	82.0 (0.218)
Age range	76-100	76-101	76-100
Sex			
Men	26.7 (<0.001)	40.5	59.5 (0.002)
Women	73.3	59.5	40.5
Education			
Primary	76.7 (<0.001)	50.8	29.7 (<0.001)
Secondary	21.7	44.1	55.4
University	1.6	5.1	14.9
Living situation			
Living with someone	30.6 (<0.001)	46.4	45.9 (0.291)
Living alone	54.3	44.5	50.0
Living in an institution	15.1	9.1	4.1
Mobility			
No problems	31.4 (<0.001)	52.5	64.0 (0.138)
One limitation	22.9	22.7	20.0
Two limitations	45.7	24.8	16.0
High blood pressure			
No	50.0 (0.175)	53.7	51.4 (0.484)
Yes, slight	43.8	37.6	43.2
Yes, severe	6.2	8.7	5.4
Diabetes			
No	76.4 (0.380)	80.7	94.6 (0.011)
Yes, slight	17.0	14.0	5.4
Yes, severe	6.6	5.3	0[a]
Interview type			
Direct interview	69.6 (<0.001)	84.3	98.4 (0.004)
Indirect interview	22.2	12.0	1.1
Mixed interview	8.2	3.7	0.5
Death during follow-up	37.2 (<0.001)	21.2	20.0 (0.881)
Mean days of follow-up	979.4 (<0.001)	1125.6	1168.4 (0.238)

[a] No observations.

(light-to-moderate drinkers), and (3) average difference in survival among persons drinking more than 30 drinks/month (heavy drinkers).

Sampling probability weights were used in all analyses to adjust for the oversampling of men aged 85–99 and women aged 90–99. All analyses were run in Stata 12.

3. Results

3.1. Alcohol consumption

Table 1 presents the personal and health-related characteristics of the three categories of alcohol consumption. A majority of the older adults in the study sample (60%) were categorized as light-to-moderate drinkers, that is, they drank between 0.5 and 30 drinks/month. About 31 percent reported no drinking and were categorized as abstainers, and nine percent drank more than 30 drinks/month and were categorized as heavy drinkers. During the follow-up period about 36 percent of the sample died. As can be seen in Table 1, the groups differed in several ways. Compared to light-to-moderate drinkers, it was more common for abstainers to be older, women, have primary education only, live alone or in an institution, and have mobility impairments. They were also interviewed by proxy to a higher extent. In contrast, heavy drinkers were more often men, had secondary or university education, and were diabetes-free to a higher extent than light-to-moderate drinkers. In this group, the absolute majority was interviewed directly. Light-to-moderate drinkers were somewhere in-between the other two groups. High blood pressure was the only variable that did not differ significantly between the groups.

Table 2 presents differences between the alcohol consumption categories from multinomial logistic regressions. In Model 1, adjusted for age and sex, differences remained significant between the three alcohol consumption categories with regard to sex (adjusted for age only), educational level and interview type. Heavy drinkers did not differ significantly from light-to-moderate drinkers in any other of the included variables. Older age, living alone or in an institution as well as having two mobility limitations were significantly more common among abstainers compared to light-to-moderate drinkers. In the fully adjusted Model 2, being a woman was no longer significantly more common among abstainers; neither was older age, living alone or in institutions, or indirect interviews. However, differences with regard to level of education or mobility limitations remained significant. As for differences between heavy and light-to-moderate drinkers, sex, educational differences and indirect interviews remained significant in the fully adjusted Model 2; and, in addition, differences with regard to lower odds of reporting diabetes became significant.

3.2. Survival

Abstainers died during follow-up to a higher extent than the two other groups; they also had a shorter average follow-up time (bottom of Table 1). Estimates from the Laplace regressions, presented in Table 3, show differences in survival between and within the three alcohol consumption categories. The estimates are based on the average number of days until death for the first 10 and 30 percent of the deceased (the 10th and 30th percentiles). For the 10th percentile, results from Model 1 showed that average survival time was 11 months (332 days) longer among light-to-moderate drinkers, drinking 0.5 drinks/month, compared to the abstainers. Among the light-to-moderate drinkers, each additional drink per

Table 2
Comparisons between the three alcohol consumption categories among older Swedes aged 76 and older, (n = 863). Odds ratios (OR) and P-values from multinomial logistic regressions, reference group is light-to-moderate drinkers.

	Model 1[a]				Model 2[b]			
	Abstainers		Heavy drinkers		Abstainers		Heavy drinkers	
Age[c]	1.05	(0.003)	0.97	(0.243)	1.01	(0.530)	0.97	(0.216)
Sex								
Men	1.0	(ref)	1.0	(ref)	1.0	(ref)	1.0	(ref)
Women	1.79	(0.001)	0.47	(0.009)	1.35	(0.132)	0.41	(0.006)
Education								
Primary	1.0	(ref)	1.0	(ref)	1.0	(ref)	1.0	(ref)
Secondary	0.35	(<0.001)	2.08	(0.021)	0.40	(<0.001)	2.18	(0.013)
University	0.22	(0.011)	4.12	(0.002)	0.25	(0.022)	5.00	(0.001)
Living situation								
Living with someone	1.0	(ref)	1.0	(ref)	1.0	(ref)	1.0	(ref)
Living alone	1.51	(0.046)	1.56	(0.141)	1.48	(0.066)	1.85	(0.059)
Living in an institution	1.84	(0.049)	0.63	(0.459)	1.04	(0.907)	1.94	(0.368)
Mobility								
No problems	1.0	(ref)	1.0	(ref)	1.0	(ref)	1.0	(ref)
One limitation	1.54	(0.060)	0.78	(0.504)	1.43	(0.123)	0.90	(0.789)
Two limitations	2.64	(<0.001)	0.63	(0.239)	2.18	(0.001)	1.18	(0.707)
–								
High blood pressure								
No	1.0	(ref)	1.0	(ref)	1.0	(ref)	1.0	(ref)
Yes, slight	1.21	(0.295)	1.28	(0.393)	1.05	(0.802)	1.80	(0.054)
Yes, severe	0.77	(0.442)	0.72	(0.604)	0.57	(0.131)	1.30	(0.691)
Diabetes								
No	1.0	(ref)	1.0	(ref)	1.0	(ref)	1.0	(ref)
Yes, slight	1.39	(0.172)	0.31	(0.060)	1.41	(0.180)	0.26	(0.020)
Yes, severe	1.31	(0.456)	–[d]		0.89	(0.793)	–[d]	
Interview type								
Direct interview	1.0	(ref)	1.0	(ref)	1.0	(ref)	1.0	(ref)
Indirect interview	1.92	(0.005)	0.09	(<0.001)	1.39	(0.208)	0.09	(<0.001)
Mixed interview	2.58	(0.008)	0.12	(0.020)	2.28	(0.044)	0.16	(0.075)

[a] Model 1 adjusted for age (given linear representation) and sex. All variables were analyzed in separate models. Analyses of age were adjusted for sex only, and analyses of sex for age only.
[b] Model 2 included all variables in the same model.
[c] Age was given linear representation in the regression models.
[d] No observations.

Table 3
Association between alcohol consumption (drinks/month) and average survival time (days) among older Swedes aged 76 and older (n = 863). Results from Laplace regressions for the 10th and 30th percentiles, linear splines with two knots (0.5 and 30).

	Model 1[a]		Model 2[b]	
	Average survival time in days, per additional drink/month	P-value	Average survival time in days, per additional drink/month	P-value
10th percentile[c]		[<0.001][d]		[0.497][d]
Increase 0–0.5 drinks/month[e]	332.6	0.014	194.0	0.241
0.5–30 drinks/month[f]	19.50	0.002	8.23	0.519
>30 drinks/month[g]	−10.19	0.001	−5.43	0.405
30th percentile[c]		[0.018][d]		[0.142][d]
Increase 0–0.5 drinks/month[e]	330.7	0.039	212.1	0.118
0.5–30 drinks/month[f]	12.88	0.104	6.23	0.460
>30 drinks/month[g]	−10.85	0.377	−9.74	0.450

[a] Model 1 adjusted for age (given linear representation) and sex.
[b] Model 2 additionally adjusted for level of education, mobility problems, high blood pressure, diabetes, living situation and interview type.
[c] Results for the 10th percentile show differences for the average survival time until 10% of the sample died, results for the 30th percentile until 30% died.
[d] P-values in [] show P-values for the overall effect of patterns of alcohol consumption.
[e] Referred to as abstainers (no drinks/month); shows the increase in survival days between abstainers and those who drank 0.5 drinks/month.
[f] Referred to as light-to-moderate drinkers; shows the increase in survival days per each additional drink.
[g] Referred to as heavy drinkers; shows the decrease in survival days per each additional drink.

month was related to 19 days longer survival time. However, heavy drinking (more than 30 drinks per month) was associated with shorter survival; for each additional drink per month, average survival time was approximately ten days shorter. In Model 2 when all covariates were included in the analyses, the estimates were almost halved and no longer statistically significant. As shown by the black lines in Fig. 1, the inversely J-shaped pattern in Model 1 was flattened in Model 2.

Results for the 30th percentile were very similar to those of the 10th percentile, except the lower estimates for the light-to-moderate drinkers, which is reflected by the somewhat flatter grey curves as compared to the black ones in Fig. 1. In Model 1, the difference between abstainers and light-to-moderate drinkers, drinking

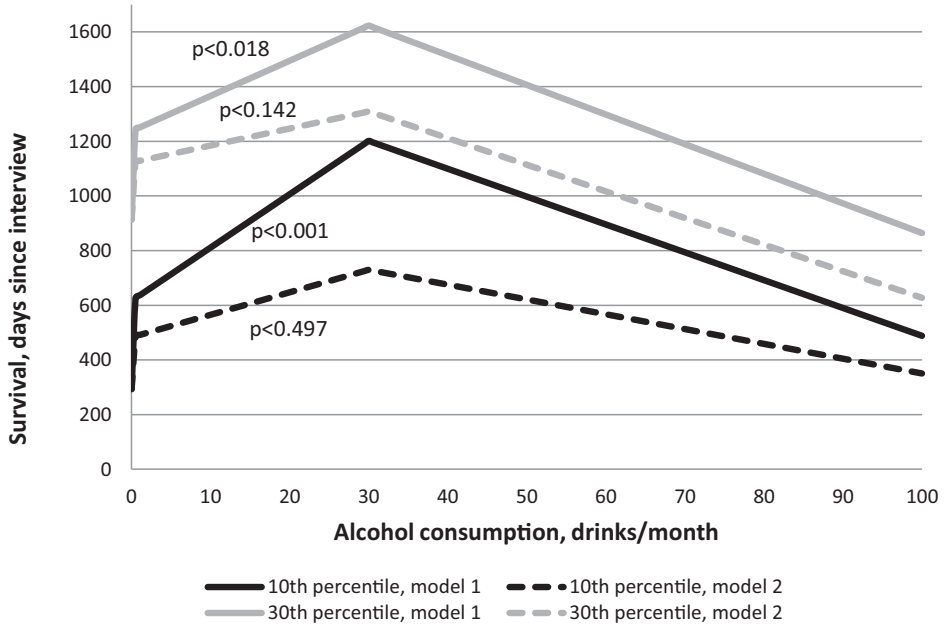

Fig. 1. Association between alcohol consumption (drinks/month) and survival (days) among older Swedes aged 76 and older, 10th and 30th percentiles. Model 1 was adjusted for age and sex, model 2 was additionally adjusted for education, mobility problems, high blood pressure, diabetes, living situation and interview type. *P*-values indicate statistical significance for the alcohol variable as a whole.

0.5 drinks/month, was statistically significant. In Model 2, estimates were lower and no longer statistically significant.

4. Discussion

This study investigated personal and health-related characteristics in three alcohol consumption groups and the association between alcohol consumption and survival in a nationally representative sample of the oldest old. Results suggested that abstainers had lower levels of education and more functional health problems, while heavy drinkers were more often men, had higher levels of education, and no serious health or functional problems. Results also suggested an inversely J-shaped association between alcohol consumption and survival among the oldest old; however, to a large extent, differences in survival time between persons with different alcohol consumption appeared to be due to differences in baseline health, function and other characteristics, and were no longer significant after adjusting for all covariates.

A major strength of this study was the use of nationally representative data with a high response rate. Thereby the risk of studying selected/non-representative local populations or not including older persons with health problems or living in institutions is minimized. High response-rates are particularly important in studies of the oldest old that include health-related outcomes, since non-response is commonly associated with impaired health and function in the older population (Kelfve et al., 2013). The over-sampling of men aged 85–99 and women aged 90–99 further strengthens the reliability of the results. Still, results must be interpreted with caution since the sample size is rather small, measures of alcohol consumption are rather crude and only measured once, and there is no question in the dataset to distinguish between lifetime abstainers and former drinkers. Consequently, the abstainer group is very diverse, with varying levels of health and different reasons for abstention (Marti et al., 2015). In post-hoc analyses, data on alcohol consumption from an earlier time-point (10 years prior to the study baseline) was used for a subsample ($n = 544$) to differentiate between long-term abstainers (crude proxy for lifetime abstainers/never-drinkers) and recent quitters (proxy for former drinkers). Estimates for survival time were lower among both recent quitters and long-term abstainers compared to the drinker group, but the recent quitters had much lower estimates, and differences were statistically significant compared to the drinker group also in the fully adjusted model. This highlights the importance of also considering earlier drinking habits. Larger studies of the oldest old with more detailed and repeated measures of alcohol consumption are needed to further investigate these associations in the older population.

With regard to generalizability, the descriptive results may not be valid for coming cohorts of older adults considering that alcohol habits are changing, and need to be reinvestigated. On the other hand, the association between alcohol consumption and survival should be valid and generalizable also to other populations of the oldest old with similar drinking patterns.

The findings of this study that the association between alcohol consumption and survival among the oldest old (aged 76–101) has an inverse J-shape, with a shift in risk at 30 drinks/month, is in line with previous studies and guidelines for older adults (Bellavia et al., 2014; National Institute on Aging, 2012). Differences in survival time between abstainers and light-to-moderate drinkers, somewhere between six and eleven months depending on the statistical model and percentile, appear to be largely due to health and functional impairments in the abstainer group. These impairments restrict their alcohol consumption – both because of the health problems per se and because of difficulties accessing alcohol due to functional limitations or living arrangements – and they are also associated with reduced survival time. Thus, when evaluating these results one must keep in mind that at very old ages, a certain level of health and function is required for safe alcohol consumption. Consequently, these results should not be interpreted as an indication that older abstainers should start drinking for health reasons.

Previous studies have found that alcohol consumption is increasing in the older population, with weekly drinking increasing the most (Kelfve et al., 2014). This general increase in weekly alcohol consumption may suggest that risky heavy drinking is also likely to increase (Engdahl and Ramstedt, 2011; Flensborg-Madsen

et al., 2007), although there are indications that when consumption frequency increases the usual amount of alcohol consumed is reduced (Brunborg and Osthus, 2015). Findings from Sweden indicate that alcohol-related health problems among people over the age of 60 are increasing – both alcohol-related deaths (Hallgren et al., 2010) and alcohol-related hospitalizations. If this is the case also for those aged over 80 years remains to be investigated.

It was not possible to analyze associations separately for women and men in this study due to the small sample size. It is likely, however, that the personal and health-related characteristics associated with the three consumption categories differ for women and men. Also, while the association between alcohol consumption and survival can be assumed to have the same shape in both women and men, the shift in risk may take place at a lower level among women (Bellavia et al., 2014).

In conclusion, this is one of the first studies of alcohol consumption in very old age and its association with survival, suggesting an inversely J-shaped association that to a large part appears to be explained by impaired health and function. Other studies are needed to investigate changes in alcohol consumption and health over time in order to disentangle the bidirectional association between alcohol and health/survival.

Contributors

All authors have contributed to the conceptualization, analyses, interpretation and writing of this manuscript. All have contributed to the conceptualization and setup of the study. NA and IK have run the analyses. All have been involved in interpreting the results. NA has been in charge of writing and finalizing the manuscript; SK, CL and IK have helped in writing and revising the manuscript. All authors have approved the final version of the manuscript.

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Conflicts of interest

None.

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