

# Screening for high-risk and elevated alcohol consumption in day and shift workers by use of the AUDIT and CDT

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<b>Background</b>	Alcohol consumption levels and drinking patterns have been reported to vary between day and shift workers, although the results have been conflicting. Previous results indicate that questions about alcohol habits may be asked in the workplace. However, no studies have evaluated the Alcohol Use Disorders Identification Test (AUDIT) or the alcohol biomarker carbohydrate-deficient transferrin (CDT) in serum for this purpose.
<b>Aim</b>	To investigate, in conjunction with routine health examinations, whether there is any difference between permanent day and shift workers in high-risk alcohol consumption, according to the AUDIT and CDT. Gamma-glutamyl transferase (GGT) in serum was included mainly as a comparison test.
<b>Methods</b>	The employees who attended for a regular health examination during the study period were offered voluntary alcohol screening with the AUDIT and CDT.
<b>Results</b>	Altogether, 990 employees (day, two-shift, and three-shift workers) participated in the study, 194 (20%) of whom screened positive with the AUDIT and/or CDT. There were no significant differences in the screening results between day and shift workers, whereas significantly fewer of the two-shift workers (odds ratio = 0.5, 95% confidence interval = 0.3–0.9) screened positive with CDT.
<b>Conclusions</b>	The present findings on employees who attended for regular health examinations suggest that shift workers did not show a higher level of risky alcohol consumption than day workers, according to the results with the AUDIT, CDT and GGT. On the contrary, the two-shift workers appeared to drink significantly less.
<b>Key words</b>	AUDIT; CDT; GGT; shift work; work schedules.
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## Introduction

There are several reasons for workplaces to focus on problems related to alcohol use and abuse, such as the associated risk of accidents leading to injury, the risks of increased poor-health and absenteeism, and negative effects on the working atmosphere, which may all lead to increased costs for both employers and employees [1–6]. In the USA, Canada and New Zealand, for example, the overall costs for reduced productivity and lost employment due to alcohol were estimated to be very high [7–11]. Accordingly, a number of studies have

indicated that workplaces should develop methods aimed at early identification and rehabilitation of those employees who have, or are at risk for, alcohol-related problems [4,12–15].

Alcohol consumption levels and drinking patterns seem to vary between different industries and workplaces [16,17], and there may be differences in alcohol use between different work environments within the same branch of industry [15]. Alcohol habits also appear to vary between day workers and shift workers, although the results have been conflicting [18]. Shift workers have reported higher levels of alcohol consumption, frequency of heavy drinking, and proportion of alcohol-related problems [19–21]. According to Webb *et al.* [22], shift work is a predictor of high-risk drinking, and in particular, those who also have sleeping problems seem to report a higher alcohol consumption level [23,24]. However, other studies observed no significant difference in alcohol problems or consumption levels between day and shift workers [24–28], and some have reported lower levels of alcohol consumption in shift workers [22,29,30].

Previous results indicate that questions about alcohol habits may be asked in the workplace, if this is done in conjunction with other health-related questions [31,32]. It is also acceptable to offer alcohol screening using laboratory markers (blood tests), in combination with questionnaires (self-reports), in conjunction with regular health examinations [33]. However, in most studies on alcohol and shift work, the alcohol consumption data have been self-reported and typically added to questions on other lifestyle issues such as smoking, diet and exercise [18].

The Alcohol Use Disorders Identification Test (AUDIT) [34], an alcohol-screening questionnaire, and carbohydrate-deficient transferrin (CDT) in serum, a laboratory test, are both fairly new instruments that may be used for detecting elevated, risky levels of alcohol consumption [35]. The AUDIT and CDT have been demonstrated to be useful as complementary screening tools for alcohol in health examinations in the workplace, because they appear to identify partly different segments of the high-risk drinking population [33]. The CDT test has shown high specificity in selected groups with alcohol problems [36,37], and it was also found to have greater discriminatory power than gamma-glutamyl transferase (GGT), a conventional liver function test, for identifying lower levels of alcohol consumption in an unselected population [38]. The AUDIT has shown high sensitivity and specificity in screening for alcohol problems [39], and proven effective for identifying elevated levels of alcohol consumption in working life [40].

In a search using MEDLINE and PsycINFO with keywords and MeSH headings related to alcohol and shift work, we found no studies that had used the AUDIT or CDT, and only one study that involved GGT [26].

The present study aimed to investigate, among those employees who attended for a regular health examination, whether there is any difference in alcohol screening results between permanent day workers and two-shift or three-shift workers. The alcohol screening was performed with the AUDIT and CDT, and GGT was also included for comparison.

## Method

### Selection of participants

This work formed part of an ongoing controlled study aimed at assessing the effects of brief alcohol interventions in the workplace. It was carried out over 36 months (between February 1997 and January 2000) at the company health service of a large Swedish workplace in the transport sector. Once every 3 years at a maximum, the employees are scheduled by the company departments for a routine health examination. The examination is carried out during normal working hours (daytime or shiftwork) and comprises a survey of health behaviour and working environment as well as a medical investigation.

### Alcohol screening

The alcohol screening consisted of self-reporting, using the AUDIT questionnaire (Appendix 1), and a blood sample for determination of CDT in serum. GGT in serum was also measured, but mainly for comparison with the AUDIT and CDT. All employees received written information about the study in advance, and those who attended for a health examination during the study period were also asked individually upon arrival to the company health service whether they had read the letter and were willing to participate. The local ethics committee approved the study.

### Subjects and work schedules

The company has four main types of work schedule: day work, two-shift work, three-shift work and night work. In all shiftwork schedules, a certain amount of individual flexibility is permitted with regard to starting and finishing times (see Appendix 2). In our analyses, we grouped the work schedules into three categories: day work, two-shift work and three-shift work, which also included night work. The rationale for combining three-shift and night workers is that both have schedules that include night work, and they also have fewer working hours per week than the day and two-shift workers.

Those employees who attended for a routine health examination during the study period were also offered the opportunity to undergo a voluntary alcohol screening. Accordingly, far from all employees had the opportunity

to take part in the study. A total of 990 employees (677 men and 313 women), representing ~15% of all employees at the workplace (the mean number of all employees during the study period was 6487), agreed to participate in the study. About 40% (*n* = 399) of the participants were on a regular daytime schedule, 30% (*n* = 294) were two-shift workers and 30% (*n* = 297) three-shift workers (Table 1). Most of the three-shift workers were men (96%), whereas the day and two-shift workers were more evenly distributed with respect to gender (57 and 55% men, respectively).

The average age of the participants was 43.2 ± 9.6 years (mean ± SD), with a range of 20–64 years. The average age of the day workers was 43.9 ± 9.6 years (range = 21–64 years), while that of the two-shift workers was 42.6 ± 10.0 years (range = 21–63 years) and that of the three-shift workers 42.8 ± 9.1 years (range = 20–64 years).

The AUDIT and CDT tests

The AUDIT questionnaire (Appendix 1) consists of 10 questions, each of which can give a maximum of four points (i.e. the total score range is 0–40 points). The questions can be subgrouped into three categories: alcohol (risk) consumption (nos 1–3), drinking behaviour or dependence (nos 4–6) and alcohol-related problems (nos 7–10). We adopted the conventional cut-off level of ≥8 points for the AUDIT, as this has been demonstrated

**Table 1.** The distribution (%) of work schedules in relation to sex, age and occupational status, and the results of the alcohol screening instruments (the AUDIT and CDT) and the comparison instrument (GGT)

	Relative distribution (%)		
	Day work ( <i>n</i> = 399)	Two-shift work ( <i>n</i> = 294)	Three-shift work ( <i>n</i> = 297)
Sex			
Male	57.4	55.4	96.0
Female	42.6	44.6	4.0
Age			
<35 years	18.0	24.1	21.9
35–49 years	51.1	45.2	51.5
50–64 years	30.8	30.6	26.6
Occupational status			
Manual	17.8	38.1	83.2
Non-manual	82.2	61.9	16.8
The AUDIT			
Negative	91.2	88.4	88.9
Positive	8.8	11.6	11.1
CDT			
Negative	87.2	93.2	87.2
Positive	12.8	6.8	12.8
GGT			
Negative	93.2	98.6	92.6
Positive	6.8	4.4	7.4

to give a satisfactory degree of sensitivity and specificity in unselected populations [39]. CDT was determined by a commercial assay (CDTect RIA; produced by Pharmacia Diagnostics, Uppsala, Sweden or Axis-Shield ASA, Oslo, Norway), which measures CDT in absolute amounts (in units/l, with 1 unit equivalent to 1 mg of transferrin). The intra- and interassay imprecision (CV) of the CDTect method is <10% [41]. The cut-off levels for CDT of <20 U/l for men and <27 U/l for women were those recommended by the manufacturer of the test. For GGT, the cut-off values of <1.3 µkat/l for men and <0.8 µkat/l for women (1 µkat = 60 units) in routine clinical use were applied. The screening result was considered positive if it exceeded the cut-off level of either or both of the AUDIT and CDT.

Weekly alcohol consumption

The weekly alcohol consumption was estimated from the first two questions in the AUDIT, using the same calculation method as Seppä *et al.* [40]. Accordingly, question 1, ‘How often do you have a drink containing alcohol?’, was scored as follows: ‘never’ = 0; ‘monthly or less’ = 0.25; ‘two to four times a month’ = 1; ‘two to three times a week’ = 3; and ‘four or more times a week’ = 5. Question 2, ‘How many drinks containing alcohol do you have on a typical day when you are drinking?’, was scored in grams of pure alcohol as follows: ‘1 or 2’ = 20 g; ‘3 or 4’ = 40 g; ‘5 or 6’ = 70 g; ‘7 to 9’ = 100 g; and ‘10 or more’ = 120 g. We also used ≥110 g alcohol per week for male and ≥80 g for female subjects as a cut-off for ‘some risk to considerable risk’ according to Rydberg *et al.* [42].

Statistics

Odds ratios (OR) were estimated through multiple logistic regression models with adjustment for age group, sex, work schedule (day, two-shift and three-shift work) and work status (manual and non-manual work). Three different logistic regression models were used with the AUDIT, CDT and GGT, respectively, as outcome variables. Odds ratios with 95% confidence intervals (95% CI) are reported together with *P*-values for log likelihood ratio test. The logistic procedure in the SAS software package was used.

Results

Alcohol screening results

Of the 990 persons who participated in the study, the proportion that screened positive with one or both of the AUDIT and CDT was 19.6% (*n* = 194) (Table 1). If GGT was added to the screening instruments, the proportion of positive results increased to 23.9% (*n* = 237). The correlation between the AUDIT and

CDT was low, both for men ( $r = 0.15$ ) and women ( $r = 0.20$ ), and GGT also showed very poor correlation with the AUDIT (men,  $r = 0.11$ ; women,  $r = 0.09$ ) and CDT (men,  $r = 0.02$ ; women,  $r = -0.09$ ).

The proportion of positive results with either or both screening instruments (the AUDIT and/or CDT) was 19.5% for day workers, 17.0% for two-shift workers and 22.2% for three-shift workers. In the multiple logistic regression models, there was no significant difference in positive screening results between day workers (reference) and all shift workers ( $P = 0.71$ ), or with the two-shift (OR = 0.8, 95% CI = 0.6–1.3) and three-shift workers (OR = 0.9, 95% CI = 0.6–1.5) separately. When using <35 years as the reference age group, no significant differences emerged between those aged 35–49 years (OR = 1.3, 95% CI = 0.8–1.9) or 50–64 years (OR = 1.2, 95% CI = 0.7–1.9). Moreover, manual workers showed no difference in screening results compared with non-manual workers (OR = 1.1, 95% CI = 0.7–1.6).

### The different screening tests

When the AUDIT and CDT results were evaluated separately, the results from the multiple logistic regression models indicated a significantly lower risk for screening positive with CDT for the two-shift workers compared with day workers (Table 2). Furthermore, there were significantly fewer positive results with the AUDIT for women. The screening results for GGT showed an increasing trend with age.

Using the calculation of weekly alcohol consumption according to the method by Seppä *et al.* [40], and

applying the cut-offs of  $\geq 110$  g alcohol per week for males and  $\geq 80$  g for females as indications of 'some risk to considerable risk' [42], there were no significant differences between day workers (reference) compared with two-shift (OR = 0.9, 95% CI = 0.5–1.7) or three-shift workers (OR = 1.0, 95% CI = 0.6–1.6).

### Work schedule and positive screening results

A selection was made from the 194 individuals who screened positive with the AUDIT and/or CDT in that every second individual was chosen consecutively according to date of birth. Of those selected in this way (40 day workers, 25 two-shift workers and 33 three-shift workers), 85% of the day workers, 80% of the two-shift workers and 91% of the three-shift workers had at least 1 year of experience with their present working hours. The corresponding figures for a minimum of 5 years' experience with current work hours were 65% of the day workers, 68% of the two-shift workers and 70% of the three-shift workers.

### Discussion

The purpose of this workplace study was to investigate whether there were any differences in alcohol drinking habits between permanent day workers, two-shift workers and three-shift workers. The study population included those employees who were scheduled for a regular health examination during the study period. The alcohol screening was based on the AUDIT questionnaire and CDT

**Table 2.** Distribution of positive results with the different alcohol tests (the AUDIT, CDT, and GGT) and the results of logistic regression analyses (ORs and 95% CI) in relation to sex, age, work status and work schedule

	<i>n</i>	Positive results (%)			Odds ratio (95% CI)		
		AUDIT	CDT	GGT	AUDIT	CDT	GGT
Sex							
Male	677	12.5	11.5	6.5	1 (reference)	1 (reference)	1 (reference)
Female	313	5.4	9.9	5.8	0.4 (0.2–0.8) $P = 0.009^*$	0.9 (0.5–1.5) $P = 0.61$	0.9 (0.5–1.8) $P = 0.81$
Age							
<35 years	208	7.8	5.7	3.2	1 (reference)	1 (reference)	1 (reference)
35–49 years	490	11.0	12.2	5.7	1.1 (0.7–1.9)	1.6 (0.9–2.8)	1.3 (0.6–2.8)
50–64 years	292	8.9	11.3	8.6	0.9 (0.5–1.6) $P = 0.67$	1.5 (0.8–2.8) $P = 0.27$	2.0 (0.9–4.4) $P = 0.15$
Work status							
Non-manual	560	7.9	11.3	6.4	1 (reference)	1 (reference)	1 (reference)
Manual	430	13.5	10.7	6.0	1.4 (0.8–2.4) $P = 0.22$	0.9 (0.5–1.5) $P = 0.59$	0.8 (0.4–1.7) $P = 0.64$
Work schedule							
Daytime	399	8.8	12.8	6.8	1 (reference)	1 (reference)	1 (reference)
Two-shift	294	11.6	6.8	4.4	1.3 (0.8–2.1)	0.5 (0.3–0.9)	1.2 (0.6–2.5)
Three-shift	297	11.1	12.8	7.4	0.8 (0.5–1.4) $P = 0.36$	1.1 (0.6–1.9) $P = 0.03^*$	0.7 (0.3–1.3) $P = 0.27$

\*Significant difference.



in serum, whereas GGT in serum was included for comparison.

Our data showed no marked differences between day and shift workers in positive results with the AUDIT (cut-off  $\geq 8$  points), and, in agreement with previous results [26], GGT values. However, in comparison with the day and three-shift workers, significantly fewer of the two-shift workers showed elevated CDT values. The disagreement in alcohol screening results between the AUDIT and CDT may be explained by the difference in time period covered by the tests. The AUDIT is intended to capture any high-risk consumption over the past 12 months, as well as lifetime experience with alcohol [34]. An elevated CDT value, on the other hand, provides an objective measure of whether a person has been drinking heavily (at least 50–80 g alcohol per day or more on average) during the past 2–4 weeks [36,37]. Also in previous studies, the AUDIT and CDT have been indicated to identify partly different segments of the high-risk drinking population [33].

What is the reason behind the lower intake of alcohol according to CDT observed in two-shift workers compared with day and three-shift workers? One might speculate that the work schedule as such could impact on drinking behaviours, as it is well known that shift work has a huge impact on social life [43]. Two-shift work schedules that include morning and evening shifts sometimes lead to more pronounced impact on social life than rotating three-shift schedules [44]. Common social activities, like visiting friends and relatives, or going to restaurants and pubs, tend to occur in the evenings and during weekends. However, two-shift workers are often prevented from attending such activities due to work schedules. When work starts early in the morning, any high alcohol intake during the previous night might be voluntarily limited in order to be fit for work. In a recent study of alcohol consumption habits in countries including Sweden, Germany and the UK, it was demonstrated that drinking mainly takes place in conjunction with an evening or late afternoon meal [45]. In addition, especially in the northern parts of Europe, high alcohol intake seems to be concentrated on weekends, which may be linked to the common 5 day working schedule [46]. In Sweden, ~60% of all alcohol is sold on Thursdays and Fridays [47].

In shift studies that also include alcohol-drinking habits, the consumption level is commonly quantified in grams of pure alcohol (ethanol) per day [27–29]. Other measures include average weekly consumption in units of alcohol [48] or specific cut-off values for risk consumption [19,49]. In the present study, we calculated an approximate weekly alcohol consumption level based on the first two questions in the AUDIT questionnaire. Using the cut-off values of  $\geq 110$  g/week for males and  $\geq 80$  g/week for females, indicating some to considerable

risk [42], we observed no difference between day and shift workers.

One limitation of the present study is that we had no control over how many, or which, individuals had the opportunity to take part in the alcohol screening but declined to do so. However, in a recent very similar workplace study by Hermansson *et al.* [31], only 2% of those who were offered a voluntary alcohol screening chose not to participate, and the company nurses who carried out the screening in the present study reported verbally (data not recorded) that only ‘a few employees’ had declined to take part in the alcohol screening. Nonetheless, certain selection factors may have been operating. For example, since the alcohol screening was voluntary, this may have encouraged mainly those with a low or zero alcohol consumption to attend. However, there are many factors indicating that alcohol screening should be voluntary and form part of a routine health check [35]. It should also be noted that the setting is of major importance to minimize response bias in self-reported data on alcohol intake [50], as is the fact that the respondent should experience no negative consequences from giving an honest response [51]. Actually, the basic precondition of the study was to emphasize and demonstrate to the employees that the alcohol screening offered an opportunity to check their drinking habits within a health-maintenance perspective. The screening was not a surveillance serving the interests of the employer, but was based on voluntary participation.

About 80% of the individuals who screened positive had a minimum of 1 year’s experience and ~65% had a minimum of 5 years’ experience with their current working hours. Unfortunately, corresponding data for the employees who screened negative were lacking, which is another weakness of the study.

There are a number of reasons to motivate the inclusion of data on alcohol drinking habits in studies of employees with irregular working hours. These include the fact that shift work appears to be related to gastrointestinal and cardiovascular disease [18], as are also elevated levels of alcohol consumption [52]. A significant proportion of shift workers are also affected by sleep malfunctions [53] and, consequently, they are at higher risk for accidents, especially in the transport sector [54]. High levels of alcohol consumption have also been reported in conjunction with sleep problems [23,24], and there is a direct correlation between the degree to which a person is under the influence of alcohol and the risk of accidents [55].

## Conclusion

Among employees participating in a routine health examination, the results with the AUDIT, CDT and GGT did not indicate that shift workers drink more

alcohol than permanent day workers. On the contrary, according to the CDT values, the two-shift workers were found to drink significantly less. To increase the knowledge of possible relationships between alcohol drinking habits and shift work, additional research with respect to elevated, risky levels of consumption is needed. To facilitate comparison between different studies, any future studies should preferably include validated alcohol screening questionnaires, such as the AUDIT, as well as specific and objective alcohol markers, such as CDT.

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## Appendix 1. The AUDIT Questionnaire

## The AUDIT Questionnaire

## Appendix I

1. How often do you have a drink containing alcohol?  
☐ Never      ☐ Monthly or less      ☐ 2-4 times/month      ☐ 2-3 times/week      ☐ 4 + times/week
2. How many drinks containing alcohol do you have on a typical day when you are drinking?  
☐ 1 or 2      ☐ 3 or 4      ☐ 5 or 6      ☐ 7 or 9      ☐ 10 or more
3. How often do you have six or more drinks on one occasion?  
☐ Never      ☐ Less than monthly      ☐ Monthly      ☐ Weekly      ☐ Daily or almost daily
4. How often during the last year have you found that you were not able to stop drinking once you had started?  
☐ Never      ☐ Less than monthly      ☐ Monthly      ☐ Weekly      ☐ Daily or almost daily
5. How often during the last year have you failed to do what was normally expected of you because of drinking?  
☐ Never      ☐ Less than monthly      ☐ Monthly      ☐ Weekly      ☐ Daily or almost daily
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?  
☐ Never      ☐ Less than monthly      ☐ Monthly      ☐ Weekly      ☐ Daily or almost daily
7. How often during the last year have you had a feeling of guilt or remorse after drinking?  
☐ Never      ☐ Less than monthly      ☐ Monthly      ☐ Weekly      ☐ Daily or almost daily
8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?  
☐ Never      ☐ Less than monthly      ☐ Monthly      ☐ Weekly      ☐ Daily or almost daily
9. Have you or someone else been injured as a result of your drinking?  
☐ No      ☐ Yes, but not in the last year      ☐ Yes, during the last year
10. Has a relative, friend, doctor, or other health worker been concerned about your drinking or suggested that you should cut down?  
☐ No      ☐ Yes, but not in the last year      ☐ Yes, during the last year

Procedure for Scoring AUDIT: Questions 1-8 are scored 0, 1, 2, 3, or 4. Questions 9 and 10 are scored 0, 2 or 4 only. The minimum score (for non-drinkers) is 0 and the maximum possible score is 40.

In determining the response categories it has been assumed that one "drink" contains 12 g ( $\pm 25\%$ ) (Bergman and Källmen, 2002)



## Appendix 2

### Day work

Day work is scheduled between 07.00–18.00 h, with 40 working hours per week.

### Two-shift

The two-shift work includes morning and afternoon shifts and is scheduled between 04.00 h (usually 06.00 h) and 24.00 h. There are four different two-shift schedules with an average 38 h worked per week. In the first schedule, the morning shift starts between 05.30 and 06.00 h, and finishes around 14.00 h, and the evening shift starts between 11.00 and 15.00 h, and finishes between 22.00 and 24.00 h. In the second schedule, which is rostered mainly during weekends (three or four weekends out of five) but also includes working hours on Mondays, Thursdays and Fridays, the morning shift starts between 04.00 and 05.00 h, and finishes around 14.00 h. The afternoon shift starts between 11.00 and 12.00 h, and finishes around 21.00 h. The third two-shift schedule supports external customers, and covers a 4 week rotating roster that includes two out of four weekends. The length of each shift varies between 10 and 12 h. The morning shift can start already at 05.00 h, and

the afternoon shift usually finishes around midnight. Finally, there is a fourth two-shift schedule with 12 h shifts, where the day shift lasts from 06.30 to 18.30 h and the night shift runs from 19.00 to 06.00 h, and includes two out of five weekends.

### Three-shift

Two three-shift schedules with an average 35 h worked per week are used. The first schedule is a 5 week rotating roster with 8 h shifts starting at 06.30, 14.30 and 21.30 h. During weekends there are also 12 h shifts that start at 06.30 and 18.30 h. This schedule includes two out of five weekends. The second three-shift schedules start at 06.42, 14.42 and 22.42 h, and finish at 15.00, 23.00 and 07.00 h, respectively. It includes two out of five weekends, and the average shift time is 8 h 18 min.

### Night work

The night work schedule starts at 19.00 h and finishes at 07.00 h. Employees work two consecutive nights, and three consecutive nights during weekends. Every ninth week, three consecutive day shifts are included, which start at 07.00 h and finish at 19.00 h. The average work time is 30 h per week.