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A comparative analysis of different methods for obtaining estimates of alcohol consumption in a Danish population survey

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Aims: The aim of the present study was to compare different measures of alcohol consumption used in a Danish survey. *Methods*: A stratified random sample was extracted from the Civil Registration System. From January 1997 to January 1998 approximately 8 telephone interviews were conducted every day, including Sundays and holidays, ending with a total of 3,050 interviews after 1 year. Two main approaches to measure alcohol consumption were used: the quantity–frequency and the recent occasion approaches; the latter is subdivided into previous week and previous day approaches. *Results*: The overall estimated number of units (= 12 g of pure alcohol) per week was 6.8 (95% confidence intervals (CI): 6.5–7.1), 6.7 (95% CI: 6.4–7.1) and 8.5 (95% CI: 7.8–9.1) for the quantity–frequency, previous week and previous day approaches, respectively. A total of 50% of the men and 70% of the women did not drink alcohol the previous day. Among people classified as high consumers in the previous week and previous day approaches, less than 60% and 30%, respectively, were similarly classified in the quantity–frequency approach. *Conclusion*: There was agreement on the level of alcohol consumption between the quantity–frequency and previous week approaches, but higher estimates when using the previous day approach. The previous day approach varied more in relation to the interview day and season compared with the quantity–frequency approach and the previous week approach. The recent occasions approach showed some difficulties in classifying the individuals. If the alcohol consumption is included in a model as a risk indicator or a confounder, the quantity–frequency approach would be more preferable than the recent occasion approach.

Key words: alcohol drinking, methodology, survey.

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INTRODUCTION

There is considerable interest in evaluating the long-term effect of exposure to alcohol because high alcohol intake has been associated with chronic disease and negative social behaviour (1, 2). It is therefore of interest to estimate the level of alcohol consumption in the population in order to be able to describe and monitor trends in alcohol consumption, and furthermore to identify high-risk populations in order to organize prevention programmes. The estimation of associations between alcohol consumption and different effect measures is based on a quantification of the alcohol intake, but measuring alcohol consumption in population studies is not without problems. The alcohol consumption in surveys often estimates only 40–60% of the sales figure (3). The underestimation probably arises at two levels at least (4–9). Some individuals with excessive alcohol consumption may not participate in surveys, and some of the participants in the survey may, consciously or unconsciously, underestimate their alcohol intake.

Alcohol consumption can be measured in many ways (10). The types of question usually fall into four categories: (a) *Summary measures*, where the respondents are asked about the amount of alcohol they usually drink. This first approach often gives the lowest estimates of alcohol consumption (6, 11). (b) *Recent occasion approach*, where the respondents are asked about their concrete consumption, e.g. within the previous week or previous day. (c) *Quantity–frequency approach*, where the respondents were asked about the usual amount of alcohol they consume on a drinking occasion, and the usual frequency of their drinking occasions; estimated consumption is then quantity times frequency. (d) *Graduated frequency approach*, e.g. how often do the respondents drink one drink, two drinks, etc., the estimate being a summing up of each type of drinking episode (12). The last approach often gives higher estimates but requires many questions (5).

The amount of alcohol consumed in a population is not constant through the week, and probably not

through the different seasons. One might therefore expect the estimated consumption to differ depending on which day in the week or time of year the interview was performed, especially using the recent occasions approach. The aims of the present study were: (a) to compare estimates of alcohol consumption based on the quantity–frequency approach and recent occasion approach; (b) to evaluate whether the estimate of consumption varied in relation to interview day, season, and after holiday periods; (c) to evaluate whether the length of the recall period influenced the estimates of consumption at weekends; and (d) to evaluate the ability of the recent occasion approach to identify individuals with high consumption, using the quantity–frequency approach as a reference standard.

METHODS

All individuals in Denmark (5.3 million) are registered in the Civil Registration System, from which a stratified sample of men and women aged 19–90 years was drawn; an equal number of individuals from each one-year age group and sex were randomly extracted from the registry. All the individuals identified in the initial sample were contacted by telephone. Those people with an ex-directory telephone number and those without a telephone were invited to participate in the study by a letter, in which they were asked to write down a telephone number at which they could be contacted.

From January 1997 to January 1998 approximately eight telephone interviews were performed daily, including Sundays and holidays. We asked two main types of question in order to measure the alcohol consumption. The first type of question used the quantity–frequency approach: *During the past 12 months, approximately how often have you drunk beer?* This

question was followed by: *When you drink beer, approximately how much do you usually drink?* The same questions were asked for wine and spirits. The total amount of alcohol was estimated by multiplying the amount with the frequency and summing up for each beverage type. The interview then switched to the recent occasion approach: *Think back to your alcohol consumption during the past week. Please state for each day of the week, what types of alcoholic beverage you drank and in what quantities.* The interviewer asked about consumption for every day, starting with yesterday and ending with seven days ago.

From the recent occasion approach we estimated the consumption based on the information summed up from the previous week based on the previous day. From all measures the number of units per week were estimated (a unit is defined as 12 g of pure alcohol). The estimates from three measures were analysed: (a) the quantity–frequency approach; (b) the recent occasion approach (previous week); and (c) the recent occasion approach (previous day). The alcohol consumption based on these three measures was stratified according to sex and day of interview. We also stratified according to the time of year when the interview took place to study whether estimates of the mean consumption differed according to season (three months in each season). Furthermore, we looked at estimates obtained one to seven days after a period of national holiday. We studied whether the length of the recall period had any influence on estimates of the mean alcohol consumption for the population, and on estimates of consumption during the previous weekend (Friday, Saturday, and Sunday) using the questions from the previous week approach. Finally, we evaluated the ability of the previous week and the previous day approach to identify respondents

Table I. *Estimates of mean consumption of alcohol per week with three measures expressed in numbers of units per week*

Sex	Type of measurement	No. of people	Units per week[a]	
			Mean (CI[b])	Median
Men	Quantity–frequency approach	1,477	9.4 (8.9–10.0)	6.6
	Recent occasion approach (previous week)	1,496	9.5 (8.8–10.1)	6.0
	Recent occasion approach (previous day)	1,496	11.8 (10.6–13.0)	0.0
Women	Quantity–frequency approach	1,522	4.3 (4.0–4.6)	2.4
	Recent occasion approach (previous week)	1,527	4.1 (3.8–4.4)	2.0
	Previous occasion approach (previous day)	1,527	5.2 (4.7–5.8)	0.0
Total	Quantity–frequency approach	2,999	6.8 (6.5–7.1)	4.2
	Recent occasion approach (previous week)	3,023	6.7 (6.4–7.1)	4.0
	Recent occasion approach (previous day)	3,023	8.5 (7.8–9.1)	0.0

[a]One unit is 12 g of pure alcohol.
[b]CI=95% confidence intervals.

Men

Number of units per week

Women

Number of units per week

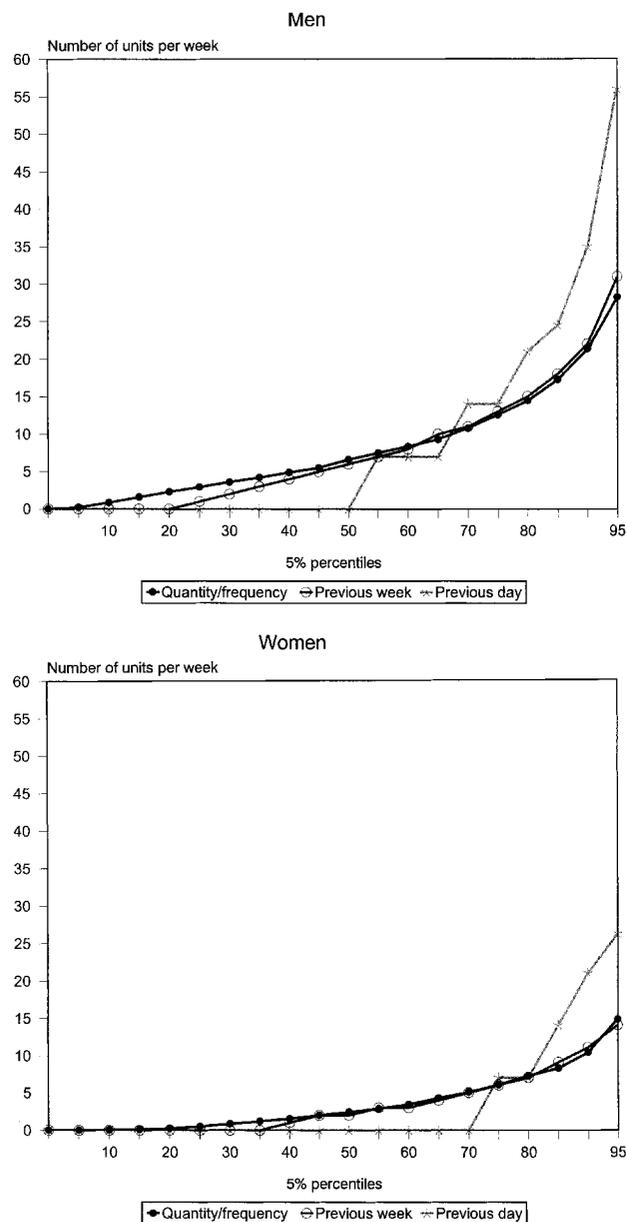*Fig. 1.* Estimates of alcohol consumption per week in three measures, expressed in units per week (percentiles for men and women).
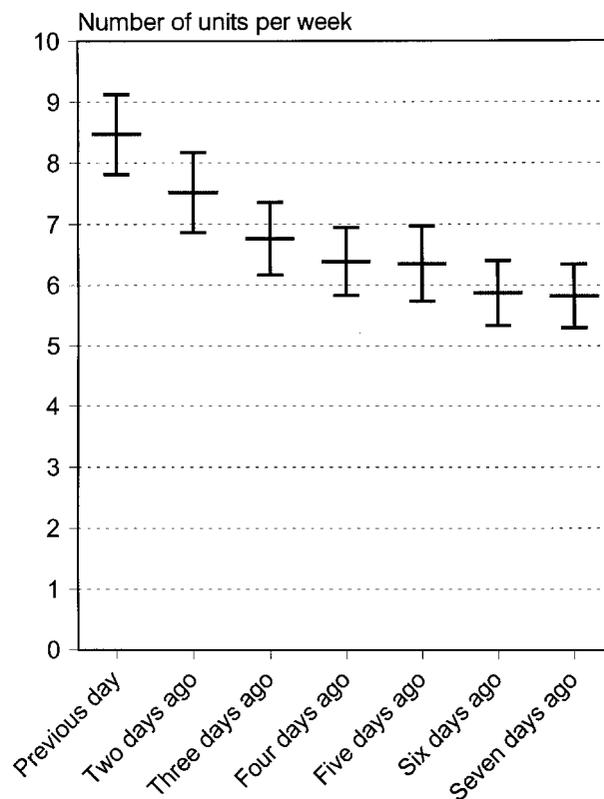
Number of units per week

Fig. 2. Length of recall and estimates of alcohol consumption, expressed in units per week. Estimates based on consumption the previous day, two days ago and up to seven days ago.

with a high consumption using the quantity–frequency approach as a reference standard.

A person was considered to have a high consumption when the alcohol consumed exceeded 21 units of alcohol per week for men and 14 units for women; this is the amount per week that the Danish National Board of Health suggests should be the upper limit of alcohol consumption.

Statistical methods

The sampling procedure resulted in an intentional over-sampling of the older age groups. This was done to improve precision of the estimates in these age groups because the older age groups were expected to have a higher non-response rate and to be a smaller study base due to higher mortality rates. This resulted in an over-representation of the older age groups in the study population. Weights were later applied to obtain the mean results for all age groups (apart from Table V). The weights were constructed so that the weighted sample distributions reflect the known sex and age distribution in the population. A total of 28 different weights were applied (2 categories of sex and 14 age groups). The analyses were performed using SPSS version 8.0 software. Pearson correlation coefficients were calculated for Table V.

RESULTS

A total of 4,413 individuals were extracted from the Civil Registration System. In all, 8% of them could not be contacted by telephone and 23% did not want to participate; the 3,050 who were interviewed represent a response rate of 69%. As expected the response rate was particularly low in the oldest age group, i.e. among people over 80 years old (46%).

Table II. *Estimates of mean consumption of alcohol per week, stratified by interview day and season*

Time of interview	Quantity–frequency approach			Recent occasion approach (previous week)			Recent occasion approach (previous day)		
	No. of people	Units per week[a]		No. of people	Units per week[a]		No. of people	Units per week[a]	
		Mean	CI[b]		Mean	CI[b]		Mean	CI[b]
Day of interview									
Monday	432	7.4	6.4–8.3	434	7.4	6.5–8.2	434	7.5	6.2–8.7
Tuesday	443	6.6	5.8–7.3	442	6.1	5.3–7.0	442	5.0	3.5–6.4
Wednesday	435	6.4	5.7–7.1	435	6.6	5.7–7.6	435	5.0	4.0–6.0
Thursday	431	7.1	6.3–8.0	437	6.4	5.6–7.2	437	6.5	5.2–7.9
Friday	422	6.5	5.7–7.3	430	6.6	5.6–7.5	430	6.6	5.2–8.0
Saturday	420	6.8	5.9–7.6	424	7.1	5.9–8.3	424	12.4	10.2–14.6
Sunday	416	7.0	5.9–8.1	421	7.0	6.0–8.0	421	16.3	13.7–18.9
Season[c]									
Winter	682	6.5	5.9–7.1	685	6.3	5.6–6.9	685	7.5	6.2–8.8
Spring	723	6.3	5.6–6.9	736	6.4	5.8–7.1	736	8.2	6.9–9.3
Summer	705	7.1	6.5–7.8	706	7.9	7.0–8.7	706	10.6	8.9–12.3
Autumn	889	7.3	6.6–8.0	896	6.4	5.9–7.1	896	7.7	6.7–8.8
Total	2,999	6.8	6.5–7.1	3,023	6.7	6.4–7.1	3,023	8.5	7.8–9.1

[a]One unit is 12 g of pure alcohol.
[b]CI=95% confidence intervals.
[c]Winter: December, January, February; spring: March, April, May; summer: June, July, August; autumn: September, October, November.

Table III. *Estimates of mean consumption of alcohol per week, when interviewing one to seven days after a period of non-working days*

Interview performed after non-working days[a]	Quantity–frequency approach			Recent occasion approach (previous week)			Recent occasion approach (previous day)		
	No. of people	Units per week[b]		No. of people	Units per week[b]		No. of people	Units per week[b]	
		Mean	CI[c]		Mean	CI[c]		Mean	CI[c]
Yes	280	6.1	5.3–7.0	282	7.2	6.0–8.3	282	7.5	5.7–9.3
No	2,719	6.9	6.5–7.2	2,741	6.7	6.3–7.1	2,741	8.6	7.9–9.3
Total	2,999	6.8	6.5–7.1	3,023	6.7	6.4–7.1	3,023	8.5	7.8–9.1

[a]Included Easter, Ascension Day, a national holiday, Whitsun, and Christmas/New Year.
[b]One unit is 12 g of pure alcohol.
[c]CI=95% confidence intervals.

The mean consumption of alcohol in all three estimates was higher for men (Table I). The quantity–frequency (QF) approach and the previous week (PW) approach gave similar results; the previous day (PD) approach gave higher estimates for both sexes, but also more imprecise estimates with a larger confidence interval than for the two other estimates. The medians in PD were zero, meaning that fewer than 50% of the participants in this survey drank alcohol the previous day. Figure 1 shows the percentile for the estimates of alcohol units per week in the three different measures for both sexes. The curves for the QF and the PW approach were quite close, having a median (=50%

percentile) at the same level. The curves for PD had a different shape. In all, 50% of the men and 70% of the women did not drink alcohol the previous day, so the curves show the distribution of alcohol consumption among the remaining 50% and 30% of the individuals interviewed. However, the mean estimates shown in Table I did not differ much since the areas under the three curves in Figure 1 are of equal size despite the differences in shape.

When stratifying for the day of the week on which the interview was performed, the estimated consumption was relative stable in the QF and PW approaches; using the PD approach, the highest mean estimates

related to Saturdays and Sundays, and the lowest on Tuesdays (Table II). When stratifying for season, the consumption was most stable in the QF approach and least stable in the PD approach, where we found the highest mean estimate when the interview had been performed during the summer. The PW approach was in between, but closer to the QF than the PD approach.

With respect to interviews after a period of non-working days, there was a tendency to lower estimates when using the QF and PD approaches and higher estimates for PW when the interview took place up to seven days after such a period (Table III). To some extent, the previous week included consumption during non-working days.

After stratifying for the day of interview, the mean estimate of consumption on the previous weekend was highest when Monday was the interview day; estimates from all the other days were at the same level (Table IV). The absolute difference from Monday to Friday was 1.1 units. Figure 2 gives the estimates of alcohol consumption as a function of length of recall.

Table IV. *Mean consumption during previous weekend (units of alcohol), stratified for interview day, based on the previous week approach*

| Interview day | No. of people | Alcohol consumption: previous weekend (in units[a] of alcohol) | |
		Mean	CI[b]
Monday	434	5.0	4.5–5.6
Tuesday	442	4.0	3.4–4.5
Wednesday	435	4.1	3.6–4.7
Thursday	437	3.9	3.4–4.5
Friday	430	3.9	3.3–4.5

[a]One unit is 12 g of pure alcohol.
[b]CI = 95% confidence intervals.

The longer the recall period, the lower the estimate. The correlation was not linear since the change was particularly high from the previous day to two days before, and from two to three days before.

Figure 3 compares consumption the previous day with consumption during the previous two days and
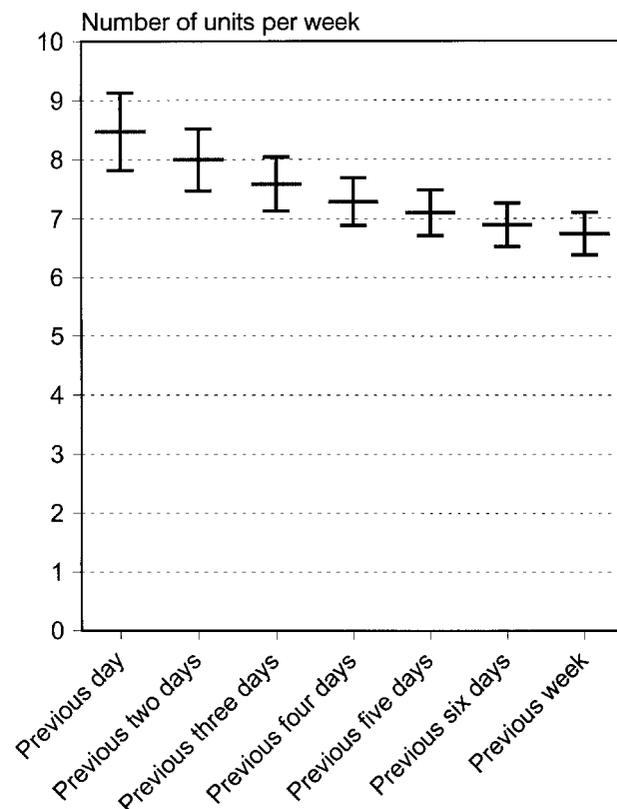

Fig. 3. Length of recall and estimates of alcohol consumption, expressed in units per week. Estimates based on consumption the previous day, the previous two days and ending up with the previous seven days.

Table V. *Agreement in identifying high-level consumers (defined as having more than 14 units[a] of alcohol per week for women and 21 per week for men), comparing the previous week and previous day approaches with the quantity–frequency approach*

| Sex | Type of approach | Consumption categorized as | The quantity–frequency approach: consumption categorized as | | Correlation coefficient[b] |
			Low	High	
Men	Previous week approach	Low	1,263	69	
		High	67	76	0.48
	Previous day approach	Low	1,184	83	
		High	146	62	0.27
Women	Previous week approach	Low	1,394	52	
		High	28	41	0.49
	Previous day approach	Low	1,306	51	
		High	116	42	0.29

[a]One unit is 12 g of pure alcohol.
[b]All correlations significant at the 0.01 level.

three days up to the PW approach. Increasing the number of days in the estimate and thereby increasing the length of recall reduced the estimate and narrowed the confidence interval. The change in estimates was not constant during the recall period of a week as Figure 2 also showed.

Table V shows that, among the individuals who were classified as high consumers by the PW approach, more than 40% were classified as low consumers by the QF approach. Of the PD high consumers, only 30% were similarly classed by QF. Only about 20% of those classified as having a high consumption in either QF or PD were classified in the high-consumption group in both.

DISCUSSION

The study compared three ways of measuring alcohol consumption; there was agreement on the level of alcohol consumption between the QF and PW approaches, but there were higher estimates when using the PD approach. The PD approach showed variations in relation to the interview day and season in contrast to the QF and PW approaches. This indicates that a comparison of drinking levels from different surveys can only be meaningful when the questionnaire or interview guide questions are exactly the same.

Our finding that the highest estimates of alcohol consumption were in the PD approach contrasts with that of a previous Danish study (13), perhaps because that study never performed interviews on Sundays and seldom on Saturdays. Our finding of similar QF and PD estimates contrasts with another study (14). However, the results are not directly comparable since that study was not based on beverage-specific questions.

Larger estimates are not necessarily more correct (5), although our results indicate that the recall period might be too long when asking about a whole week ago. A recent Swedish study showed that the recall was reliable for only two or three days (15). However, a short recall period has the disadvantage that it cannot document any individual variability within one week (15). The PD approach depended more than the other approaches on the interview day and season, making it more difficult to compare results from different surveys even with the same type of questions. Furthermore, PD can only be used in a population that drinks regularly. Even in Denmark, where there is a relatively high percentage of regular drinkers compared with the other Scandinavian countries, 50% of the men and 70% of the women reported that they did not drink alcohol the previous day and the PD estimate of alcohol consumption for the whole population was based on those 50% men and 30% women who actually drank alcohol on the previous day. It is impossible to use the PD approach to identify a group with low consumption

because the lowest possible estimate of consumption per week, apart from no alcohol intake at all, is 7 units, or perhaps 3.5 units, corresponding to 1 unit, or half a unit, respectively, the previous day.

All consumption measures showed variation in estimates during the seasons, most distinctly for the PD approaches, but the PW approach also gave significantly higher estimates in the summertime. Still, it was closer than one might expect to the QF approach compared with the PD approach if the increase in the PD estimate in the summertine solely was due to an increase in consumption. However, it cannot be excluded that drinking habits change throughout the year.

Consumption measures should always be chosen carefully, and should correspond to the aim of the study since the different types of question have different qualities (7). The present study showed the difficulties in identifying respondents with a high consumption of alcohol (Table V). The QF, PW, and PD approaches did not identify the same individuals as having a high consumption. In fact, 70% of the high PD consumers were classed as low QF consumers. A non-differential misclassification on exposure usually biases the results towards the null value, but if the misclassification is severe enough it can completely obliterate an association (16). Therefore, if the purpose is to use alcohol consumption as a risk indicator or a confounder in a multivariate model, or to find a dose–response relationship, the PD and PW approaches might not be appropriate.

In the QF approach, consumers might underestimate their own alcohol consumption since it is based on usual consumption of alcohol. This problem is probably reduced in the PD approach and, to a lesser extent, the PW approach. The results of the three approaches did not differ very much, indicating that the failure of surveys to cover more than about 50% of the sales figures mostly is due to selection bias.

In summary, we found that, of the three approaches, QF was the most stable and PD the least stable in relation to interview day and season. However, surveys using the same sampling technique and questionnaire performed at the same time of the year can still be useful in estimating changes in drinking habits over time because the proportion of non-responders is expected to be similar each time.

ACKNOWLEDGEMENTS

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