Alcohol-related Problems and Sick Leave.

Do Attitudes towards Drinking matter?

by

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Stavanger, February 2022

Neda S. Hashemi

Summary

Background: Drinking alcohol is integrated into people's social- and work lives. Drinking attitudes and norms stand out as significant predictors of drinking alcohol but few studies have been focused on working populations. Existing norms and attitudes toward alcohol, nature of work, sociocultural context, and workplace culture can form different drinking patterns and subsequently lead to a range of consequences for the individual who drinks, surroundings people, and society as a whole. Earlier studies have revealed that drinking alcohol increases the risk of sick leave among employees. However, there is a lack in exploring subgroups including measurement groupings and type of data. Moreover, the majority of prior studies focused on individual determinants and had less attention on group-level determinants. To better understand the relationship between alcohol behavior and sick leave, there is a need to explore the determinants at both the individual and group levels while considering employees within their work units and organizations.

Aims: The overall aim of this thesis was to obtain new knowledge and a deeper understanding of the relationships between alcohol consumption and sick leave (Papers I and III), and how drinking attitudes might have a role in this relationship (Papers II and III).

Materials and methods: In this thesis, data from the national WIRUS project (Workplace Interventions preventing Risky alcohol Use and Sick leave) was used. The relationship between alcohol consumption and sickness absence was explored by reviewing previously published literature and was analyzed descriptively (based on type of design, direction of associations, and type of measurement) and using meta-analysis (Paper I). Six databases were searched, and observational and experimental studies from 1980 to 2020 that reported the results of the

association between alcohol consumption and sickness absence in the working population were included. Newcastle-Ottawa Scale was applied to assess the quality of each association test.

The status of drinking attitudes, as well as the association between drinking attitudes and alcohol-related problems, were examined in a cross-sectional study of 4,094 employees in 19 Norwegian companies (Paper II). Drinking attitudes were assessed using the Drinking Norms Scale, and the Alcohol Use Disorders Identification Test scale was used to assess any alcohol-related problems. The data were analyzed using multiple logistic regression.

Paper III, by considering the organizational structure of the working units, explored whether alcohol-related individual differences (drinking attitudes and alcohol-related problems) can predict one-day, short-term, long-term, and overall company-registered sick leave days. The data from the WIRUS-screening study were linked to company-registered sick leave data for 2,560 employees from 95 different work units. Three-level (employee, work unit, and company) negative binomial regression models were used to examine the association between alcohol-related individual differences and sick leave.

Results: In Paper I, fifty-nine studies (58% longitudinal) were included in the systematic review. The systematic review supported the association between alcohol consumption and sickness absence, revealing that sickness absence was more than two times higher among risky drinking employees than among low-risk drinking employees. The increased risk for sickness absence was more likely to be found in cross-sectional studies, studies using self-reported absence data, and those reporting short-term sickness absence (Paper I).

In Paper II, a higher proportion of employees reported positive (i.e., liberal) drinking attitudes. When compared with employees with

negative drinking attitudes, employees with positive drinking attitudes were three times more likely to report alcohol-related problems (Paper II). Moreover, positive drinking attitudes were found to be more frequent in men than in women. However, the association between drinking attitudes and alcohol-related problems was noticeably stronger for women than for men (Paper II).

A high variation in sick leave across work units and companies was found in the sample of Norwegian employees (Paper III). However, alcohol-related problems and drinking attitudes showed no association with higher levels of sick leave in work units within companies (Paper III).

Conclusions: This thesis supports earlier evidence on the association between alcohol and sick leave in general and suggests that some specific types of measurement groupings and types of data may produce large effects in different ways. Although there was a lack of association between alcohol-related individual differences and sick leave among a sample of Norwegian employees, this thesis suggests the importance of between company-level differences on sick leave over within company differences. Therefore, further research is warranted to explore whether other unmeasured factors and/or specific company policies and practices can explain these differences. Moreover, the thesis suggests that drinking attitudes are associated with alcohol-related problems. To facilitate early health promotion programs that target alcohol problems, employees' drinking attitudes may be assessed alongside actual alcohol consumption. These assessments might need to be gender-specific.

Keywords: Alcohol consumption; Norms; Public health; Sick leave; Presenteeism; Workforce; Drinking attitudes; Alcohol-related problems; Risky drinking; Culture; Sickness benefit; Organizational structure.

Abbreviations

ANCOVA: Analysis of covariance

ANOVA: Analysis of variance

AUDIT: Alcohol Use Disorders Identification Test

DNS: Drinking Norms Scale

GBD: Global Burden of Disease

NB: Negative Binomial

NIAAA: National Institute on Alcohol Abuse and Alcoholism

OHS: Occupational Health Service

OR: Odds Ratio

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PROSPERO: International prospective register of systematic reviews

RR: Risk Ratio

SDR: Social Desirability Responses

WDT: Workplace Drug Testing

WHO: World Health Organization

WIRUS: Workplace-based Interventions preventing Risky alcohol Use and Sick leave

WMA: World Medical Association

List of papers

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II. Hashemi, N. S., Thørrisen, M. M., Skogen, J. C., Sagvaag, H., Gimeno Ruiz de Porras, D., & Aas, R. W. [2020]. Gender Differences in the Association between Positive Drinking Attitudes and Alcohol-Related Problems. The WIRUS Study. International journal of environmental research and public health, 17(16), 5949. https://doi.org/10.3390/ijerph17165949

III. Hashemi, N. S., Dalen, I., Skogen, J. C., Sagvaag, H., Gimeno Ruiz de Porras, D., & Aas, R. W. [2021]. Do differences in drinking attitudes and alcohol-related problems explain differences in sick leave? A multilevel analysis of 95 work units within 14 companies from the WIRUS-project. Submitted to a scientific journal (18th November 2021), Under Review.

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1 Background

1.1 Research field

1.1.1 Public health

According to the Institute of Medicine, public health is defined as: "*what we, as a society, do collectively to assure the conditions for people to be healthy*" [1]. These "conditions" are linked to the contributing factors of health, and they can be achieved by collaboration of individuals [2]. To help individuals make better decisions about their health and welfare, rather than trying to protect them from harm or disease, they need to be actively supported—developing healthy policies, reorienting health services, building supportive settings, and promoting personal skills can empower individuals to have more control over their health [3].

Enabling people to have more control over their health can help them have more control over their overall life, as actors. However, individuals' autonomy and decisions regarding their health can be threatened by the existing factors [3]: lack of communication, lack of knowledge, entrenched social attitudes and norms that may distract individuals aspiring to attain healthy lifestyles, community culture, and increasing adverse health-related behaviors, such as smoking, alcohol, and other substance use. These factors interact with each other and create a set of opportunities for individuals that not only influence their behavior but also impact their overall health [4, 5].

Among these factors, the policies and health problems associated with alcohol use have been major public health concerns for many years [6]. Depending on the degree of consumption, alcohol, according to the Global Burden of Disease (GBD) study, causes more than 200 diseases and injuries, ranging from cancers to traffic injuries [7]. In 2016, alcohol was ranked as the seventh most important risk factor globally for deaths

and loss of healthy life years, and as the leading risk factor in the 15 to 49 age group [8]. Moreover, three million deaths per year worldwide, WHO reports, are caused by the risky drinking of alcohol (i.e., a drinking pattern that raises the likelihood of medical, social, occupational, and economic problems [9]) [10].

A considerable economic burden is also attributed to risky alcohol consumption. In 2006, the cost of risky alcohol consumption was reported to be about $223.5 billion in the USA [11]. In addition, a review of the economic costs of drinking alcohol, between 1990 to 2004, suggests that the global economic burden related to alcohol varies from $210 to $665 billion [12]. A major part of these costs results from productivity loss at work, health care costs, and car crashes [13, 14].

That alcohol consumption may transform into a chronic damaging behavior in some individuals was first proposed about 200 years ago [15, 16]. Focusing on alcohol-related problems has often generated discourse regarding public health perspectives that allow state actions to control alcohol consumption and prevent related problems. Here, one may argue that states have no right to curb individuals' freedom—individuals themselves are responsible for their drinking-related consequences. However, when individuals' drinking harms other people in any way, state intervention is expected [17, 18].

Alcohol-related problems are not limited to the risky level of drinking. An individual who moderately consumes alcohol in an unsafe setting is also vulnerable to alcohol-related problems [19]. Everyone who consumes alcohol can thus be at risk and also be a potential risk for non-drinking individuals (i.e., innocent victims). Hence, as revealed by the expanding frame of information and epidemiological data, alcohol-related problems occur within complex and multiple interactions of interpersonal, individual, and social factors [20]. To obtain a comprehensive perspective on these interactions, prevention specialists

suggested a public health model of alcohol-related problems (see Figure 1), where three principal components work simultaneously to develop or impair particular problems [20].

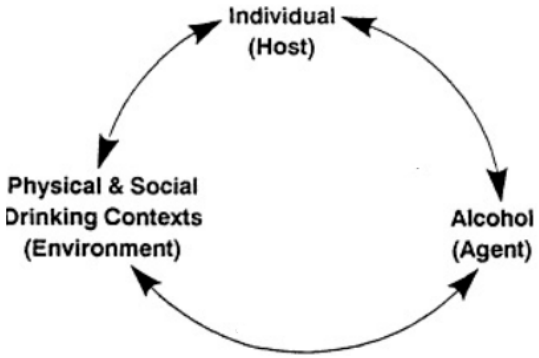

Figure 1. A public health model of alcohol-related problems
Source: [20], with permission from Institute of Medicine (US) Committee to Identify Research Opportunities in the Prevention and Treatment of Alcohol-Related Problems, Prevention and Treatment of Alcohol Problems: Research Opportunities. Washington (DC): National Academies Press (US); 1990, p. 24-25. License ID: 1184332-2.

A particular alcohol-related problem, as the model shows, does not exclusively emerge from one source—there are multiple interactions of factors that shape the type and degree of problematic outcomes. From a public health perspective, to prevent a particular alcohol-related problem, one may isolate or alter the relevant agent, individual, or environmental factors that are contributing influences [20].

1.1.2 Occupational health

Although workplaces are alcohol free sones in most countries, they are not immune to the impact of alcohol consumption. Since the majority of adults are employed, the workplace can either be a risk factor for alcohol use or provide an opportunity to implement different prevention and health promotion programs [21]. Such programs can be implemented through the contribution of occupational health services (OHS),

employers, and employees. The OHS aims to sustainably develop a working environment without harming human health, the system, and resources in the short or long term by considering both the social and health dimensions [22]. When employees' workability is impaired by alcohol, the OHS and the employer must ensure that the employees are not in danger and do not pose risks of any kind to others.

In working populations, alcohol is a risk factor for attention impairment, on-the-job injuries and accidents, and sick leave [23-26]. Alcohol-related sick leave, in particular, is a major concern in that it imposes numerous costs on industries [27-29]. For example, the global cost of alcohol-related sick leave is estimated at $30–$65 billion per year [12, 29]. In 2011, the costs of alcohol-related sick leave (both short- and long-term) in Norway were estimated at 11,531 million NOK ($1.3 billion) per year [30], while these costs amounted to about $200 million in 2001 [31].

These costs include a decline in work performance in terms of productivity [32, 33], increased risk of accidents and reduced work safety [27, 34], and a rise in the number of lost workdays due to sick leaves or being late to work [32, 35-37]. To this end, to manage employees' health, several predictors of their health behavior have been suggested to be considered by employers and OHS (see Figure 2) [38, 39]. These predictors can be external (e.g., demographics, genetics, socialization, environmental factors, and personality characteristics) or/and internal (e.g., environmental exposure at work, and socializations).

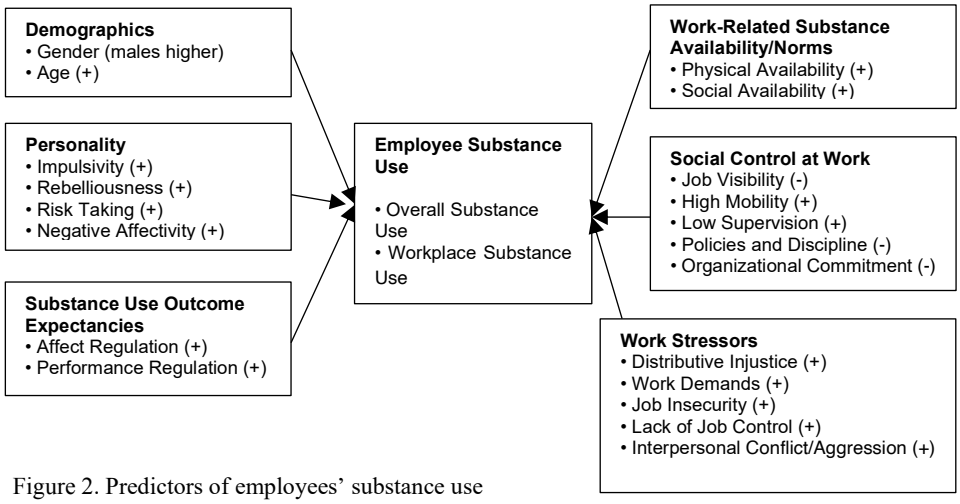

Figure 2. Predictors of employees' substance use
Source: ([38], Frone, M. (2008). Employee alcohol and illicit drug use: scope, causes, and organizational consequences. In J. Barling, & C. L. Cooper. The SAGE handbook of organizational behavior: Volume I - micro approaches (pp. 519-540). SAGE Publications Ltd.

To prevent and manage alcohol-related workplace problems, and to implement workplace health promotion programs, alongside considering the predictors displayed in Figure 2, several work-related factors need to be addressed as well [40, 41]:

- The existing workplace culture and components that may encourage drinking alcohol at work: attitudes formed in a work group, or availability and easy access to alcohol (e.g., social events or work-related receptions)
- Workplace factors—personal and contextual—that may affect the patterns of employees' alcohol consumption
- Workplace risk factors that may augment the risk of alcohol-related injuries (e.g., duties demanding more concentration, or conducting tasks as part of a team)
- Workplace indicators (e.g., frequent absences) that may adversely affect work performance.

Addressing these factors alongside developing health programs depends on conducting several steps. First, the workplace needs to have a representative group in place to sustainably develop and implement workplace health programs with the contribution of employees. In this regard, it is suggested to consult with all employees when developing the policies or health promotion programs [40].

Further, it is recommended to make sure that there is clear communication and information throughout the entire development stages to encourage a maximum number of employees to participate [40]. However, due to a lack of communication, punitive culture, available resources, and program sustainability, employees do not participate adequately in these plans [40, 42]. It is thus suggested by studies to conduct a process evaluation to not only identify the barriers affecting employee participation and the implementation process but also enhance the effectiveness of implementation [43-45]. It is important to plan process evaluation prior to implementation; otherwise, the process evaluation will be incomplete and unsystematically conducted [45, 46]. According to a systematic review of numerous workplace health promotion programs, process evaluation was not systematically performed on existing promotion programs, and even the quality of the evaluations ranged from poor to average [45].

Moreover, among the above-mentioned factors, a lack of attention to work-related contextual factors was found to hinder the implementation of workplace health promotion programs [47, 48]. In light of this, considering the interaction between the environment, contextual factors, and individuals is crucial for the successful implementation of health promotion programs.

1.2 Alcohol use

1.2.1 Perspectives and theories

Alcohol is a psychoactive substance [10, 49, 50]. Alcohol use varies in different cultures and can be directly related to the reasons for its consumption. The reason for alcohol consumption may be explained by expectancy theory [51]. The expectancy theory tries to explain why people drink alcohol, with a focus on belief-related conceptual factors: drinking alcohol may lead to positive effects (e.g., alcohol will enhance social bonding (i.e., a mechanism to relieve nervousness and tension during social interactions [52])) or negative effects (e.g., alcohol will cause guilt) [51]. Such expectancies may affect drinking behavior, so those with positive expectancies drink more alcohol, while those with negative expectancies drink less [53].

Although alcohol consumption in individuals with positive expectancies constitutes several social benefits [54, 55], the fact that uncontrolled/risky drinking can generate harmful consequences on social behavior (e.g., self-disclosure) is undeniable [56]. The adverse outcomes of risky drinking not only affect consumers but also impose irreparable harm on the people around them. Some of these unfavorable outcomes can be health-related issues (e.g., family members' anxiety or injury), societal effects (e.g., assault), or even considerable economic issues (e.g., damage to properties, spending money on drinking rather than family necessities) [57, 58]. Therefore, knowing the signs and distinctions of each stage of drinking alcohol can help individuals before they succumb to alcohol dependence and its consequent outcomes.

Different stages of drinking alcohol, as well as different cut-off points for the levels of alcoholic drinks, are defined in several resources [59, 60]. These variations can be due to differences in the volume of drinking alcohol as well as the patterns of consumption. However, for both men

and women, WHO has defined taking 10g of pure alcohol as a standard drink [61]. Moreover, according to a recent study based on data from 25 countries, the definition of a 'standard drink' ranged from 8–20 grams of pure ethanol/alcohol, with the most common category being 10 grams (reported by 62% of the countries) [62].

According to the National Institute on Alcohol Abuse and Alcoholism (NIAAA), three types of drinking are presented as moderate drinking, binge drinking, and heavy drinking [63].

Moderate drinking: this refers to an amount of alcohol consumption that is moderate and does not cause any problems [64]. NIAAA defines moderate drinking as one drink per day for women and two drinks per day for men. However, 'moderate drinking' is an inexact term for displaying a pattern of drinking, and 'lower-risk drinking' is recommended as a substitute [3]. Although moderate drinking is widely believed and documented that should not be a reason for concern among adults as it may have protective health effects [65-67], there are some inconsistencies in the findings of studies exploring moderate drinking and individuals' health. For example, in a study, light to moderate drinking was found to be associated with an increased risk of cancer [68]. Another study found that moderate drinking can be a risk factor for cognitive decline and adverse brain outcomes [69].

Binge drinking (occasional abuse): this is also called heavy episodic drinking but does not have any internationally agreed definition. It refers to drinking to intoxication [70-72], as well as a risk for alcohol-related problems [73]. The threshold given by NIAAA defines binge drinking as four drinks for women and five drinks for men in about two hours. According to WHO, drinking at least 60g of alcohol on one occasion amounts to binge drinking [74]. Worldwide, about 18.2% of individuals engage in binge drinking [10]. In the USA (California), about 24.7% of men and 10.7% of women engage in binge drinking [75], and among

European countries, as Nazareth et al. (2011) found, the Netherlands's level of binge drinking is the highest (8.4%), while Portugal's is the lowest (1.5%) [76]. Such a discrepancy among the USA and European countries can be related to the type of study samples, sample size, and different years of studies (2005 versus 2011). Based on the most recent and available reports, binge drinking in the USA, in general, was about 18.6%, and among European countries, Austria showed the highest rate of binge drinking (40.5%) [77, 78].

Heavy drinking (high-risk): this is a crucial risk factor for suicide among young people and adults [79-81]. NIAAA defines heavy drinking as binge drinking on ≥5 days in the past month. Alternatively, it is defined as having more than four drinks per day for men and more than three drinks per day for women [63].

Heavy drinking has been found to be associated with long-term personality trait changes in adults [82-84]. A review on personality and alcohol use has reported increased extraversion, decreased emotional stability, agreeableness, and conscientiousness to be the results of heavy alcohol use [82]. Moreover, individuals with alcohol use disorders (e.g., alcohol abuse and alcohol dependence) have been found to be suffering from psychiatric disorders [10, 85], such as depression or anxiety disorders, with 2 to 3 times higher risk of suicide attempts than the general population [10, 86, 87].

Besides, there is one category/pattern as problematic or risky drinking that includes, but not limited to, heavy drinking, binge drinking, and any consumption by pregnant women. WHO, in general, defines risky drinking as a pattern of alcohol consumption that augments the risk of adverse consequences for physical and mental health as well as social issues not only for the consumers but also for the people surrounding them [9, 88]. Risky drinking links to individual characteristics (e.g., general health, sociodemographic status, and physiological factors) [89].

This type of drinking has been linked to mental health problems and cognitive dysfunctions. One study has found lower scores on psychological functioning and higher scores on depression among individuals with risky drinking behavior, comparing to non-risky drinkers [90].

Risky drinking definition can be based on predefined standard drink sizes, which varies extensively across countries and are not comparable, or can be based on valid instruments assessing different aspects of alcohol-health relationship [91]. One of these instruments that screens and identifies individuals with alcohol-related problems (risky drinking) or alcohol dependence, is the Alcohol Use Disorder Identification Test (AUDIT) [9]. It is a 10-item questionnaire, where each item is scored from 0 to 4, and the total score could be between 0 to 40. Earlier, a threshold of ≥8 scores was recommended as an indication of alcohol-related problems or risky drinking [9, 92]. There is support for considering AUDIT as a one-factor (indicating different levels of alcohol-related problems), as well as two factors (drinking patterns and consequences), and three factors (drinking habits, alcohol dependence, and harmful alcohol use) [93-95]. However, following the suggestion of the most recent confirmatory factor analysis of AUDIT by Skogen et al. (2019), this thesis used it as a unidimensional measure [96].

Measuring alcohol use is not limited to AUDIT. In earlier studies, alcohol use and risky drinking were operationalized in different ways. For example, some studies used the CAGE test (an alcohol abuse screening tool) to measure problem drinking [24, 97, 98], some used a non-validated questionnaire to investigate individuals' average drinks per week [99, 100], and some used objective measures (e.g., high alcohol levels in blood) [101, 102].

1.2.2 Macro level: Society

When exactly the production of alcohol began is uncertain. However, based on evidence, the process of fermenting alcoholic drinks dates back to at least 10,000 years ago [103, 104], with the earliest evidence of alcoholic drinks found in China, dating from 7000–6600$_{BCE}$ [105, 106], and from 5400–5000$_{BCE}$ in Iran [103, 107].

Alcohol use varied depending on the region. Around 4000$_{BCE}$ in Egypt, alcoholic drinks were believed to be a necessity of life [107, 108]. Egyptians produced different types of beer and wine for different purposes, such as funerals, religious rituals, medicine, nutrition, and pleasure [107, 109]. Generally, their consumption was moderate. The Chinese consumed alcohol when they held imperative ceremonies (victory, marriage, or birth), before going into battle, taking an oath, death, and festivals [110]. However, nowadays, moderate amounts of alcoholic drinks are part of everyday life in China [111].

On the other side of the globe, Europe has been producing alcoholic drinks for thousands of years. The Europeans tried to make alcoholic drinks from any locally available materials [112, 113], and drunkenness was common [114]. By improving communication links and industrialization, alcohol began to be used in a wide range of contexts, from drinking at family meals to being a major part of rituals [115, 116].

Today, in most societies, alcohol is considered a part of religious rituals, celebrations, events, and, in general, as a social activity [117, 118]. According to WHO's global report on alcohol in 2018 [10], in the last 12 months, about 6.4 liters of pure alcohol per capita was consumed by less than half of the world's adult population (47%). Compared to reports from 2005, the global average alcohol consumption increased by 17% in 2018 (5.5% versus 6.4% liters per capita).

However, the highest levels of alcohol consumption are found in the European region—now known as the heaviest drinking region of the world, among which the central countries (east and west of Europe) have higher levels of drinking compared to north or south of Europe. Based on WHO's global status report on alcohol (2018), the amount of drinking is estimated to be about 9.8 liters of pure alcohol per year for each European adult, a level over 1.5 times the world's average (6.4 liters) [10].

Compared to other Scandinavian countries, Norwegian people's alcohol consumption is at a lower level. When compared to the available reports from 2010 (9.0 liters per capita), Norwegians' alcohol consumption decreased in 2017 (7.5 liters per capita) [10]. However, this is still relatively high according to WHO (7.5–9 liters per capita) because the worldwide consumption is roughly 6.4 liters per capita per year.

Although the European region is the heaviest drinking region, one may consider the existing variations in drinking culture. For example, in some cultures like Italy, alcohol is used together with a meal or as part of it; in another culture like Scandinavia, alcohol is used also as an intoxicant to larger degree [119, 120]. However, the existing drinking cultures do not provide constant and predictable behavior in a given environment. Rather, in monitoring drinking cultures, there is a need to move from the macro- to the meso- and micro-levels [119]. But first, it would be beneficial to go through different socio-cultural contexts and socioeconomic aspects of alcohol consumption in societies.

Socio-cultural contexts: there are several cross-cultural contrasts in the way individuals behave when they drink that should probably be taken into account. For example, in some cultures (e.g., the UK, the USA, and Australia), drinking alcohol is linked to anti-social behaviors. However, in other cultures (e.g., some South American cultures), drinking alcohol is linked to being well-disposed and harmonious [121]. Determinants

including environmental factors (e.g., cultural alcohol policies, economic circumstances), and individual risk factors (e.g., age and gender issues) can influence the existing variation of drinking patterns and consequences in a society [103, 122].

Moreover, regarding religion, different religions (i.e., Hinduism, Catholicism, and Islam) have different views about drinking alcohol [123-125]. In a study on religious factors associated with alcohol use, it is found that in those religions that individuals view their religion as encouraging to abstinence, individuals were less likely to drink [125]. Moreover, individuals who had religious commitment were less likely to be drinkers.

Socioeconomic status: drinking alcohol can also be related to several socioeconomic consequences for larger societies, including work-related issues, relationships, and public safety [126]. One might assume that, as societies grow more affluent, there will be an increased tendency to consume higher levels of alcohol [127]. On the other hand, in lower-income societies, there will be an increased tendency to develop alcohol-related harms [10]. However, moving from lower-income societies toward higher-income ones does not necessarily reduce alcohol-related harm. Owing to the industrialization of alcoholic products in many European regions as well as the increased availability of alcohol, the rate of heavy drinking as well as alcohol-related harms rose steeply [10, 128, 129]. Alcohol-attributable cancers and alcohol-use disorders are more prevalent in high-income and upper-middle-income countries than in lower-income ones [10].

1.2.3 Meso level: Workplaces

For decades, alcohol-related problems, risky drinking, and the association between workplace and alcohol consumption have been major concerns for researchers, organizations, and practitioners [27, 32,

130]. As the majority of adults are employed (nearly 70% of the adult population in Norway [131]) and are spending a major part of their awaken time at work, the workplace can encourage risky alcohol consumption as well as provide opportunities to reduce risky drinking behaviors through prevention strategies [21].

Risky drinking in the working population as an initiation or extension of unhealthy behavior may impose considerable costs and safety concerns on the company. In this regard, it has been reported that alcohol use, depending on the level of consumption, can lead to several undesirable consequences, including impaired attention, reduced workability, on-the-job accidents, adverse impact on company image, lateness and absenteeism, and productivity loss [24-26]. The pattern of alcohol consumption varies across different industries and work groups and depends on the nature of the work, workplace culture, ease of access to alcohol, or work environment [132]. For example, according to a British report, frequent drinking is more common among managers and professional occupations than among routine occupations (e.g., manual occupations) [133]. Conversely, an Australian study found that the amount of alcohol consumption among manual occupations and lower-skilled ones was higher when compared to other occupations [132].

Work-related drinking can be considered drinking alcohol while working, drinking alcohol before going to work, and drinking immediately after work and can be related to working environment matters or situations in which engage employees while performing their tasks [134, 135]. As revealed by a study on workplaces, drinking alcohol while working was found in about 7% of American employees [136] and in 9% of Australian employees [137]. In contrast, in Norwegian workplaces, drinking during working hours is uncommon due to existing alcohol policies and the existing culture [138, 139].

However, in Norwegian companies, alcohol consumption is present in different work-related contexts, such as social events after work organized by colleagues, while having home office, or during work-related travels [135, 138, 140]. Although work-related drinking in the form of social events can lead to social integration, it may have the risk of marginalization or exclusion from working groups due to either excessive drinking or even non-drinking (abstaining from alcohol) [138]. A study conducted on Norwegian employees showed that nearly 11% of them felt excluded in social work-related settings due to their colleagues' alcohol use [141].

1.2.4 Micro level: Employees

As the characteristics of the work environment (e.g., alcohol availability, workplace social control, work stressors) may have additive (i.e., simultaneous) and independent effects on individuals' substance use, employed individuals, compared to unemployed ones, can be likelier to drink alcohol (off-the-job or on-the-job) [142]. One to three out of ten employees, studies have suggested, may benefit from alcohol prevention interventions for risky drinking [143-145]. Moreover, employees may be negatively affected by their colleagues' drinking, known as the secondhand effects of drinking (e.g., covering for a coworker, conflict with coworkers, being verbally abused, being physically harmed, or receiving unwanted sexual attention) [141, 146, 147]. As one study on Norwegian employees showed, roughly one-sixth of employees are affected each year by their colleagues' drinking [141].

According to the literature, a set of different individual risk factors (e.g., economic status, age, and gender) can influence the existing variations in drinking patterns and consequences [103, 122].

Economic status: in both individual and population levels, the alcohol consumption rate has been reported to be relatively higher among

individuals with high income [148]. Although other circumstances are also connected, drinking patterns within and across societies indicate that alcohol requires investment and resources in a barter economy [10]. However, alcohol-related health harm seems to have a negative association with income. Individuals with a higher socioeconomic status are found to have lower alcohol-attributable mortality [10]. Relatively, in any given society, the "harm per liter" of alcohol consumption is reported to be considerably greater among lower-income individuals than among higher-income ones [149, 150]. Greater alcohol-related harm in lower-income individuals may impose several adverse impacts on the individuals, including injuries and chronic and infectious diseases [10]. Moreover, when compared to their counterparts, individuals with lower socioeconomic status are twice as likely to die from alcohol-attributable causes [151].

Age: an increased rate of worldwide alcohol-related injuries leading to death (about 17.6%) is observed among young individuals [152-154]. Globally, about 26.5% of young individuals (i.e., 15- to 24-year-olds) drink alcohol [10]. In general, young individuals are likelier to indulge in risky drinking as well as binge drinking [155-157]. Binge drinking among young individuals is prevalent (≥ 20%) particularly in European regions and higher-income societies [10]. However, after periods of risky drinking (i.e., in their 20s), many young individuals have reported a reduction in their alcohol drinking pattern with increasing age [158]. Such age-related changes in alcohol consumption can be rooted in several factors, including social context, brain development, or personality features [159, 160].

Although one may assume that the amount of alcohol consumption may decline with age, more frequent alcohol consumption is reported among older individuals than younger ones [157, 161, 162], particularly in Nordic countries [163-165], other European countries [166, 167], and the USA [168, 169]. In a study on older individuals between 60 and 94 years

of age, more than half of them (62%) were reported to drink alcohol, among which 13% of men and 2% of women had risky patterns of drinking [170]. Moreover, older individuals may be more susceptible to alcohol-related negative outcomes (e.g., due to their sensitivity to the levels of blood alcohol, or due to their decreased body mass) [171-173].

Gender: historically, men have been exceeding women in both the quantity and frequency of alcohol use and misuse [165, 174-177]. According to a WHO report, about 53.6% of men and 32.3% of women are current drinkers [10]. Men also have a higher likelihood of engaging in binge drinking than women (50.2% vs. 19.9%) [161, 174]. Table 1 presents the prevalence of binge drinking among men and women in different WHO regions and worldwide [10]. In addition, men are more likely to persist with drinking when they get older than women [161, 178]. Therefore, in old age, men have more potential to be categorized as risky drinkers when compared to women [179, 180].

Table 1. Prevalence (in %) of binge drinking in WHO regions and worldwide, stratified by gender

WHO Region	Men (%)	Women (%)
European Region	56.5	24.5
Region of the Americas	53.0	20.0
Western Pacific Region	52.8	20.1
Eastern Mediterranean Region	12.8	3.1
South-East Asia Region	50.6	18.7
African Region	60.5	28.2
World	**50.2**	**19.9**

However, over time, concurrently with changes in women's social positions, their drinking level has also increased and become closer to that of men's [175, 181, 182]. When the differences in drinking are based on gender roles, there might be a consumption convergence in societies where gender roles converge [183]. In countries with greater societal

gender equality, such as the Nordic countries, several results assert that there are smaller gender differences in terms of drinking behavior [184-186]. Nordic studies have reported that, over the past 2 to 3 decades, there has been a gender convergence in drinking behavior [165, 182].

Convergence, according to Bloomfield et al. (2001), is "a narrowing of the gender gap" [187]. The socio-cultural factor is one of the major theoretical perspectives for explaining this issue [165, 175, 176]. Based on the socio-cultural factor, "gender-specific social roles caused women and men to drink differently in the past" [165, 176]. For instance, traditional perceptions and beliefs dictate that drinking influences women's social responsibilities and behavior more negatively than men's [176]. Because of this perception, as women would fear being judged negatively for heavy drinking, their consumption was lower [175]. However, with the changing roles of women in Western society, as mentioned above, drinking levels and drinking problems among women increased and became closer to men [175]. Several studies have supported the convergence theory, revealing that this convergence appears largely among younger generations of women [176, 177, 188].

Since alcohol-related consequences may differ between men and women, the increase in the number of drinking among women has thus given cause for concern in Norway [165, 189] and many other countries [165, 190]. One may assume that because of riskier drinking, men experience more alcohol-related problems. Even if women drink the same amount of alcohol as men, they are more vulnerable since they absorb higher concentrations of alcohol in their blood. High concentration of alcohol might give more impairment and alcohol-related organ damages [191-193].

Besides, the reasons and circumstances that influence men's and women's drinking as well as alcohol-related problems may vary in different ways, including psychologically (e.g., incentives to drink),

physiologically (e.g., alcohol metabolism), and socially (e.g., impacts of drinking partners) [103].

1.3 Drinking attitude

1.3.1 Perspectives and theories

The above-mentioned cross-cultural contrasts in alcohol-related behavior cannot be solely related to variations in drinking levels. They are also linked to social and cultural norms, attitudes, and beliefs about alcohol consumption [121, 194].

The influence of norms on human beings' behavior has been focused on for decades. It refers to the influence of others whose opinions are valued as important (e.g., family, friends, or colleagues) on an individual [195]. This type of norm is known as a subjective norm. Another norm of importance that is of interest in this thesis is personal norm (i.e., attitude). Attitude directly affects human behavior and is defined as an internal psychological tendency expressed by evaluative responses toward a behavior with some degree of liking or disliking the attitude object [196, 197]. Further, since attitude enables individuals to express their own values regarding the attitude object, it has a value-expressive function [195]. Both subjective norm and attitudes are determinants in the theory of reasoned action [198] influencing behavioral intention. Fishbein and Ajzen, in the theory of reasoned action, attempted to explain the relationship between norms and behaviors within human action.

In terms of attitudes, the three responses—also known as *the three components of attitudes*—are cognition, affect, and behavior [195, 199-201]. Responses based on cognition refer to individuals' beliefs about the attitude object [198]. The emotional experiences and feelings about the attitude object are examples of affective responses [195]. However, behavioral responses are known as intentions to act or individuals' action

[196]. Moreover, according to the theory of planned behavior developed by Ajzen, attitudes are individuals' evaluations about performing a behavior with some degree of like or dislike. However, due to individual differences in evaluation tendencies, some individuals believe and hold some attitudes more strongly than others [202]. Accordingly, the theory of planned behavior implies that having a more positive attitude toward a behavior may result in having a greater intention to display that behavior [201, 203]. Several studies have shown that individuals with negative attitudes toward alcohol often drink less, and that those with positive attitudes drink more [204-207]. Although these studies were conducted in different settings (e.g., general population, college students, and work samples) and mostly used non-validated items to measure attitudes, they highlighted the importance of existing norms and attitudes when it comes to modifying alcohol-related behaviors and beliefs.

1.3.2 Macro level: Society

Individuals are not isolated from their socio-cultural surroundings. Shared socio-cultural beliefs (i.e., situational norms) are known to shape the future-directed attitude of individuals toward alcohol use. In this regard, a society's existing policies, religion, and culture have a potential role in developing individuals' character, behavior, and attitudes [208, 209]. A society's established norms are suggested to be potent predictors of current drinking as well as frequent heavy drinking [210-213]. For example, by comparing different religions' views on drinking norms, it is found that Islam strongly tries to direct individuals to avoid or abstain from alcohol use (i.e., proscriptive norms), whereas Hinduism has non-proscriptive norms about alcohol use and is accepting moderate drinking alcohol [125, 214]. Although moderate drinking is approved among Hindus, heavy drinking is not acceptable (i.e., prescriptive norms for moderate drinking and proscriptive norms for heavy drinking). Therefore, a higher prevalence of abstinence is predicted among

Muslims and a higher prevalence of moderate drinkers among Hindus [125].

All in all, substances/intoxicants are part of society, and each culture has its own manner of using/abusing substances. At the societal stage, how substance use is represented by media and policies—the imposition of cigarette taxation and legal drinking age, for example—plays an imperative role in forming individuals' intention to use substances [215, 216].

1.3.3 Meso level: Workplaces

Social determinants—such as modeling a behavior by family, friends, colleagues, neighbors, school policies, or working environment policies—restrict or enforce substance use [138, 217-220].

The direct effect of peers' behaviors on an individual's behavior is a potent factor for smoking, alcohol consumption, and marijuana use [221-224]. It is thought that young people are greatly affected by what they perceive to be the group norms among their peers; therefore, there is a substantial likelihood that they will believe and behave in similar ways by changing their own attitudes [225]. However, it is worth mentioning that social interaction can be considered the starting point for individuals' attitudes and behaviors. Through the process of socialization, people acquire the shared knowledge, attitudes, and behaviors that are required for effective integration in a group, environment, or organization and, consequently, adjust their own behaviors accordingly [226]. To gain social recognition and group belonging, individuals struggle with peer pressure to change their attitude and behavior accordingly [227].

One of the crucial places where individuals socialize and share their understandings is the workplace. Attitudes and beliefs about what is

proper and what is functional have been observed in organizational studies concerning alcohol and work.

A workplace's existing norms and subcultures may have differential impacts on encouraging or discouraging individuals to drink alcohol [228, 229]. Ames et al. (2000) highlighted how existing workplace policies can influence employees' alcohol drinking behavior [230]. Their study compared employees working in the same industry but in two different work settings with different managerial cultures (i.e., a traditional U.S. management design vs. a nontraditional Japanese transplant model). Compared to the nontraditional model, more permissive alcohol drinking attitudes, and, accordingly, more alcohol availability at work as well as higher drinking rates were observed in the traditional model. The results highlight the extent to which the implemented policies and norms can predict drinking attitudes and alcohol availability at work. Another study on employees by Frone and Brown (2010) found that alcohol-drinking norms can predict both alcohol-drinking behavior and workplace impairment [231]. Another study on attitude toward alcohol among employees revealed that employees working in a discouraging drinking norm workgroup (i.e., having a negative drinking attitude) were 45% less likely to show risky drinking behavior [232]. Moreover, the only available study that focused on different types of organizations in Norway found that private-sector employees report more positive drinking attitudes and more alcohol-related problems than public-sector employees [233].

1.3.4 Micro level: Employees

Regarding the individual levels, attitudes may vary and even become shaped according to personal factors, one of which is gender. It is likely that women and men, experience different pressures to drink, which may affect their drinking behavior. In this regard, a few studies have explored the gender-specific attitude-drinking relationship. Some of these studies

reported stronger attitude-drinking relationships among women than men [207, 234], while others reported the opposite [205, 235]. Yet, in these studies, the attitudes were measured by estimating one's perception of others' drinking attitudes and not the individuals' personal drinking attitudes. Therefore, the respondents could have been influenced by their misperception of others' beliefs and over- or underestimated their actual drinking behavior [236, 237].

1.4 Sick leave

1.4.1 Perspectives and theories

Several factors may limit an individual's actions and affect their decision concerning work attendance. The process of deciding between going to work or not going to work can be explained by several integrative models, including the illness flexibility model [238] and the attendance model [239, 240].

Feeling sick or ill, due to health-related or non-health-related reasons, is the starting point for the illness flexibility model, which tries to explain the circumstances that may influence the association between health (as the reason or a goal) and sick leave (as an action) [241]. This perspective is in line with the one requirement stated by Kristensen (1991) for a theory of sickness absence: ''*A theory of sickness absence should consider the individual as a product of his or her environment and, at the same time, as a conscious actor who makes choices within a given social framework*.''

On the other hand, according to the attendance model, workplace absence does not occur just because of illness but due to attendance motivation (e.g., job satisfaction, pay system, pressures to attend) and/or ability to attend (e.g., health-related issues, injury, transportation) [240].

Depending on the reason for sick leave, its duration can be varied (i.e., short- or long-term). There is no agreement on the definition of short- or long-term sick leave [243]. Studies exploring sick leave have defined short- and long-term sick leave based on either the existing sick leave insurance system or the available collected data. For example, some studies have regarded long-term sick leave as being on absence for eight weeks or more (e.g., in Norway) [243], while others have defined it as a period of seven days or more [244, 245], or even 90 days [243].

Besides the variation in the definition of sick leave duration, how a sick leave unit is measured also varies considerably [246]. For instance, among the studies addressing sick leave, some measured absence spells (i.e., episodes [247]) [100, 248, 249], while others measured absence days and hours [250, 251]. Moreover, how the sick leave data were collected differed in the earlier published studies. Sick leave data can be self-reported, company registered, or national-registered (through public insurance offices) [246]. Although self-reported sick leave data can be assumed to be less reliable [252], it should be considered that not all countries have access to registry data. In some countries, such as Nordic countries, it is common to keep administrative registries of sick leave, which offer opportunities to deeply explore the different associations related to working populations [253, 254].

Overall, although the variety in sick leave definition, unit measure, and type of collected data may offer opportunities to explore different dimensions and aspects of sick leave, it may be challenging to compare different results from different studies.

1.4.2 Macro level: Society

Sick leave is regarded as an important public health concern. It varies extensively across different countries. Among Nordic countries, Norway reports high levels of sick leave with an average of 16.3 days per year

(from 2010 to 2020), while Sweden and Denmark report about 10.1 days and 8.3 days per year, respectively [255].

On average, the rate of all types of sick leave among Norwegian employees in the third quarter of 2021 was 6.4% [256, 257] (see Figure 3). However, it is worth mentioning that 2020 and 2021 were in the middle of the COVID-19 pandemic and the rate of sick leave was increased during this period [258, 259]. However, by looking into the records before the COVID-19 pandemic, the sick leave rate was about 5.8% in 2019, while this amount was about 4.4% in the Netherlands [260] and 3.6% in Denmark [261].

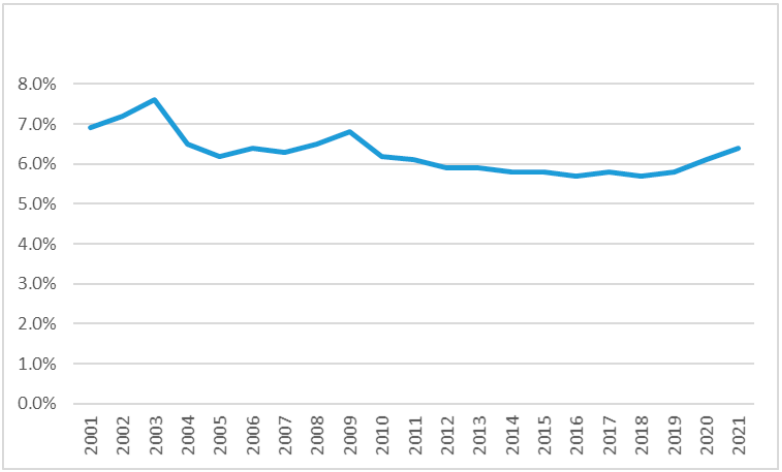

Figure 3. Total sick leave rate in Norway from 2001 to 2021
Data source: [256, 257]

The between-country variation in sick leave depends on different factors, one of which is the existing sick leave policies. In fact, a comparison of absence policies and absence rates may lead to a better perception of the principal causes of sick leave. For example, after comparing sick leaves in two different Nordic countries, Norway showed a higher sick leave rate in general than Denmark from 2016 to 2019 (see Figure 4). This trend was persistent in the data from 1996 to 2012 [262, 263].

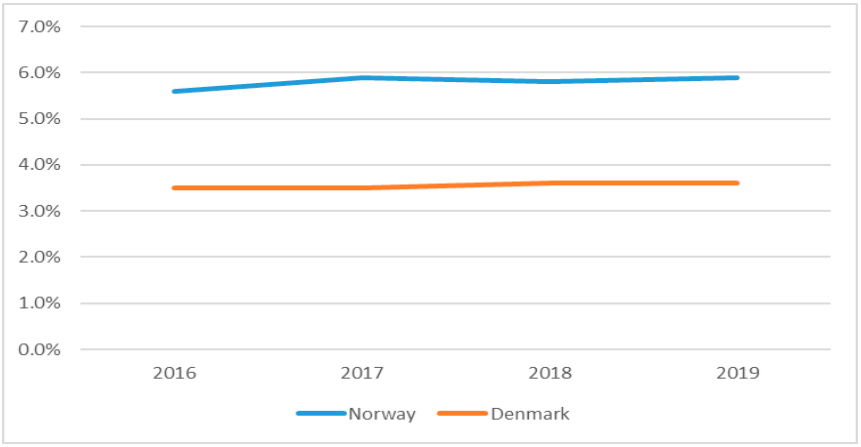

Figure 4. General sick leave rates in Norway and Denmark from 2016 to 2019
Data source: [265]

However, the short-term absence reports were quite different. Norway appeared to have lower rates of short-term absences than Denmark (see Figure 5).

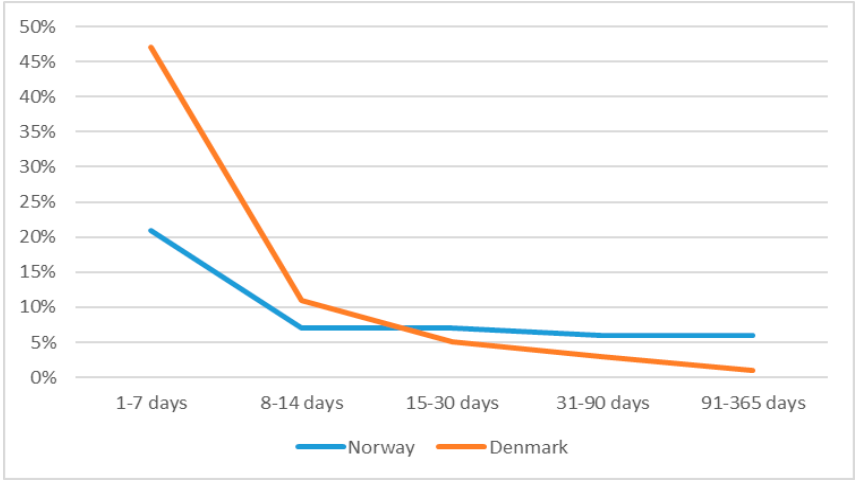

Figure 5. Proportion of employees with different absence days in Norway and Denmark between 2010 and 2011
Data source: [262, 266]

Such a discrepancy might arise from the two countries' different sickness policies and benefit systems. It is stated that Norway generally benefits from its 'generous' sickness benefits system [267]. That is, it is not common for an employee to get laid off due to sick leave in Norway. In contrast, in Denmark, where the 'flexicurity' system is in place, employees avoid taking sick leave because of their fear of getting laid off [262]. According to this system, most of the employment contracts comprise a paragraph concerning the 120 days' rule (i.e., the employee may be laid off in case they take more than 120 days off from work in a year). Therefore, two assumptions may arise here: (i) since a long-term absence in Denmark may lead to getting laid off, Danish employees may tend to take more short-term absences and refrain from taking longer absences; or (ii) taking more frequent short-term sick leaves may prevent higher total sick leave rates.

As sick leave can be an expression of employees' health situation [268], in addition to the existing sick leave system as a contextual factor, gaining knowledge of other environmental factors (e.g., shared understanding of values and beliefs in work settings, work conditions), as well as personal factors (e.g., socioeconomic status, employee health) may help to overcome barriers in getting back to work [269-272].

1.4.3 Meso level: Workplaces

The variation in sick leave rates is not just across societies but also across different sectors, branches, workplaces, departments, and types of occupations. For instance, the rate of sick leave in Norway is reported to be about 1.5 times higher in the public sector than in the private sector [273]. In this regard, studies have suggested that different factors—including shared beliefs about absence and employment, as well as work environment characteristics (e.g., existing technology, friendship patterns, job security, male- or female-dominated workplace, and communication)—can be the possible reasons for the variation in sick

leave in different work settings [274]. Studies have found that women take more sick leave in female-dominated workplaces than male-dominated ones [275, 276]. These studies suggest that female-dominated workplaces compared to male-dominated workplaces, develop attitudes among women that are more tolerant towards sick leave [275, 277].

Earlier research supports that the risk of taking sick leave can also increase in case of poor working conditions, including physical (e.g., ergonomic postures and workload) and psychosocial work conditions (e.g., exposure to bullying, low job control, and lack of influence) [23, 264, 278-281]. One study on stress-related factors and sick leave found a positive association between risky drinking, stress factors, job burnout, and sick leave [98]. This finding indicates that higher levels of sick leave are likelier when employees face stressful events and drink high levels of alcohol.

Alcohol-related sick leave is considered as being late for work, being on partial absence during a workday, leaving early, taking a one-day leave as a result of a hangover, and being absent for several days [282]. One study in 2016 reported that about five percent of sick leave days during the past 12 months were due to alcohol use in Norway [283]. Studies have found a strong association between higher levels of drinking alcohol and a higher prevalence of reporting impaired work performance [49, 282, 284] as well as higher rates of sick leave [29, 282, 285, 286]. Although the existing systematic reviews found fairly strong evidence for alcohol-sick leave associations, the reported associations were based on observational data, included fewer longitudinal studies [29, 285, 286], did not conduct a meta-analysis [29], and did not distinguish between registered versus self-reported data [29, 286] or short-term versus long-term sick leave data [285, 286]. Hence, one of the thesis objectives was to expand on the results from these studies in several ways.

One study on Swedish employees found that when the total alcohol consumption in the population increased by one liter on average, sick leave increased by 13% [36]. Subsequently, similar results were found in a study on Norwegian employees [37]. Several studies conducted in Finland and Sweden have also reported that drinking alcohol, as well as alcohol-related problems, are generally positively associated with taking sick leave for both men and women [35, 97, 100, 249, 287], while others found the opposite [248]. Moreover, an Australian study reported that employees with monthly risky drinking patterns are about 8.7 times likelier to report alcohol-related sick leave than employees with low-risk drinking patterns [288].

However, the notion of a positive and strong association between alcohol use and sick leave is not persistent. Some studies have found a negative association [289] or no association [248, 290-292], while others have reported a U-shaped association [97, 244, 249, 293]. It is worth mentioning that these studies defined and operationalized alcohol and sick leave differently or measured alcohol in combination with other substance use.

Another work-related factor, mentioned earlier, that may affect sick leave is shared beliefs in the workplace. According to the above-mentioned attendance model, Steers and Rhodes suggested that decisions on future illness behavior may be affected by organizational values [239]. These values, beliefs, and behaviors that develop normative assumptions can be acquired through the process of informal social interaction in work settings. Research on absence behavior and normative context have pointed out attitude as a potent factor for reporting sick leave. These attitudes were mainly towards possible causes for sick leave and impairment (e.g., towards cheating, work, flexibility, and peer referents' sick-leave related norms) [231, 294-297]. However, few studies have addressed absence behavior by considering the type of normative context and organizational culture. Moreover, the

majority of studies that explored the alcohol–sick leave association focused on individual determinants (e.g., sociodemographic). Therefore, to grasp the full picture of the alcohol-sick leave association, it may be beneficial to explore both the individual-level and group-level factors (e.g., norms and drinking attitudes) across different companies and work units.

1.4.4 Micro level: Employees

The studies that explored the alcohol-sick leave association suggested that the employees' sociodemographic characteristics, including socioeconomic status, gender, and age, are significant predictors of sick leave [298-301].

Socioeconomic status: as a personal factor, socioeconomic status was found to be strongly associated with health and sick leave, implying that lower socioeconomic status results in more sick leave reports [262]. An inverse relationship between socioeconomic status and both short- and long-term sick leave has been found extensively among men and at a lower rate among women [35, 245]. Health behaviors—including smoking, alcohol consumption, physical activity, and dietary habits—may explain a considerable part of the socioeconomic association with sick leave [23, 302]. There is empirical evidence that the association between alcohol use and sick leave is stronger among employees with lower socioeconomic status (education and income) [29].

Gender: in general, women report poorer health than men [303]. In Norway, in the third quarter of 2021, the sick leave rate (both self-certified and medically certified) was 4.9% for men and about 8.4% for women [257] (the same period as the COVID-19 pandemic [258, 259]). By looking into the records before starting the COVID-19 pandemic, the sick leave rate was 4.5% for men and about 7.4-7.5% for women in 2018 and 2019 [257]. However, owing to their higher levels of alcohol

consumption and binge drinking behavior [304], men seem to take more alcohol-related sick leave than women. In an Australian study, about 4.5% of men and 2.5% of women reported alcohol-related sick leave within three months [288]. In Norway, about 9.5% of men and 6.4% of women reported alcohol-related sick leave during the past 12 months [233, 305]. Another study on Norwegian employees found that men were about two times likelier to report alcohol-related sick leave than women [304]. Although women commonly report higher levels of sick leave than men [306, 307], their sick leave seems to be less affected by alcohol consumption.

Age: although age is a strong predictor in sick leave studies, no one has analyzed it in more detail. However, as young adults are found to indulge more in binge drinking than older ones [308], it can be assumed that they may report a higher rate of short-term sick leave (because of the direct effects of alcohol intoxication and hang over) as well. In this regard, one study reported a higher rate of self-reported alcohol-related sick leave among young employees [288].

Therefore, studying employees' alcohol use and sick leave demands an understanding of their sociodemographic characteristics, which are strongly related to work performance and work attendance.

1.5 Summary of the knowledge gaps

Over the last few decades, researchers, managers, and organizations have become increasingly concerned about individuals' alcohol-related problems. These concerns comprise both the general population (due to alcohol being a risk factor for deaths, contributing to more than 200 diseases and injuries, and imposing a considerable economic burden) and working populations (due to the economic costs of alcohol-related problems, increased work impairment, the rate of injuries and accidents, and productivity loss).

As the majority of adults are employed (70% in Norway) and spend a significant amount of time at work, the workplace is regarded as a favorable arena where workers share their understanding regarding the behaviors and attitudes for effective participation in a work setting. There is evidence that group norms and attitudes toward drinking are potent predictors of drinking behaviors. Individuals with positive drinking attitudes tend to drink more often than individuals with negative drinking attitudes. These prior findings emphasize the importance of norms and attitudes about adjusting alcohol-related behaviors. However, these studies were mainly conducted in non-work settings (e.g., college students) or used non-validated items to measure drinking attitudes. Moreover, there is a lack of research exploring the influence of gender and/or employment sector in the association between drinking attitude and the level of alcohol consumption. Therefore, there is a need to extend the existing literature by exploring a heterogeneous adult working sample in more detail using internationally validated instruments.

Existing norms and informal rules regarding drinking alcohol (social events after work, drinking on work-related travels), ease of access to alcohol, and the work environment can form different drinking patterns. For example, one to three out of ten Norwegian employees are found to be characterized as risky drinkers. Such drinking behavior may lead to a variety of adverse outcomes, with regards to productivity (e.g., impaired work performance), work environment (e.g., verbal abuse), behavioral change, and sick leaves.

Sick leave due to alcohol can be related to alcohol intoxication and hangover (for one or a few days) or negative health effects of alcohol over time (long-term sick leave). In addition, the rate of sick leave can vary with business and is influenced by various factors other than individuals' health behaviors, including organizational values, absence policies and benefits, work conditions, and work group culture. However, the majority of prior studies focused on individual

determinants (e.g., drinking behavior, sociodemographic factors) and focused less attention on group-level determinants (e.g., social norms and attitudes).

Moreover, regarding the alcohol–sick leave association, there is mixed evidence. Some studies found evidence for the higher prevalence of sick leave among individuals with alcohol-related problems, while others reported U-shaped associations and no or even negative association. Such disparities may be due to differences in the operationalization of sick leave, high variability of measurement approaches, sick leave benefits schemes, or adjustment for potential confounders, which makes international comparisons challenging. In addition, while attitudes toward drinking may impact sick leave, the contribution of drinking attitudes to sick leave remains to be clearly understood.

Altogether, the following main knowledge gaps in the prior studies were of interest to be explored in this thesis:

- Evidence on the relationship between alcohol consumption and sick leave in earlier published studies,
- The way in which alcohol and sick leave were measured in earlier studies,
- The status of drinking attitudes among Norwegian employees,
- The relationship between drinking attitudes and alcohol-related problems among Norwegian employees,
- The influence of gender and sector differences on the association between drinking attitudes and alcohol-related problems,
- The degree to which sick leave varies in different work units and companies,
- If alcohol-related problems can predict sick leave while accounting for work unit levels, and
- If drinking attitudes predict sick leave while accounting for work unit levels.

2 Aims of the thesis

This thesis aimed to obtain new knowledge and a deeper understanding of the relationships between alcohol consumption and sick leave, and how drinking attitudes might have a role in this relationship. The more specific aims related to each of the papers are as follows:

1. To provide an updated summary of the existing scientific literature on the association between alcohol consumption and sickness absence (Paper I).
2. To explore the differences in the relationship between alcohol consumption and sickness absence among subgroups considering measurement types, and longitudinal versus cross-sectional data (Paper I).
3. To explore the status of drinking attitudes among employees (Paper II).
4. To investigate the association between employees' positive or negative drinking attitudes and alcohol-related problems (Paper II).
5. To explore whether the association between drinking attitudes and alcohol-related problems is moderated by gender and/or employment sector (Paper II).
6. To explore the variation of employees' sick leave across the work units nested in companies (Paper III).
7. To investigate whether alcohol-related individual differences including drinking attitudes and alcohol-related problems can predict one-day-, short-term-, long-term, and overall sick leave days while considering the organizational structure of working units (Paper III).

3 Material and Methods

3.1 The WIRUS-project

This thesis is part of the Norwegian national WIRUS-project (Workplace Interventions preventing Risky alcohol Use and Sick leave). The WIRUS-project consists of six studies, which aimed to provide new insight into alcohol consumption, sickness presenteeism and sick leave, testing the impact of workplace-based alcohol interventions, carrying out cost-benefit and cost-effectiveness analysis of interventions, and share the awareness concerning drinking culture in Norwegian work settings. Other results from WIRUS-project have been published elsewhere [49, 96, 134, 135, 144, 284, 309-315].

Table 2 gives an overview of aims, study designs, study samples, data collection methods, and statistical analyses applied in this thesis.

3.2 Study I: Systematic review and Meta-analysis

3.2.1 Design

Paper I was designed as a systematic review and meta-analysis based on the Cochrane Collaborations recommendations [316]. The review protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO; registration number: CRD42018112078, registration date: 29/10/18) [317]. The paper is reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [318].

Table 2. An overview of the studies

	Study I: Article I	Study II: Article II	Study II: Article III
Aim	To explore and uncover relationship between alcohol use and sickness absence by looking at differences in type of design (cross-sectional vs. longitudinal), type of data (self-reported vs. registered data), and type of sickness absence (long-term vs. short term).	To explore the association between employees' positive or negative drinking attitudes and alcohol-related problems, and whether this association is moderated by gender and/or employment sector	To examine the relationship of alcohol-related problems and drinking attitudes with sick leave while taking into account the nesting of employees within working units within companies.
Design	Systematic review and meta-analysis	Quantitative, WIRUS[1]-screening study (Cross-sectional design)	Quantitative, WIRUS[1]-screening study (Prospective cohort design)
Study sample	A total of 59 studies including 162 tested associations between alcohol use and sickness absence	Participants (*n*=4,094) across 19 Norwegian public (*n*=12) and private (*n*=7) companies	Participants (n=2,560) clustered in 95 different departments across 14 Norwegian public (*n*=9) and private (*n*=5) companies
Data collection	Systematic search through six different databases (Medline, Embase, Cinahl, PsychInfo, Amed, and ISI Web of Science)	Using self-reported questionnaires, e.g., AUDIT[2] and DNS[3]	Using self-reported questionnaires (e.g., AUDIT[2] and DNS[3]), and company-registered work sick leave data
Analyses	Narrative descriptive analysis and meta-analysis	Analysis of covariance (ANCOVA) and multiple logistic regression models	3-level multilevel negative binomial regression analysis

[1] WIRUS = Workplace Interventions preventing Risky alcohol Use and Sick leave; [2] AUDIT = Alcohol Use Disorders Identification Test; [3] DNS: Drinking Norm Scale

3.2.2 Data collection procedures and instruments

Applied methods including protocol, eligibility criteria, databases and search strategy, study selection, data extraction, and quality assessment are described in detail under the method chapter in paper I.

Regarding the eligibility criteria, quantitative studies with observational and experimental designs on working population (salaried persons, hired and self-employed), which were reporting results on alcohol consumption and sick leave (from one or more statistical tests, data on participants that could be converted to odds ratios (ORs), and for at least two categories of alcohol intake levels), and were published 1980 or later in English or a Scandinavian (Norwegian, Swedish, or Danish) language were included.

By considering the above-mentioned criteria, we searched through six databases along with manual searches in two thematic blocks (abstract-level text) from 1980 to 2020:

(i) Exposure: drink* OR alcohol* OR drunk* OR hangover OR "hang over" OR alcohol drinking (MeSH) OR binge drinking (MeSH) AND (ii) Outcome: "sick leave" OR "sickness absence" OR absenteeism OR "lost work days" OR "lost work hours" OR "leave of absence" OR "work absence" OR "illness days" OR absenteeism (MeSH) OR sickness absence (MeSH) OR sick leave (MeSH).

After checking the titles and abstracts of the found studies, potentially relevant studies were assessed in full-text format independently by two reviewers. Regarding the data extraction, Relevant information was extracted independently by two reviewers. Standardization was necessary as studies were applying somewhat dissimilar alcohol consumption measures, according to each study's national guidelines.

To assess the quality of each association (included studies tested more than one statistical association between alcohol consumption and sickness absence), a modified version of the Newcastle-Ottawa Scales (NOS) [319] on five key domains were applied:

(i) Representativeness of the sample (non-random sample or inadequate description; probability or non-probability sampling procedure),
(ii) Measure of alcohol consumption (non-validated self-reported measure or inadequate description; validated self-report instrument),
(iii) Measure of sickness absence (self-reported or inadequate description; record linkage (register data)),
(iv) Level of adjustment (unadjusted or unclear; adjusted), and
(v) Test description (inadequate description or missing key information; adequate description of key information).

3.2.3 Statistical Analysis

In Paper I, included samples were analyzed in two different ways: narrative descriptive analysis, and meta-analysis. Due to using different measures and sub-groups, included studies had several tested associations between alcohol consumption and sickness absence. Therefore, for the descriptive part (Aim 1), the tested associations were used as the primary unit for analysis, as well as for quality assessment, rather than studies. Descriptive analysis was based on direction of associations (statistically significant positive; neutral; statistically significant negative) and type of measurement (alcohol: frequency and quantity, volume per day, average drinking per week, binge drinking, diagnosed problem drinking, and sales of pure alcohol; sickness absence: total number of absence days, short-term absence, and long-term absence).

For the meta-analysis, to find out the overall synthesized measure of pooled estimate (overall odds ratios (OR) with 95% confidence intervals

(CI)), a random-effect model was applied. To investigate measurement challenges and subgroup differences among included studies (Aim 2), a series of tests (e.g., subgroup analyses, sensitivity analysis, and Harbord regression-based test) and plots (forest plots, L'Abbe plot, and funnel plot) were applied. Sensitivity analyses were performed on both the meta-analysis part and descriptive part as studies explored alcohol in relation to sickness absence differently (e.g., alcohol and self-reported general sickness absence, self-reported alcohol-related sickness absence, or all-cause absence).

3.3 Study II: WIRUS-Screening study

3.3.1 Design

Paper II and III were based on data from the WIRUS screening study. Paper II was designed as a cross-sectional study of employees in 19 private and public companies in Norway, and Paper III was designed as a prospective cohort study on a sample of employees in 14 companies in Norway. Paper III, as a prospective cohort study, was a combination of cross-sectional alcohol screening data and longitudinal sick leave data.

3.3.2 Sample and data collection procedures

Employees (salaried employees in any blue, white, or pink-collar occupations) were recruited between 2014 and 2019 from private and public companies in Norway. The recruitment strategy tried to gather a heterogeneous sample of employees and workplaces. Hence, the included companies were recruited according to geographical, sector, and industry diversity. Companies represented the following economic activities: Transportation/storage, education, manufacturing, public administration, human health/social work activities, and accommodation/food service (categorized by the European Classification of Economic Activities [320]).

All employees in the included companies were invited to participate by receiving a web-based questionnaire via their employer-provided e-mail address. The inclusion criteria were: (i) age 16–72; (ii) salaried employees; (iii) basic understanding of the Norwegian language; and (iv) provided written informed consent.

Included participants and companies for Paper II and Paper III are presented in Figure 6. A total of 17,855 employees from 19 Norwegian companies were invited to participate.

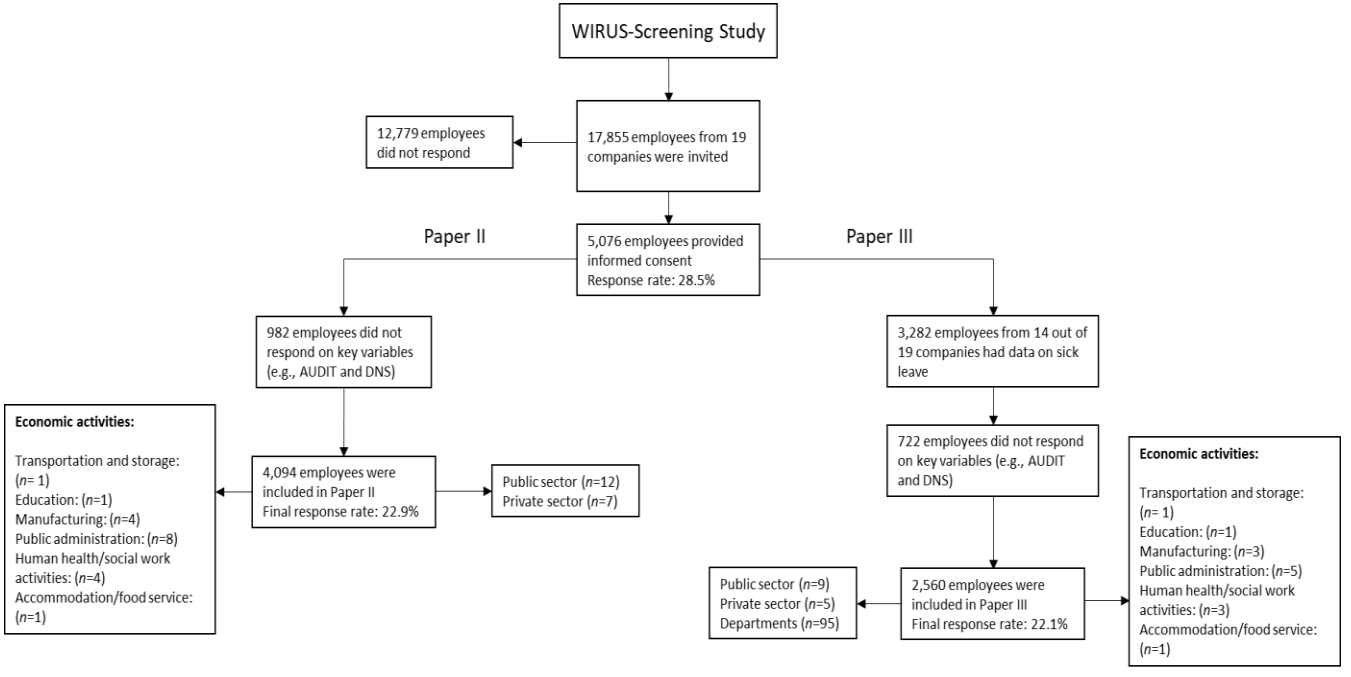

Figure 6. Flowchart for included participants and companies (Papers II and III).

Altogether, 5,076 employees (response rate: 28.5%) agreed to participate. However, only those participants who responded to all relevant items were included in the analyses. For Paper II, a total of 4,094 employees responded on all relevant study variables (e.g., drinking attitudes and alcohol-related problems). For Paper III, about 2,560 employees having valid information on key variables (e.g., drinking attitudes, alcohol-related problems, and sick leave data) constituted the final sample.

Discrepancy between 4,094 (paper II) and 2,560 (paper III): in Paper III, five companies including 1,794 employees were excluded due to not having data on sick leave. Due to the pandemic situation, the research team was not able to collect the data on sick leave for these remaining five companies.

The study samples for both Paper II and Paper III were predominantly female (66.0%). The majority of the respondents (Paper II: 71.5%; Paper III: 69.5%) were aged 40 or older, more than two-thirds had completed a university/college education (both papers), and approximately nine out of ten employees (Paper II: 90.4%; Paper III: 89.3%) were employed within the public sector companies. More detailed information about study samples is presented in Paper II and Paper III (Table 1).

3.3.3 Variables and measurements

The predictor and outcome variables in paper II were drinking attitudes (predictor) and alcohol-related problems (outcome), and in Paper III were drinking attitudes (predictor), alcohol-related problems (predictor), and sick leave (outcome). Control variables were age, gender, educational attainment, cohabitation status, position size, work position, and employment sector. An overview of variables can be found in Table 3.

Table 3. Overview of variables in Paper II and Paper III

Variables	**Paper II**		**Paper III**	
	Role	**Scale and application**	**Role**	**Scale and application**
Drinking Attitudes (Drinking Norms Scale)	Predictor	*In descriptive analyses:* Two versions of continuous and dichotomized (based on those who disagreed and those who agreed with the statement). *In regression analysis:* Dichotomized based on a median split (predominantly negative drinking attitudes: < 2.14 and predominantly positive drinking attitudes: ≥ 2.14).	Predictor	*In regression analysis:* Continuous (higher score = more positive/liberal drinking attitudes).
Alcohol-related problems (AUDIT)	Outcome	*In regression and descriptive analyses:* Dichotomized version of sum scores (presence of alcohol-related problems: ≥ 8, and without them: 0–7).	Predictor	*In regression analysis:* Continuous (higher score = higher levels of alcohol-related problems).
Sick leave	-		Outcome	*In regression and descriptive analyses:* Continuous (four types: one-day; short-term; long-term; overall sick leave days)

Gender	Moderator	*In regression and descriptive analyses and analysis of covariance:* Categorical dichotomous (male; female).	Covariate	*In regression and descriptive analyses:* Categorical dichotomous (male; female).
Age	Covariate	*In descriptive analyses:* Categorical version (18–29 years; 30–44 years; ≥45 years). *In regression analysis:* Continuous.	Covariate	*In descriptive analyses:* Categorical dichotomous (≤ 39; ≥40 years). *In regression analysis:* Continuous.
Educational attainment	Covariate	*In regression and descriptive analyses:* Categorical (primary/lower secondary; upper secondary; university/college).	Covariate	*In regression and descriptive analyses:* Categorical (primary/lower secondary; upper secondary; university/college).
Cohabitation status	Covariate	*In regression and descriptive analyses:* Categorical dichotomous (living alone; living with others).	Covariate	*In regression and descriptive analyses:* Categorical dichotomous (living alone; living with others).
Position size	Covariate	*In regression and descriptive analyses:* Categorical as fraction of full-time work (10–50%; >50–90%; 100%).	-	
Work position	-		Covariate	*In regression and descriptive analyses:* Categorical dichotomous (employee; middle manager or senior executive).
Employment sector	Moderator	*In regression and descriptive analyses:* Categorical dichotomous (private; public).	Covariate	*In regression and descriptive analyses:* Categorical dichotomous (private; public).

Composite scores on alcohol screening variables including alcohol-related problems and drinking attitudes were obtained from combining a collection of items, referred to as measurement scales [321]. One may develop these scales when one wants to measure events that cannot access directly but believes to exist due to his theoretical understanding. These measurement scales can be used to understand, evaluate, and differentiate physical or behavioral characteristics of individuals [322]. Although items in a scale measure various aspects, they represent the same characteristics of the respondents [323]. Therefore, various items involve assigning scores in a scale need to be evaluated extensively to confirm that items deliver consistent scores, referred to as the psychometric properties of a measurement instrument [322].

There are several key concepts relating to the psychometric properties of instruments, one of which is reliability [321]. Reliability refers to the overall consistency of an instrument in time and space. Different types of score consistency are considered by psychologists [324]. However, in this thesis, internal consistency reliability was employed to confirm that alcohol screening multi-item scales are consistent and reliable in the present study samples.

Internal consistency is typically measured by Cronbach's coefficient alpha, α, which is a pairwise correlation between items incorporated into a scale [325]. In general, scales representing alpha scores more than 0.60 can be considered as scales with acceptable internal consistency. In this thesis, alcohol screening scales including alcohol-related problems (Cronbach's α = Paper II: 0.71; Paper III: 0.78) and drinking attitudes (Cronbach's α = Paper II: 0.71; Paper III: 0.73) demonstrated acceptable internal consistency within the study samples.

Alcohol-related problems: the ten-item Norwegian translation of the Alcohol Use Disorders Identification Test (AUDIT), developed by World Health Organization (WHO) [9], was used in Paper II and Paper

III to measure alcohol-related problems. AUDIT items are presented in Appendix A (section A1). The AUDIT is widely used to assess alcohol consumption and related problems in a wide range of settings and populations [9, 326]. AUDIT covers three key domains including alcohol intake (items 1-3), dependence on alcohol (items 4-6), and alcohol-related harms (items 7-10) [9]. However, the recent confirmatory factor analysis of AUDIT by Skogen et al. (2019), suggested of using AUDIT as a unidimensional measure, that is, sum scores can be used as a measure of alcohol-related problem, as it is used in this thesis [96].

For Paper II, a dichotomized version of AUDIT based on the recommended threshold of ≥8 in total score as an indication of alcohol-related problems [9, 92] was employed. For Paper III, a continuous version (sum score) of AUDIT was employed. However, another version as dichotomized (threshold of ≥8 in sum score) was applied as an extra test to make sure that the results are consistent. Such a consistency was also tested by grouping individuals according to their pattern of responses on all AUDIT-items (latent classes probability). In this regard, different models were examined. However, the models with three or four classes seemed more reasonable. Since one class in the four-class model had low probability (4.2%) we opted to keep the three-class model. The classes were characterized as: class 1: low-level consumption; class 2: moderate level consumption; and class 3: higher-level consumption.

Attitudes towards drinking: the seven-item Drinking Norms Scale (DNS) [232] was used in Paper II and Paper III to measure drinking attitudes. DNS items are presented in Appendix A (section A2). The DNS was initially developed by researchers while taking into account the earlier study of Ajzen and Fishbein (1980) [327], as well as reviewing the existing social norms literature. This four-point Likert scale addresses two dimensions of norms about alcohol including attitudes toward drinking in general (items 1, 5, and 6) and work-related drinking (items 2-4, and 7), which can range from 1 (strongly disagree to 4 (strongly

agree). A low DNS score indicates a lower level (negative) of drinking attitudes, as opposed to a high score. Although the scale considers two dimensions, earlier psychometric analyses have suggested of using DNS preferably as a unidimensional measure [232], as it is used in this thesis.

For paper II, a dichotomized version and for Paper III, a continuous version (sum score) of DNS were employed. As no validated cut-off values for drinking attitudes were found in the literature, a median split (2.14 in paper II) was applied to turn sum scores into a dichotomized version. Although various methods can be employed to dichotomize a continuous variable, the best results seem to be obtained by median splits when having a variable with a symmetric distribution [328]. In this thesis, DNS showed a symmetric based on data from the WIRUS study.

Sick leave: sick leave was the outcome variable in Paper III. Our data set covered 14 public and private sector companies. Company-registered work absences occurring within 12 months before screening, as well as 12 months after screening were gathered from the employers. However, the research group decided to proceed only with the data collected after screening (i.e., prospective data).

Administrative register data for all the employees allowed us to link individuals to their own sick leave records, using the personal identification numbers. Normally, in some countries including the Nordic countries, administrative registries of sick leave data are being kept, which provide better access to detailed information of working populations [253, 254].

Information on registered sick leave was collected from day one. Duration and spells/episodes (i.e., number of times a type of sick leave has occurred) of sick leave in different forms including one-day (i.e., absences that only lasted one day), short-term (i.e., absences lasting for less than 14 days), intermediate (i.e., absences within 15-55 days), long-

term (i.e., absences more than 56 days), and overall absence (i.e., number of sick leave days within 12 months) were constructed based on collected registry data. Calculated days were based on calendar days, rather than working days, which allowed to include all days. However, other types of leaves including maternity leaves, pregnancy-related absences, and lengthy absences due to other reasons than sick leave (e.g., vacation) were excluded.

Several methods have been suggested to measure and operationalize sick leave data [246, 329, 330], which provide opportunities for various ways of analysis, reflecting different aspects of sick leave. However, three main recommended units in measuring sick leave are spells (i.e., episodes), time (i.e., duration as days or hours), and person (i.e., number/percentage of sick listed employees) [246]. Spells and days are the most common and person is the less common units of measure within the sick leave research [246]. Hence, to have the opportunity to compare our results with other studies in this area of study, in Paper III, sick leave days in four different durations as the units of measure were employed: one-day; short-term; long-term (combination of long-term and intermediate sick leave data), and overall absence days. However, as a sensitivity analysis, results based on sick leave spells were estimated as well.

Control variables: another group of variables (i.e., neither the predictors nor the outcomes) which were not of primary interest in the present studies, but their influence on the measure of associations need to be controlled, were included as control variables (see Table 4). Multiple approaches and criteria to select a variable as a control variable have been suggested [331]. However, these approaches are part of two broad domains: selection based on background knowledge and selection as a result of statistical analyses [332].

In this thesis, as the first step, control variables were selected by relying on earlier research [298-301, 333, 334]. Next, in order to rule out any spurious relations and avoid over-adjustment, associations between selected control variables and predictors, as well as outcomes were explored. More details can be found under the covariates chapter in the papers (Papers II and III). In addition, to ensure that the employed statistical approach has enough power to find any potential control variables, the level of *P*-value to reject the null hypothesis was raised to ≥ 0.20 rather than using a 0.05 level. This approach has been suggested for selection of potential control variables by several studies [335-337].

Therefore, in Paper II, age (18–29 years; 30–44 years; ≥45 years in descriptive analyses and continuous in regression analysis), gender (male; female), cohabitation status (living alone; living with others), educational attainment (primary/lower secondary; upper secondary; university/college), fraction of full-time work (10–50%; >50–90%; 100%), and employment sector (public, private) were included as potential confounders. Similarly, in Paper III, gender (male, female), age (≤ 39 years; ≥40 years in descriptive analyses and continuous in regression analysis), cohabitation status (living alone, living with others), educational attainment levels (primary/lower secondary, upper secondary, university/college), work position (employee, middle manager or senior executive), and employment sector (public, private) were included.

Moderators: in Paper II, to explore whether the association between drinking attitudes and alcohol-related problems is moderated by gender and/or employment sector (Aim 5), both gender and employment sector variables were used as moderators. Based on which work divisions the sample where employed, the employment sector variable was constructed. Further, employment sector was sorted into two groups of private sector (including transportation and storage, accommodation and food service activities, and manufacturing) and public sector (including

public administration, education, and human health and social work activities). The categorization was based on the European Classification of Economic Activities (Eurostat) [320]. More detailed information is presented under the measurement section in Paper II.

3.3.4 Statistical Analysis

Various quantitative methods were employed to describe the included predictor variables and explore whether, and to what degree, an association exists between variables within study samples. An overview of statistical analyses employed in Papers II and III is presented in Table 4.

Table 4. Overview of statistical analysis used in Papers II and III

Analysis	Paper II	Paper III
Descriptive statistics (frequencies (n), proportions (%), means (M), and standard deviations (SD))	X	X
Descriptive statistics (median and interquartile range)		X
Bivariate chi-square tests of independence	X	
Analysis of covariance (ANCOVA)	X	
Multiple logistic regression	X	
Negative binomial (NB) regression		X
Analysis of internal consistency (Cronbach's alpha)	X	X
Bivariate non-parametric correlation analyses (Spearman's rho)	X	X
Kolmogorov-Smirnov tests		X

Two main data analysis methods used in Papers II and III were descriptive statistics and inferential statistics. Descriptive statistics allowed us to summarize the characteristics of our data, and inferential statistics allowed us to test the present studies' hypotheses (i.e., associative tests) and draw conclusions.

To opt an appropriate statistical method, one may need to know the conditions, as well as the assumptions behind the statistical methods while considering study's aim, distribution and type of the data set [338]. Therefore, as the first step, distribution of data was checked visually for Papers II and III.

For Paper II, regarding the descriptive statistics (Aim 3), indexes such as mean and standard deviations (SD) were presented for symmetrically distributed continuous variables. Categorical variables were explored using series of cross-tabulations in order to report frequencies (n) and proportions (%), as well as to test their differences by applying chi-square tests of independence. The same procedure was followed for Paper III. However, for asymmetric continuous variables (sick leave data), median and interquartile ranges (IQRs) were the descriptive measures.

After exploring the type and normality of the data set, as well as checking the data for the absence of strongly influential outliers, regression models were selected. In Paper II, as the type of the outcome variable was categorical (presence or absence of alcohol-related problems), the logistic regression model was selected as the final statistical method (Aims 4 and 5). In Paper III, outcome variables were continuous with non-normal distribution, indicating the need for employing nonparametric methods. As outcome variables (one-day, short-term, long-term, and overall sick leave) were count data, Poisson models, zero-inflated regressions, and negative binomial distribution models were the

possible methods to apply [339]. After testing competing models, negative binomial regression model showed a better fit to the data set.

In Paper III, employees were from 95 different work units. As we aimed to explore the variation of sick leave across work units nested in companies, as well as the association between alcohol-related problems and drinking attitudes and sick leave among individuals clustered in work units within companies (Aims 6 and 7), 3-levels multilevel negative binomial regression models were estimated. More detailed information about used statistical methods can be found under the analysis chapter in Papers II and III.

Statistical software packages including Stata and IBM SPSS were used to conduct analyses. Latent class analysis, as well as multi-level negative binomial (NB) regression models were conducted using Stata version 17.0 [340], with functions gsem and menbreg, respectively. In addition, all descriptive analyses presented in Paper III were performed using IBM SPSS, version 26. However, for Paper II, all descriptive and multiple logistic regression models were conducted using IBM SPSS, Version 25.

3.4 Ethical consideration

Participants included in Papers II and III received an invitation letter and were informed about the overall aims of the WIRUS-study and were assured that their participation was voluntary. All participants provided written informed consent prior to participation (Appendix B, section B1) and were informed that they could withdraw their consent at any given time without any consequences. The Declaration of Helsinki, developed by the World Medical Association (WMA) in 1964 [341], was used to protect and respect the right of human participants in Papers II and III.

As this study was health research using personal data, getting approval to collect and store sensitive data was required. Hence, the WIRUS Screening study (Papers II and III) got approval from the Regional

Committee for Medical and Health Research in Norway (REK) (reference number 2014/647). As Paper I was a systematic review and meta-analysis of previously published literature and did not require recruitment of human participants, it was not considered necessary to get ethical approval for Paper I.

4 Results

The three studies contributed to fulfill the overall aim of the thesis, which was to obtain new knowledge and a deeper understanding of the relationships between alcohol consumption and sick leave, and how drinking attitudes might have a role in this relationship. The main results of the three papers included in this thesis are presented in Table 5.

Table 5. Overview of the main results of the present research

	Aim	Main results
Paper I	To explore and uncover the association between alcohol use and sickness absence by looking at differences in type of design (cross-sectional vs. longitudinal), type of data (self-reported vs. registered data), and type of sickness absence (long-term vs. short term) (Aims 1 and 2).	The majority of the tested associations indicated that higher levels of alcohol consumption were associated with higher levels of sick leave. Most associations indicating positive and statistically significant results were based on longitudinal data. Risky drinking was found to be associated with increased odds of sick leave. Increased risk for sick leave was more likely to be found in cross-sectional studies, studies using self-reported absence data, and those reporting short-term sick leave.
Paper II	To explore the status of drinking attitudes, and the association of employees' attitudes toward drinking with their alcohol-related problems, and whether this association is moderated by gender and employment sector (Aims 3-5).	A majority of the participants reported predominantly positive drinking attitudes. A higher proportion of men than women reported predominantly positive drinking attitudes. Employees with predominantly positive drinking attitudes were almost three times as likely to report alcohol-related problems compared to employees with more negative drinking attitudes. Gender moderated the association between positive drinking attitudes and alcohol-related problems. The association was stronger in women than in men. Employment sector did not moderate the association between drinking attitudes and alcohol-related problems.
Paper III	To explore variation of sick leave across the work units nested in companies. And to examine the relationship between alcohol-related problems, drinking attitudes and sick leave, while taking into account the nesting of employees within working units within companies (Aims 6 and 7).	Higher variations of one-day, short-term, and overall sick leave days were found between companies than between work units within companies. Alcohol-related problems and drinking attitudes were not associated with sick leave.

A brief presentation of the main findings of each paper is presented in the following section.

4.1 Paper I

Fifty-nine observational and experimental studies comprising a total sample of 439,209 employees from 15 different countries met the inclusion criteria to be included in the systematic review. However, only eight studies were eligible to be included in the meta-analysis. The majority of the studies were from Sweden (20%) and Finland (20%). Longitudinal design was the most applied study design in the included studies.

In total, 162 tested associations between measures of alcohol consumption and sickness absence from the 59 included studies were identified. The majority of the associations (91%) stated a positive association, that is, higher levels of alcohol consumption were associated with higher levels of sickness absence. More than half of the positive associations were statistically significant.

Altogether, 10 samples out of eight eligible studies were included in the meta-analysis to explore the association between risky drinking and sickness absence. The pooled likelihood of reporting sickness absence was more than two times higher among risky drinking employees (OR: 2.34, 95 % CI: 1.17-4.65). This association was more likely in studies employing cross-sectional designs (OR: 8.28, 95 % CI: 6.33-10.81), self-reported absence data (OR: 5.16, 95 % CI: 3.16-8.45), and short-term absence data (OR: 4.84, 95 % CI: 2.73-8.60) compared to their counterparts. Regression-based tests suggested no publication bias.

4.2 Paper II

Overall, 61.5% of employees reported positive drinking attitudes. The proportion of men reporting positive drinking attitudes were slightly higher than women (68.2% versus 58.0%).

One out of ten employees reported alcohol-related problems. Multiple logistic regression models (adjusted for gender, age, cohabitation status, educational attainment, fraction of full-time work, employment sector, and the interaction between drinking attitudes and gender) revealed that employees with positive drinking attitudes were almost three times more likely to report alcohol-related problems, compared to those with negative drinking attitudes (OR = 2.75; 95% CI: 2.00–3.76). The association was stronger for women (OR = 5.21; 95% CI: 3.34–8.15) compared to men (OR = 3.10; 95% CI: 2.11–4.55). However, employment sector did not show any statistically significant moderation effect.

4.3 Paper III

An average of 27 employees were working in each of the 95 work units (min. 10, max. 50). The average sick leave days for the median of work units within companies for one-day, short-term, long-term, and overall absence were 6.9 hours, 7.9, 7.5, and 15.2 days, respectively. One-day, short-term, and overall sick leave days showed statistically significant variations across companies, as well as work units within companies. Although for companies, one-day, short-term, and overall sick leave days explained 15.0%, 12.0%, and 30.0% of the variance in the model, respectively, these amounts for work units within companies were 0.0%, 5.0%, and 8.0%, respectively.

The three-level negative binomial regression models (adjusted for gender, age, cohabitation status, educational attainment, work position

and employment sector) showed no association between alcohol-related problems and one-day (IRR = 1.00; 95% CI: 0.97-1.04), short-term (RR = 0.99; 95% CI: 0.98-1.01), long-term (RR = 0.96; 95% CI: 0.89-1.03), or overall sick leave days (IRR = 0.98; 95% CI: 0.95-1.00) on work units within companies. Results based on the dichotomized version of AUDIT and on the classes identified using latent class analysis, yielded similar results.

Drinking attitudes, adjusted for gender, age, cohabitation status, educational attainment, and work position, showed no association with one-day (RR = 0.99; 95% CI: 0.96-1.04), short-term (RR = 0.99; 95% CI: 0.96-1.01), and long-term days (RR = 0.94; 95% CI: 0.88-1.01) on work units within companies. However, there was a slightly negative association between higher scores on drinking attitudes and taking sick leave (RR = 0.97; 95 % CI: 0.95-0.99), indicating that one-unit higher score on drinking attitude was associated with 3% less sick leave days.

Using sick leave spells as the outcome measure rather than days did not affect the results considerably.

5 Discussion

5.1 Overview of the knowledge gaps this thesis tries to fill

The overall aim of this thesis was to obtain new knowledge and a deeper understanding of the relationships between alcohol consumption and sick leave, and how drinking attitudes might have a role in this relationship. The reason for doing this dissertation work was based on eight identified knowledge gaps in the scientific literature. The eight main findings corresponding to the gaps are summed up in Table 6 and will be discussed in Section 5.2.

Table 6. Overview of the thesis' main findings

	Knowledge gaps*	Main findings**
1	We did not know if a relationship between alcohol consumption and sick leave was evident in earlier research (Aim 1).	Evidence from earlier research revealed a positive association between alcohol use and sick leave (Paper I).
2	We did not know how alcohol and sick leave were measured and thus how it was possible to investigate and compare them (Aim 2).	High variability of measurements assessing alcohol consumption and sick leave exist in the literature. Six different ways of measuring alcohol and three different ways of measuring sick leave were found (Paper I).
3	We did not know the status of drinking attitudes among Norwegian employees (Aim 3).	Higher proportion of employees reported positive drinking attitudes. The proportion of men reporting positive drinking attitudes was slightly higher than women.

4	We did not know if there is evidence of a relationship between drinking attitudes and alcohol-related problems (Aim 4).	Employees with predominantly positive drinking attitudes were almost three times as likely to report alcohol-related problems than those with predominantly negative attitudes (Paper II).
5	We did not know if gender differences influence the association between drinking attitudes and alcohol-related problems (Aim 5).	The association between drinking attitudes and alcohol-related problems was considerably stronger for women than for men (Paper II).
6	We did not know the degree to which sick leave varies in different work units and companies (Aim 6).	A high variation in sick leave across companies and work units was found (Paper III).
7	We did not know if alcohol-related problems can predict sick leave while accounting for work unit levels (Aim 7).	Alcohol-related problems showed no association with higher levels of one-day, short-term, long-term, and overall sick leave days between work units within companies (Paper III).
8	We did not know if drinking attitudes predict sick leave while accounting for work unit levels (Aim 7).	Drinking attitudes showed no association with higher levels of one-day-, short-term-, and long-term days, but showed a slightly negative association between higher scores on drinking attitudes and overall sick leave days between work units within companies. (Paper III).

* Based on accumulated evidence up until 2017, **As revealed in 2021 based on the contribution of this thesis from the WIRUS project.

5.2 Discussion of the main findings

5.2.1 Association between alcohol consumption and sick leave

The true association between alcohol consumption and the different types of sick leave seems to be complex and varies across different subgroups. The 59 studies that met our inclusion criteria in the systematic review article tested 162 associations, of which 58.0% (94 of 162) were positive and statistically significant, indicating that higher levels of alcohol consumption were associated with higher levels of sick leave. In these studies, the typical types of alcohol-related sick leave included being late for work, being on partial absence during workdays, leaving early, one-day absence due to hangover, or being absent for several days.

Evidence has demonstrated that there is inconsistency regarding whether risky drinking or light-to-moderate drinking (i.e., low-risk drinking [3]) levels impact individuals to a higher degree [342, 343]. Therefore, to reduce problems related to higher levels of drinking (i.e., risky drinking), it may be beneficial to know the characteristics of each level of drinking [344].

In this regard, in Paper I, we aimed to compare the three different levels of drinking, including abstinence, low-risk drinking (light-to-moderate drinking), and risky drinking. However, since abstinence was not reported in all studies, we only proceeded with the two remaining groups for the meta-analysis. The pooled estimates offered by the meta-analysis supported the positive association between risky drinking and sickness absence.

The findings from the systematic review and the meta-analysis are consistent with earlier reviews [29, 285, 286]. Although Amiri et al. (2020) [285] and Marzan et al. (2021) [286] found that higher levels of

alcohol use are associated with higher levels of sickness absence among employees, they did not distinguish between short- and long-term absences. One may assume that it can be beneficial to distinguish between these two types of absences. This is because short-term absence is generally related to alcohol intoxication and hangover, while long-term absence is related to the negative health effects of alcohol over time. Therefore, in the meta-analysis conducted in Paper I, the association between risky drinking and sickness absence was distinguished between short- and long-term absences. In this regard, a statistically significant association between risky drinking and short-term absence was found, which can be related to one-day hangover absence [345]. Moreover, although Schou et al. (2016) found evidence for the association between alcohol use and short-term absence, they did not conduct a meta-analysis, and their results were from descriptive analyses [29].

Schou et al. (2016) found the alcohol-sickness absence association mainly from cross-sectional data [29]. However, the vast majority of the studies in our systematic review that reported positive associations between alcohol consumption and sickness absence employed longitudinal data (70%). Thus, these studies may confirm the possible causal relationship between alcohol consumption and sickness absence in general. One may assume that longitudinal data are more reliable than cross-sectional data as it allows us to explain patterns of change in addition to the causal relationships among variables [322]. However, in the meta-analyses, risky drinking–sickness absence association when compared to low-risk drinking employees was found in studies that used cross-sectional data rather than longitudinal data. Having few studies (10 samples out of eight studies) in the meta-analyses may have been affected this observation.

In Paper I, it should be noted, different types of sickness absence related to alcohol—all-cause (general) sickness absence and self-reported alcohol-related sickness absence—were included. One may assume that

these two types of sickness absences are different and incomparable. Moreover, it may be reasonable that the found association from alcohol-related sickness absence would be stronger than the ones out of all-cause sickness absence. In this regard, after reviewing the included studies, five out of the 59 studies were found to be using self-reported alcohol-related sickness absence [288, 304, 346-348]. Even after omitting them, the majority of the studies were those that still found a positive and significant association between alcohol consumption and sick leave, indicating that higher levels of alcohol consumption are associated with higher levels of overall sickness absence.

However, the notion that alcohol consumption is associated with sick leave is not entirely common since some studies did report a lack of association between alcohol consumption and sick leave [248, 290, 292, 349]. In line with the findings from Paper I and earlier studies, in Paper III, we aimed to explore whether alcohol-related problems can predict sick leave in a sample of Norwegian employees by considering the organizational structure of working units. However, we found that alcohol-related problems did not predict sick leave in our sample.

Alcohol-related problems showed no association with one-day, short-term, long-term, and overall sick leave days. Moreover, although almost all types of sick leave variables demonstrated statistically significant variation across companies and work units within companies, the explained variances decreased substantially when alcohol-related problems were added to the model. This result provided support for the lack of a significant association between alcohol-related problems and one-day, short-term, long-term, and overall sick leave in our data set. This finding is inconsistent with prior Norwegian studies that reported an association between alcohol consumption and sick leave [283, 304, 350]. However, Edvardsen et al. (2015) reported the prevalence of self-reported alcohol-related absence and did not actually test the association between alcohol use and sick leave [283]. In addition, Schou et al. (2014)

used a measure of self-reported alcohol-related absence (i.e., the respondents reported alcohol use as the cause of their sick leave) [304]. Østby et al. (2016) used registered all-cause sickness absence as the outcome measure [350]. More importantly, none of these studies used measures of AUDIT/alcohol-related problems as a predictor. Although variations in measurement among the earlier studies offer opportunities to examine the different dimensions of sick leave and alcohol consumption, it can be challenging to compare our results with other Norwegian studies. Moreover, in addition to measurement challenges due to cultural and organizational differences, any direct national or international comparisons may be complicated.

Measurement challenges were found in the literature. By conducting the systematic review in Paper I, we gained a comprehensive understanding of the possible components that can lead to discrepancies in research findings, which were not focused on in the earlier published systematic reviews. These components can be the involved population, measured alcohol, and measured sick leave. For instance, Hermansson et al. (2002), who found a positive association between alcohol-related problems and sick leave, included only employees from transportation in their study [102]. Such a study sample may influence data construction and limit the generalizability. However, in Paper III, we included employees from different work settings. Although Paper III includes data on employees from different work settings, the response rate in this study was relatively low (22–23%), and the sample may not be representative of the Norwegian workforce. Such a low response rate may explain the lack of association between alcohol-related problems and sick leave in Paper III. This issue is discussed in the methodological consideration in Section 5.3.

How sick leave is reported may be a crucial aspect to consider. From the meta-analysis in Paper I, we found the association between risky alcohol consumption and sick leave in the studies that employed self-reported

absence data (OR: 5.16, 95 % CI: 3.16–8.45) and no association in studies that employed registered sick leave data (OR: 1.16, 95 % CI: 0.57–2.36) when compared to low-risk drinking employees. In line with this finding, we found no association when we used register-based sick leave data in Paper III. Since there are many potential causes for registered sick leaves, the association between alcohol use and all-cause sick leave (particularly longer-term absence) is likely to be weaker. Moreover, although the registered sick leave data, which is available in a few countries, is assumed to be valid and more reliable than self-reported sick leave data [252, 297], some methodological issues may be linked with this type of data. It is generally confirmed that self-reported sickness absence is based on individuals' self-assessment, while registered/certified sickness absence is based on general practitioners' assessments. However, registered sickness absence depends on the individuals' own decision whether to ask for medical help. Hence, individuals' evaluation of when to seek medical help for sickness absence directly depends on the self-assessment of their health and may influence not only the employees' absence type (self-reported and certified) but also absence duration (short-term and long-term) [297].

The way data is registered differently in different countries deters us from drawing any conclusions or comparing our results. For instance, at the macro level, sick leave days less than 14 calendar days are not generally registered in Sweden [262]. However, it should be mentioned that in some special cases, absence days less than 14 days can be registered. For example, when individuals have chronic diseases that make them prone to take a lot of short-term absences. In this situation the employer may arrange for short-term absences to be covered/paid by the government. At the meso level (organizational level), the reliability of the systems employed to record sick leave data by different organizations varies extensively, which can lead to discrepancies in results [351]. On the other hand, at the micro level (individual level), attendance decisions (i.e., decisions on whether to attend work or seek

medical help) may influence the data to be self-reported or registered (medically confirmed).

How alcohol was measured in Paper III when compared to the included studies in Paper I is another factor that impedes the comparability of the results. Although some of the studies found no association between alcohol consumption and sick leave, either their measurement methods differed [288] or they focused on the frequency of drinking rather than risky drinking [99, 352]. Even among those studies that found an association between alcohol consumption and sick leave, alcohol consumption was measured by average weekly volume [250] or drinking volume per day [353]. In addition, when it comes to responses to health surveys, the participants tend to answer sensitive questions selectively, thus potentially underreporting their actual alcohol consumption. Under-reporters or non-responders to alcohol questionnaires, studies have shown, are commonly those with alcohol-related problems [354, 355], resulting in an underestimation of the association between alcohol-related problems and sick leave.

The findings from this thesis show how various measures and cultural issues can influence the association between alcohol and sick leave in different ways. Some causes of sick leave or work attendance are interrelated. Differences in sick leave system (e.g., sick leave benefit systems) in various societies are attributed to differences in taking sick leave [356, 357]. Various existing systems may not only lead to different sick leave behaviors but also affect some lifestyle factors, including alcohol consumption [357]. In line with this, some reports state that Norwegians, owing to their generous sick leave benefit system, have a higher rate of sick leave compared to Sweden, Denmark, and Finland [267]. Consistent with this statement, when we compared the four Nordic countries included in Paper I, the studies conducted in Norway showed a considerably higher likelihood of reporting alcohol-related sick leave

than Denmark, Sweden, and Finland among employees [37, 250, 254, 283, 304, 348, 350, 358-362].

Additionally, some countries (e.g., Sweden and Finland) do not register short-term sick leave data in national registries [262]. In this regard, although our non-association results in Paper III are in line with some studies (adjusted results) conducted in those countries [97, 292, 363-365] because of their rules about data registration, we cannot make any final conclusions. However, we can relate our results to their findings on overall sick leave (i.e., the total number of days absent from work).

As a phenomenon, sick leave may be influenced by components other than health issues. These components may influence health behaviors (e.g., alcohol consumption) and, accordingly, attendance decisions. The observed variation of sick leave between and within companies and their work units in Paper III may be explained by the concepts of absence culture and social context, both outside and inside the workplace [274, 351]. In line with this notion, absence culture can be developed according to some degree of cultural salience and trust in the psychological contract [274]. For example, as earlier studies have suggested, compared to employees with internal control, employees with more feelings of external control generally have a strict perception of taking sick leave [274, 366].

Moreover, in different organizations, several issues—teammates' behavior, workload, industrial downsizing, ethnic group, and so on [293, 365, 367-372]—may explain the variation of sick leave between and within companies as well as their work units. Further, some of these factors may affect sick leave indirectly through the influence of health behaviors. For instance, some studies included in Paper I showed that colleagues' and supervisors' behavior, as well as job stress, can affect the amount of alcohol consumed and, accordingly, increase sick leave [345, 373].

5.2.2 Drinking attitude and its association with alcohol-related problems and sick leave

Adults spend a large part of their time at workplaces. Workplaces offer a significant social context in which, through the social interaction process, employees can share and acquire knowledge regarding the behaviors and attitudes expected for effective participation in a work setting [226]. To put it another way, organizations cannot be properly understood without understanding their broader social and cultural contexts [374]. In this regard, in Papers II and III, we aimed to explore whether there is an association between drinking attitudes and alcohol-related problems and sick leave in a sample of Norwegian employees, and whether the drinking attitudes–alcohol association is moderated by gender and/or the employment sector.

In Paper II, a majority of the employees reported predominantly positive drinking attitudes, a finding that is in line with Nordlund (2008) [375]. Nordlund illustrated how Norwegians' attitudes toward drinking alcohol have become more liberal and permissive since 1964. Since average alcohol consumption has increased substantially over time in Norway, our finding was not surprising. As per the records from 2010 to 2020, the average amount of alcoholic beverage consumption increased from 89 liters to 95 liters per capita [376].

Another explanation for finding predominantly positive drinking attitudes in the present study sample may be the influence of socialization in an organization; for example, the formal/informal social contexts during which alcohol is served in organizations (e.g., when a new employee acquires information to effectively participate in a work group [226, 377], work-related travels, or socializing with colleagues after working hours [135]). This type of socialization can be part of long traditions in companies or some lines of industries [233]. Several studies

have highlighted the significant role of socialization in shaping human behavior [226, 374, 378-380].

In Paper II, perhaps not surprisingly, we found that predominantly positive drinking attitudes were more frequent among men than women, an expected result since men generally exceed women in both levels of consumption and problem drinking [165, 174-177]. For alcohol-related gender differences, there is no single explanation, but there might be multiple contributing factors, including biological differences, asserting power, and social responsibilities [103, 191, 381, 382]. However, drinking levels among women have increased over time and now become closer to men [175, 181]. In countries with societal gender equality, such as the Nordic countries, studies have found smaller gender differences in term of alcohol drinking behavior [165, 182, 184-186, 383].

The finding that men have more frequent and predominantly positive drinking attitudes than women is in line with the findings of prior studies [235, 384, 385]. However, all these studies considered a sample of non-working population (e.g., general population or college students). As such, to our knowledge, our study (Paper II) was the first to explore gender differences in relation to drinking attitudes in the working population.

Moreover, by studying the sample characteristics in Paper II, men were, as expected, likelier to have a full-time position (91.3% vs. 75.8%) and a higher position level (26.3% vs. 15.0%) compared to women. Studies suggest that employees holding higher position levels (e.g., managers) [386, 387] and full-time positions [388, 389] have less job satisfaction, experience higher levels of stress and conflict, and receive less social support when compared to employees with lower position levels and part-time jobs. Consistent with this notion, it is suggested that, as a coping mechanism, men with higher levels of stress tend to drink alcohol, expecting it to reduce their stress [235, 390, 391]. Hence, this

notion, among other assumptions, may explain the higher proportion of men who reported positive drinking attitudes than women in the present study sample (Paper II). To disentangle the relationship between job-related stress and tension, and drinking attitudes and health, further research is needed.

A positive association between drinking attitudes and alcohol-related problems was found, implying that employees with predominantly positive drinking attitudes are likelier to report alcohol-related problems than those with predominantly negative attitudes (Paper II). Our finding is in line with earlier studies in this field [194, 205, 206, 392-394], which found attitude toward drinking a strong predictor of drinking frequency, quantity, binge drinking, and alcohol-related problems. However, none of these studies studied a working population.

Such an association may be explained by the theory of planned behavior [378] and the social norms theory [395]. These theories demonstrate how human behavior can be influenced by one's perception of what is approved or disapproved. In a study on the evaluation of the theory of planned behavior, Cooke et al. (2016) reported that attitudes, when compared to other predictors/factors, exerted the strongest influence on drinking behavior [234].

In Paper II, the identified association between predominantly positive drinking attitudes and alcohol-related problems was, unexpectedly, stronger for women than men. However, due to the type of available data in this study, we were unable to explore the mechanisms behind this finding. As women have traditionally been exposed to stricter drinking norms than men [396], they may be more conscious of their attitudes to avoid possible social sanctions. Although our finding is inconsistent with earlier studies [235, 384], in contrast, drinking by women is generally acceptable in Norway. There is also a narrower gender gap in drinking alcohol (i.e., gender convergence in drinking alcohol) [165].

Further, in Paper II, we aimed to investigate the moderation effect of the employment sector on the observed association between drinking attitudes and alcohol-related problems. In contrast with prior studies that reported a significant influence of the work setting on shaping drinking attitudes and drinking behavior [230, 232, 397-399], we found no differences. The lack of employment sector interaction on the association between drinking attitudes and alcohol-related problems may be explained by the existing strict alcohol policies as well as rules on alcohol availability at work in Norway. However, the prior studies that reported the influence of work setting featured organizational cultures and policies on drinking alcoholic beverages that are different than those found in Norway.

Compared to other countries and their organizational cultures (e.g., in the USA and Australia) [136, 137], drinking alcohol or consuming other psychoactive substances before or during work is uncommon in Norway [139]. Moreover, some Norwegian companies employ workplace drug testing (WDT) programs—as pre- and post-employment testing (randomly) to monitor employees' psychoactive substance use—the results of which can directly influence individuals' employment status [139]. Implementing such a program may deter the formation of some kinds of attitudes within a work culture. Accordingly, it is suggested that individuals with alcohol-related problems may not apply for employment in companies with strict alcohol-related policies [230].

Since alcohol consumption, as a health-related behaviors, may influence individuals' decision to take a sick leave or go to work ill, we believed that it is necessary to incorporate the possible effect of the existing norms and attitudes across work units within companies on taking sick leave as well. It could be assumed that organizations characterized by more liberal drinking attitudes may take a more laissez-faire approach to control employees' behavior generally and therefore be characterized by more permissive absence norms.

However, since we found no association between alcohol-related problems and sick leave measures, finding no consistent association between drinking attitudes and sick leave was unsurprising (Paper III). Although several studies have examined organizational cultures, attitudes, and sick leave associations [297, 400, 401], this study is the first to explore the association between drinking attitudes and sick leave. We thus cannot compare our observed results with other studies. Moreover, it is not clear whether we will get the same results in different cultures and societies.

To explain our findings, we can refer to the cultural and organizational challenges discussed in Section 5.2.1 and by looking into the sample characteristics described earlier. Although we included a sample from a wide variety of settings, almost 89.3% of the sample was employed in the public sector. A prior study that focused on the type of organizations in Norway reported that employees working in the private sector have more positive drinking attitudes as well as more alcohol-related problems than individuals working in public sectors [233]. This can be related to existing alcohol practices, such as free drinking vouchers offered by their workplaces. Moreover, work impairment, alcohol-related sick leave, and positive attitudes toward alcohol-related sick leave are found to be more prevalent in private sectors and more restricted in public sectors [233]. In addition, employees in the public sector are found to be more aware of alcohol use guidelines at the workplace than private sector employees. Hence, it can be assumed that public sectors may attract individuals with certain attitudes and beliefs, or—to look at it differently—some shared beliefs and attitudes may form in such employment sectors [297]. Future research may explore the influence of the employment sector on the association between drinking attitudes and sick leave.

5.3 Methodological considerations

It is inevitable that a researcher influences the research methods and results. Although quantitative research methods are found to have a risk of bias, and this bias may cause a discrepancy between the observed measurements and the true values, the researcher needs to understand and limit the impact of potential bias on the conclusions (i.e., enhancing their validity and reliability) [402]. Therefore, in this section, the methodological issues of the thesis, including its strengths and limitations, will be discussed.

This thesis was based on a large survey and company-registered data that provided a detailed investigation of alcohol-related factors and sick leave. In the following sections the factors that can impact both the reliability and validity (internal and external validity) of our research, including the research designs, representativity of the studies' sample and selection bias, and measurement challenges will be discussed.

5.3.1 Research design

Quantitative research studies rely on two main design categories: experimental (e.g., the influence of the researcher on what may occur to some or all of the participants) or observational (e.g., when the researcher acquires the desired characteristics, measurements, or attributes without manipulating them) [403]. In this regard, to offer an explicit insight into the multifaceted association between alcohol consumption and sick leave, in Paper I, both observational (cross-sectional, longitudinal, cohort, panel, and case-control) and experimental (randomized controlled and quasi-experimental) studies were included in the review. The vast majority of the included studies in Paper I were using longitudinal data (70%), which allowed causal inferences regarding the relationship between alcohol and sickness absence. However, due to the long data collection time and coincident effect of the confounding

variables [322], the internal validity of these included longitudinal studies could be threatened.

Paper II was based on cross-sectional data, which did not allow us to discover changes over time and draw causal inferences. However, choosing a cross-sectional design was in accordance with this paper's aim. Paper II aimed to explore the possible associations between included variables without revealing causal mechanisms. Hence, having a cross-sectional design in this study allowed us to capture an image of the status of alcohol-related problems, drinking attitudes, and a set of control variables at a specific point in time and in a shorter time. However, in this study, we were not able to conclude about the direction of the observed attitude-alcohol problem association. Some studies suggest that behavior forms attitudes [404], while others (e.g., health behavior models) assume the other way around, that attitudes form behavior [405].

In Paper III, a cross-sectional design (for alcohol-related variables) was conducted as a baseline in planning a prospective cohort study (for company-registered sick leave data). In this regard, we were able to link employees' information on alcohol-related variables and general characteristics to their records on sick leave. Employing a prospective cohort design is suggested to be useful as it helps to collect information on an event that occurs frequently [322] (e.g., in this case, taking different types of sick leave). In Paper III we were able to collect data on employees' company-registered sick leave for both 12 months ahead of the screening and 12 months after screening. However, we faced some limitations while employing a cohort design. This approach was time-consuming, and we faced an extensive loss of subjects to follow-up their sick leave days. Some cases were dead, some decided to withdraw from the study, and some were no longer working in the included companies. Moreover, unexpected events such as COVID-19 pandemic deterred us

to collect the sick leave data from the remaining companies (five out of 19 companies).

It is worth mentioning that our data were collected from 2014 to 2019, so it is not clear whether findings on the absence of association between alcohol and sick leave still apply to the studied sample. A study exploring the changes in alcohol consumption in Norway revealed that the proportion of risky drinking increased during the first phase (i.e., the first three months) of the COVID-19 pandemic [406]. Moreover, the rate of sick leave is also found to be increased during the same period [258, 259]. Therefore, one may obtain different results by looking into the current study samples while considering the conditions generated by the COVID-19 pandemic.

5.3.2 Representativity and selection bias

One of the factors that may threaten the internal and external validity of this thesis is selection bias (systematic error). This factor was probably the main methodological concern in this thesis. This sort of bias can occur during the recruitment process [407, 408] (e.g., recruitment of participants in Papers II and III, and study selection in Paper I).

In Paper I, the included studies were based on large sample sizes that focused on specific or general working populations. However, our study selection criteria may have caused a study selection bias. The eligibility criteria in Paper I was based on the authors' knowledge and tried to define inclusion/exclusion criteria by PICOTS clearly to avoid bias. However, regarding the inclusion criteria for the timeframe, studies published from 1980 onwards were included. Due to changes in alcohol drinking culture and sickness absence policies over time, studies published prior to 1980 may not be relevant for today's alcohol-sickness absence association.

For the screening study in Papers II and III, to rule out any potential selection bias, all the employees from different work settings were invited to participate. However, self-selection (i.e., the preference of the participants) specified whether they participated or not. Although these two papers comprised large samples, we found 23.0% and 22.0% response rates, respectively, which might be quite low and can lead to non-response bias [409]. However, such non-representativeness was unintentional, as both Papers II and III included random population samples and individuals' participation was voluntary. Non-response bias may have potentially threatened the validity of the analyses and the accuracy of the estimates in both Papers II and III. One study on nonparticipants in a population-based health study has suggested that non-participation bias influences prevalence estimates to a larger degree than associations between exposure and outcome [410]. In this regard, non-participation bias may have affected and underestimated the reported prevalence of drinking attitudes, alcohol-related problems, and sick leave greater than the observed associations between them in Papers II and III.

As the presence of the researcher can affect the participants' decision on taking part in the study or not, WIRUS-project aimed to invite employees to participate by a web-based questionnaire via their employer-provided e-mail address. Therefore, the observer effect, which is a potential issue on non-participation [411], was eliminated. Moreover, as WIRUS-project was framed as being related to work, alcohol, and sick leave, we could expect to face low participation of invited companies and invited individuals. Further, as the process of collecting data was a time-consuming process (as mentioned above), many individuals decided to withdraw from the project, or were excluded due to death, or termination of their employment contract with the included company. Withdrawing from the project could be due to having a busy schedule or health-related situations.

However, among those individuals who agreed to participate in the project (5,076 out of 17,855) and did not withdraw from the project, a considerable number of employees were excluded in both Papers II and III due to not responding to all relevant items in the analyses. In Paper II, around 982 employees and in Paper III around 722 employees did not respond to key variables (e.g., AUDIT and DNS). Studies have suggested that low participation rate and non-responding to health-related questionnaires happens among individuals who are less healthy than responders [412]. These groups are mainly men, individuals with low socioeconomic status, and individuals having drinking problems [410, 413, 414]. Therefore, in both Papers II and III, we checked whether the respondents (study sample) are systematically different from the non-respondents (invited sample) on the study measures.

In our data, in both Papers II and III, the proportion of women and older participants (≥ 40 years old) were two-fold greater than the proportion of men and younger participants, respectively. In addition, highly educated employees (university/college) were overrepresented. Generally, as studies have indicated, men drink more alcohol than women, and younger employees drink more than older employees. Thus, it is likely that alcohol use was underestimated in this sample. The difference between the gender distribution in this study and the invited sample was not significant (Paper II: p=0.613; Paper III: p=0.431), indicating no difference in gender. However, age distribution was found to be significantly different in both Papers (difference in percentage points = 4.9 (Paper II) and 5.0 (Paper III); p <.001). Indicating that younger employees (≤ 39 years old) were about 5.0% underrepresented. When compared with the overall Norwegian workforce, women, employees age ≥ 40, employees with higher educational attainment, and employees employed in public sectors in both samples of Papers II and III were overrepresented. Although these studies did not aim to present the overall workforce of Norway, we may be cautious when generalizing the findings from Papers II and III to the Norway working population.

Taken together, having low response rates may have an impact on the obtained results and, subsequently, generalizations should be made with caution. It is, however, not clear whether similar outcomes concerning the relationship between drinking attitudes, alcohol consumption, and sick leave would be obtained by having a more representative sample.

5.3.3 Measurement methods and definitions

Self-reported alcohol surveys: Another important issue to be considered is related to employing self-reported questionnaires in Papers II and III. Since participants tend to answer some sensitive questions selectively, they may have underreported their real alcohol consumption. Under-reporters or non-responders to alcohol questionnaires are commonly heavier drinkers [354, 355]. When they are asked to self-report their levels of alcohol use or their attitudes toward a behavior, people are likelier to be influenced by Social Desirability Responses (SDR) [415-417]. Studies have reported a discrepancy between actual alcohol sales and self-reported alcohol use [418]. Therefore, participants in Papers II and II may have tried to display a favorable image of themselves on questionnaires, and subsequently, their alcohol use and drinking attitudes may have been underestimated in this thesis.

In this thesis, self-reported alcohol-related problem was measured with the AUDIT. A validated instrument with good internal consistency ($\alpha > 0.80$) [419, 420] that has been frequently used, vastly supported, and well-documented by an abundant number of studies [9, 421-424]. However, it was not possible to compare the AUDIT scores with the other objective measures of alcohol use employed in other studies. Moreover, we were not able to compare AUDIT scores with studies conducted in countries with different drink sizes, drinking units, and standard drinking limits.

Still, AUDIT, being a self-reported measure, have important limitations. Since individuals may have underreported their alcohol consumption, the AUDIT scores can be biased in this thesis by the underestimation of risky drinking. In this regard, it has been found that estimates of actual alcohol sales are considerably higher than the estimates of self-reported alcohol consumption [425].

Moreover, self-reported alcohol-related surveys in Papers II and III may have been affected by recall bias (i.e., when the respondents do not have a precise picture of what happened when they are asked about their past events) [426]. Therefore, alcohol consumption may have been underestimated or overestimated in this thesis. It is suggested that selecting the desired reference period, which can range from "during the past year" to "during the past seven days", may influence the way in which alcohol consumption can be measured and assessed [426]. In this regard, by considering short periods (e.g., seven days or less), respondents can provide more detailed information about the volume, the exact number, and the type of alcoholic drinks they consume every single day. This approach may minimize issues regarding recall bias.

However, by using a short reference period, we may not only misclassify infrequent alcohol drinkers but also not find out the respondents' typical alcohol consumption throughout a year and, accordingly, not be able to assess their alcohol-related problems [9, 426-428]. Hence, to explore both individual-level alcohol consumption and alcohol-related problems, it is recommended to consider a longer reference period (e.g., one year) when designing a research study on alcohol [426, 427]. In this thesis, by employing the AUDIT questionnaire, which asks about alcohol use during the past year, we were able to assess the respondents' typical drinking and alcohol-related problems.

When asking respondents to respond to long-term or typical alcohol consumption, they tend to talk about their recent drinking events [428,

429], thereby possibly not taking into consideration their alcohol use on some holidays or festivals (e.g., Christmas, summer holidays). In this regard, one study in Norway found that seasonal variations in alcohol use influence self-reported long-term and/or typical alcohol consumption [430]. That is, the respondents reported the highest level of alcohol consumption in the summer months. This finding was consistent with the registered data on alcohol sales. Therefore, AUDIT may have been biased by this issue in this thesis.

A discrepancy in the definition of alcohol consumption: the differences in the definition of a standard drink as well as sick leave duration in earlier studies may cause challenges and accordingly affect the generalizability of results. In this regard, we were not able to compare our results from Papers I and III with some of the earlier published studies due to discrepancies in definitions and measurements.

Standard drink sizes vary extensively in different countries (e.g., ranging from 8 grams/day in the UK to 19.75 grams/day in Japan) [426, 431, 432]. By being aware of the standard drink size, one may be able to report a more exact level of consumption and adhere to low-risk drinking habits and reduce risky drinking. A review of 32 studies that focused on standard drink size found that those who drink alcohol are often unaware of the size of a standard drink in their countries and, subsequently, their actual drink size exceeds that of the standard drink [433].

The recommended drinking levels for women and men also vary extensively in different countries (although WHO does not recommend anyone to drink but recommends risky drinking levels). For example, in the Netherlands, the standard drinking level is 10 grams/day for both men and women [434]. However, in Belgium, the standard amount is up to 21 drinks per week for men and 14 for women [435], and in Norway, it is having 20 grams/day for men and 10 grams/day for women [434, 436]. Although countries disagree on employing the same definition of

recommended drinking levels for women and men [61], the WHO guidelines define 10 grams of pure ethanol per day for both men and women as the standard drink size [62, 437]. In this thesis, for the review article (Paper I), to be in line with the general definition, we used 10 grams/day as the standard drink size.

The existing variations surrounding the definition of the standard drink size may lead to discrepancies in the threshold of low-risk and risky drinking in different cultures [431]. This variation can also be referred to as the time frame for the limits (e.g., daily or/and weekly). For instance, the measures in Denmark and Finland are based on weekly drinking limits, and in Canada and the UK, the measures are based on both daily and weekly limits [431]. Hence, since the size of servings is mainly formed by local cultures and habits, the lack of consistency in the definition of the standard drink size may complicate efforts that target reducing the risk of alcoholic drinks.

Aspects in sick leave research: several studies have focused on sick leave measurement approaches (e.g., the frequency of sick leave spells, the length of absence, incident rates, and so on) [329], which provide many opportunities to conduct various types of analysis by considering the various dimensions of sick leave [246]. Although we can benefit from these opportunities, it can prove difficult to compare our results with sick leave studies.

In addition to the numerous existing measurement approaches, several different terms and definitions for sick leave duration were found in Paper I, which may add to the confusion and mixed results in this field. In these studies, short-term absence was in a range of ≤ 3 days to < 7 days. However, in Paper III, short-term absence was defined as absences lasting for less than 14 days. Therefore, finding different results from other studies were expected in the present study. Moreover, since their variations are suggested to be considerable, when studies do not provide

enough information about the duration of sick leave spells, comparing the results may be impossible [248].

In addition, in Paper I, we included all types of sickness absence and not specifically alcohol-related sickness absence. Although both the funnel plot and the Harbord regression-based test suggested no evidence of publication bias, we conducted a sensitivity analysis (omitting each study in turn) to ensure that our results were not affected by arbitrary decisions.

Moreover, in Paper III, we benefited from using company-registered sick leave data, which is considered valid and more reliable than self-reported sick leave data [246, 252, 262]. Despite the fact that self-reported sick leave data are easy to acquire, and since national registered data is available only in a few countries, company-registered data—data collected from employees' personnel files—is considered the "golden standard" [252, 438-441]. Although there is a lack of information regarding medical reasons for the sick leave in the registered data, it is recommended to use registered data when available [438, 439, 441-445]. However, the quality of the registered data is not clear from the various types of registers.

Confounding: this is another significant methodological problem in public health studies, which may have affected this thesis. Confounding is about the characteristics of the study samples and is defined as the co-varying of several factors with the exposure and outcome measures [446-448].

Regarding Papers II and III, previously published literature suggested various confounders to be controlled in studies of alcohol and sick leave [298-301, 333, 334]. In addition to adjusting for recommended potential confounders in this thesis, we employed a series of bivariate non-parametric correlation analyses (Spearman's rho) to avoid over-adjustment. In this regard, the confounders were included if their

bivariate association with the outcome showed a *p*-value of <0.20 and if they did not display a high correlation (*rho* = ≤0.70) with other confounders [331].

However, this thesis may still be affected by some unmeasured factors. Although many confounders can be difficult to measure, the unmeasured ones may result in important challenges. Some have argued that findings related to alcohol and its outcomes can be due to unmeasured factors (e.g., environmental factors or genetic) and not due to the effect of alcohol [449, 450]. Other studies have suggested that some health-related factors, such as musculoskeletal disorders and mental disorders [353, 451], some behaviors (e.g., smoking and diet), and work-related factors [100, 249, 362, 368, 373] may directly affect the association between alcohol consumption and sick leave.

Another possible confounding factor is personality. Compared to moderate drinkers, individuals with low alcohol consumption are less outgoing and have less work participation [350, 452-454]. This factor may have affected our results out of Paper III. Therefore, further research may benefit from controlling for these factors when addressing the alcohol-sick leave association.

5.4 Implications for practice and research

This thesis has contributed to a better understanding of employees' alcohol-related problems, drinking attitudes, and their sick leave. Paper I found an association between alcohol consumption and sick leave in the working population. This highlights the importance of identifying individuals at risk to address and support their mental health and to allocate sufficient resources to prevent or reduce further consequences of their alcohol consumption [455].

Moreover, the established relationship between drinking attitudes and alcohol-related problems suggests that having positive attitudes toward drinking may have adverse consequences for the working population and organizations that have an active and encouraging drinking culture. Drinking attached to work-related settings is found to be growing in Norway in the form of social events, business dinners, and work-related travel [456, 457]. Hence, the field of practice may address the value of the workplace as one of the main arenas where individuals socialize and share their understandings. Therefore, interventions that aim to build a restrictive drinking culture while considering actual alcohol availability and workplace social control may be beneficial [230, 458, 459].

In addition, creating more awareness about drinking culture and alcohol-related problems may be an effective preventive effort that can be included in mandatory training programs (for both employees and managers). Moreover, since interventions need some time to be completed and produce cultural change, it may also be effective to reassess the beliefs occasionally.

In our study sample, almost 11% of the employees were risky drinkers. Therefore, workplaces, and employees may benefit from employing inexpensive, effective, and appropriate prevention interventions. These interventions can be in the form of face-to-face consultations with an OHS professional or receiving interventions in a web-based format (known as brief interventions) [9, 460]. These interventions have been found to be effective in managing individuals with alcohol-related problems. Brief interventions, in particular, are effective in reducing risky drinking behavior, average weekly alcohol consumption, and mortality among risky drinkers [461-464].

Alcohol-related problems or risky drinking will remain an essential public health concern. Although non-association results were reported in Paper III, this evidence sheds light on the hidden factors (e.g., sick leave

culture and social context) that may indirectly influence the direction of the explored associations. Therefore, additional research should be performed to explore whether the same results can be reproduced in different samples.

By taking the above-mentioned limitations and challenges (presented in the chapter on methodological consideration) into account, further research is warranted to explore whether other nuanced conditional factors—smoking, obesity, mental health, work environment, personality, and so on—can influence the association between alcohol-related variables and sick leave as mediators, moderators, or confounders.

In addition, quantitative studies with an experimental or longitudinal design with the same variables should be performed to explore possible effects and causal relations.

6 Conclusions

Alcohol-related problems impose a significant cost and place an immense burden on social systems and healthcare, mostly in high-income and middle-income societies. Alcohol-related individual differences (e.g., alcohol drinking patterns) are one of the underlying explanatory mechanisms for workplace behaviors (e.g., productivity impairment, conflict, and sick leave) and depend on different factors. However, how alcohol drinking patterns are linked to the working population is a policy-relevant issue and varies in different countries.

This large study of Norwegian employees adds to previous research by providing evidence that (i) having a positive drinking attitude is common among employees, (ii) attitudes toward drinking might be a substantial predictor for alcohol-related problems, (ii) gender moderates the association between positive drinking attitudes and alcohol-related problems, (iii) there is an association between risky drinking and sickness absence in general, but (iv) drinking attitudes and alcohol-related problems are not associated with sick leave in a sample of Norwegian employees. Therefore, the findings suggest that policy designers and employers may need to establish preventive schemes that focus on sick leave patterns and consider workplace programs controlling for health risk behaviors (e.g., alcohol consumption) while considering gender differences.

Future research may study other health behavioral challenges (e.g., smoking, diet, mental health, and stress), psychosocial working conditions, and workplace interventions that address risky alcohol use prevention.

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Appendices

Appendix A: Alcohol screening tools

A1. AUDIT questionnaire

A2. Drinking norm scale

A1. AUDIT questionnaire

1. During the last year, how often have you had a drink containing alcohol?

   ☐ never; ☐ monthly or less; ☐ times a month; ☐ times a week; ☐ or more times a week

2. How many drinks [alcohol units] containing alcohol do you have on a typical day when you are drinking?

   ☐ 1-2; ☐ 3-4; ☐ 5-6; ☐ 7-9; ☐ 10 or more

3. During the last year, how often have you had six or more drinks [alcohol units] 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 did you start your day with a drink?

   ☐ 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 of your drinking?

   ☐ never; ☐ less than monthly; ☐ monthly; ☐ weekly; ☐ daily or almost daily

9. Have you or someone else been injured because of your drinking?

   ☐ no; ☐ yes, but not during the last year; ☐ yes, during the last year

10. Has a relative, friend or doctor been concerned about your drinking or suggested you cut down?

    ☐ no; ☐ yes, but not during the last year; ☐ yes, during the last year

A2. Drinking norm scale

1. Having a drink or two at home after work is a harmless way to relax and unwind

   ☐ strongly disagree; ☐ disagree; ☐ agree; ☐ strongly agree

2. Getting together for drinks once in a while after work with coworkers can improve employees' morale

   ☐ strongly disagree; ☐ disagree; ☐ agree; ☐ strongly agree

3. Drinking with clients or customers is good for business

   ☐ strongly disagree; ☐ disagree; ☐ agree; ☐ strongly agree

4. Supervisors miss key information if they don't socialize with colleagues over a drink

   ☐ strongly disagree; ☐ disagree; ☐ agree; ☐ strongly agree

5. A drink or two a day is good for a person's health

   ☐ strongly disagree; ☐ disagree; ☐ agree; ☐ strongly agree

6. The more frequently people are exposed to alcohol, the more likely they are to develop a drinking problem

   ☐ strongly disagree; ☐ disagree; ☐ agree; ☐ strongly agree

7. Serving alcohol at company social events sets a bad example for employees

   ☐ strongly disagree; ☐ disagree; ☐ agree; ☐ strongly agree

Appendix B: Information to participants

B1. Information to participants in the WIRUS screening study (Papers II and III)

B1. Information to participants in the WIRUS screening study (Papers II and III)

Til ansatte i [virksomhet]

Som ansatt i [virksomhet] fyller du kriteriene for deltakelse i en forskningsstudie som er finansiert av Helsedirektoratet og Norges forskningsråd. Universitetet i Stavanger gjennomfører studien i samarbeid med flere andre institusjoner (se listen nedenfor). Studien er godkjent av regional komité for medisinsk og helsefaglig forskningsetikk. Å delta i denne studien innebærer kun å fylle ut et spørreskjema som tar 10-15 minutter. **Dette gjør du ved å klikke på denne linken:** [link]

Det er viktig for resultatenes pålitelighet at svarprosenten blir høy. Derfor håper vi du vil delta. Vi ber om at du, av hensyn til ditt personvern, ikke videresender denne e-posten.

Bakgrunn: Alkohol har en naturlig plass i de fleste menneskers liv og så mange som 95 prosent av norske arbeidstakere drikker alkohol. Samtidig som at alkoholkonsumet blant unge er redusert, har det vært en betydelig vekst i konsumet blant voksne. I en norsk studie fant forskerne at rundt halvparten av det totale alkoholforbruket var knyttet til jobbrelaterte situasjoner. Mange har oppfatninger om dette temaet. Vi er interessert i dine erfaringer med alkohol og også forhold som har med arbeidssituasjonen din å gjøre.

Formål: Formålet med denne studien er å bidra til ny kunnskap om positive og negative sider ved alkoholbruk i arbeidssituasjoner. Dette vil vi gjøre gjennom å se på ulike måter man kan bruke alkohol på i jobbsammenhenger, hvilken plass alkoholen har i ulike jobbsituasjoner, og hva som kan påvirke alkoholkonsumet. Vi ønsker også å få mer kunnskap om sammenhengen mellom alkoholbruk, sykefravær og sykenærvær (å være på jobb uten å være helt i form). Vi vil innhente sykefraværsdata fra databasen FD-trygd og informasjon fra personalregisteret i din virksomhet. Til dette formålet trenger vi ditt personnummer.

Basert på denne undersøkelsen vil noen senere bli tilbudt en frivillig helseundersøkelse hos bedriftshelsetjenesten.

Personvern og informasjonssikkerhet: Alle som jobber med prosjektet har taushetsplikt. Arbeidsgiver vil ikke bli kjent med hvem som deltar. All informasjon om deg skal bare benyttes på den måte som er beskrevet ovenfor og vil bli

oppbevart på et trygt og passordbeskyttet område. En ID knytter deg og dine opplysninger til en liste med navn og personnummer (avidentifisering). Det er kun en prosjektsekretær som har adgang til denne listen og som kan finne tilbake til den enkelte. Det vil ikke være mulig å identifisere enkeltpersoner og hva de har svart. Vi kommer til å publisere vitenskapelige artikler på bakgrunn av materialet og vil derfor følge opp den enkelte gjennom registerdata i inntil 20 år. Men alle data vil altså være avidentifisert. Etter dette tidspunktet vil alle dataene bli anonymisert.

Det er frivillig å delta i studien og du kan når som helst, og uten å oppgi grunn, trekke ditt samtykke tilbake. Hvis du trekker deg fra studien, kan du kreve å få slettet innsamlede opplysninger om deg selv, med mindre opplysningene allerede er inngått i analyser eller brukt i rapporter eller vitenskapelige artikler. Du har som deltaker rett til innsyn i publikasjonene fra studien. Du kan få dem ved henvendelse til kontaktpersonene som er nevnt under.

Ta gjerne kontakt med oss dersom du har spørsmål om studien og din deltakelse. **Vår kontaktperson er Mikkel M. Thørrisen, PhD-stipendiat i Wirus, e-post: mikkel-magnus.thorrisen@oslomet.no**.

Med vennlig hilsen Randi Wågø Aas, PhD, Prosjetleder/faglig ansvarlig for studien, Universitetet i Stavanger.

Institusjoner som samarbeider om WIRUS: Universitetet i Stavanger, KoRus Vest Stavanger, Presenter – Making Sense of Science, OsloMet – storbyuniversitetet (tidl. Høgskolen i Oslo og Akershus), Folkehelseinstituttet, SERAF, Universitetet i Oslo, KORFOR ved Stavanger Universitetssykehus, Karolinska Institutet i Stockholm og Vrije University i Amsterdam.

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Papers

Paper I

S Hashemi N, Skogen JC, Sevic A, Thørrisen MM, Rimstad SL, Sagvaag H, Riper H, Aas RW. A systematic review and meta-analysis uncovering the relationship between alcohol consumption and sickness absence. When type of design, data, and sickness absence make a difference. PLoS One. 2022 Jan 11;17(1):e0262458.
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PLOS ONE

RESEARCH ARTICLE

A systematic review and meta-analysis uncovering the relationship between alcohol consumption and sickness absence. When type of design, data, and sickness absence make a difference

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Abstract

Aim

Earlier research has revealed a strong relationship between alcohol use and sickness absence. The aim of this review was to explore and uncover this relationship by looking at differences in type of design (cross-sectional vs. longitudinal), type of data (self-reported vs. registered data), and type of sickness absence (long-term vs. short term).

Method

Six databases were searched through June 2020. Observational and experimental studies from 1980 to 2020, in English or Scandinavian languages reporting the results of the association between alcohol consumption and sickness absence among working population were included. Quality assessment, and statistical analysis focusing on differences in the likelihood of sickness absence on subgroup levels were performed on each association, not on each study. Differences in the likelihood of sickness absence were analyzed by means of meta-analysis. PROSPERO registration number: CRD42018112078.

Results

Fifty-nine studies (58% longitudinal) including 439,209 employees (min. 43, max. 77,746) from 15 countries were included. Most associations indicating positive and statistically

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significant results were based on longitudinal data (70%) and confirmed the strong/causal relationship between alcohol use and sickness absence. The meta-analysis included eight studies (ten samples). The increased risk for sickness absence was likely to be found in cross-sectional studies (OR: 8.28, 95% CI: 6.33–10.81), studies using self-reported absence data (OR: 5.16, 95% CI: 3.16–8.45), and those reporting short-term sickness absence (OR: 4.84, 95% CI: 2.73–8.60).

Conclusion

This review supports, but also challenges earlier evidence on the association between alcohol use and sickness absence. Certain types of design, data, and types of sickness absence may produce large effects. Hence, to investigate the actual association between alcohol and sickness absence, research should produce and review longitudinal designed studies using registry data and do subgroup analyses that cover and explain variability of this association.

Introduction

Alcohol is the most used and misused psychoactive substance in the general population as well as in the workforce [1]. Studies have indicated that one to three out of ten employees may benefit from alcohol prevention interventions due to risky drinking [2, 3] (i.e., a drinking pattern that increases the likelihood of social, medical, occupational, and economic problems [4]). For decades, alcohol-related problems and risky drinking among employees has been attracting interest, as well as raising concerns among researchers, organizations, and practitioners [5, 6]. Concerns are mainly due to the increased prevalence of on-the-job impairment (i.e., working under the influence of alcohol (on-the-job drinking)), and impact of risky drinking during nonworking hours (off-the-job drinking) on work performance [7].

Evidence has demonstrated that drinking alcohol may facilitate social interactions [8, 9] or can cover up negative emotions [10]. However, alcohol consumption among employees (on-the-job / off-the-job drinking) has been associated with a variety of detrimental outcomes, with regards to productivity (e.g., impaired work performance in terms of presenteeism [11, 12]), work environment (e.g., social exclusion, unwanted sexual attention, and verbal abuse [13]), and behavioral changes [14], depending on the level of drinking. Defined standard alcohol units and thresholds for at-risk drinking vary considerably across countries, regions, industries, and work groups, depending on the nature of work, existing regional culture, ease of access to alcohol, and work environment [15–17]. There is inconsistent evidence with respect to the relationship between different drinking patterns and adverse outcomes [18, 19]. Hence, a more detailed knowledge about the specific characteristics and context of different drinking patterns may be helpful in our understanding of the consequences of risky drinking [20].

Sickness absence is a major public health concern in many countries since it leads to problems not only for the individual in question, but also for the workplace, family life and the surrounding peer groups and society [21]. Furthermore, it can impose a substantial financial burden on both the individual and the community (i.e., workplace and society) [22]. For example, the cost of sickness absence is estimated at $2,660 per year for salaried employees in the USA, and about 2.5% of GDP in Europe [23, 24]. Sickness absence is a significant issue

influenced by various factors, comprising personal (e.g., individual's health behaviors, socio-economic status, or evaluation of own health), and contextual factors (e.g., existing health care system, absence policies and benefits, work conditions, and supervisor support) [25–27]. These factors may influence type and duration of one's reported sickness absence. For example, existing sickness absence benefit systems in each country may affect the evaluation of one's own health in regards to when and how long sickness absence is needed. This, in turn, may affect the reported sickness absence as being registered/certified (mostly long-term sickness absence) or becoming a self-reported one (mostly short-term sickness absence) [27, 28]. Dale-Olsen and Markussen [29] focused on the trends in absenteeism for a period from 1972 to 2008 in Norway, which is known for having a generous sickness absence benefit system [27]. Authors found that although the duration of each spell was increased by 20% for specific diagnoses, the number of sick leave spells was not changed.

Several studies have explored the relationship between different measures of alcohol consumption and sickness absence in working populations. Alcohol-related sickness absence often includes being late for work, being on partial absence during the workday, leaving early, one-day absences due to hangover, or being absent for several days [30]. Studies from Norway reported that between 14% and 50% of the total short-term absence days (1–3 days) could be linked to alcohol [31, 32]. Cunradi et al. [33] found short-term sickness absence to be associated with problem drinking. Roche et al. [34] found an association between risky drinking (compared to low-risk drinking) and self-reported sickness absence. Although self-reported sickness absence becomes less reliable when days of absence increase, but its sensitivity is acceptable as long as the length of absences not exceeding one week [35]. Moreover, although a significant association between registered absence and various measures of health has been shown [36–38], access to registered data can be problematic, and that makes many studies rely on self-reported sickness absence data.

Systematic reviews and meta-analyses have found fairly strong evidence for the association between alcohol consumption and sickness absence [39–41]. However, these studies were based on observational data and did not differentiate between heterogenous measures of alcohol consumption and sickness absence that vary in content and comparability. Based on earlier research, it is evident that there is a measurement challenge in sickness absence and presenteeism research, with high variability of measurement approaches concerning sickness absence levels (e.g., collapsing all types of sickness absence together) [11, 39] and differences in sickness absence benefit systems [27, 42]. Therefore, these concerns make the reported relationships between alcohol consumption and sickness absence in the literature "a black box" that needs to be investigated, by looking into subgroups including measurement groupings and type of data. Hence, the aim of this systematic review and meta-analysis was to explore and uncover the relationship between alcohol use patterns and sickness absence by looking at differences in type of design (cross-sectional vs. longitudinal), type of data (self-reported vs. registered data), and type of sickness absence (long-term vs. short term).

Methods

Protocol and registration

This study was designed as a systematic review and meta-analysis based on the Cochrane recommendations [43]. The review protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO; registration number: CRD42018112078, registration date: 29/10/18) [44]. This paper is reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (S1 File) [45].

Eligibility criteria

Studies exploring the relationship between alcohol consumption and sickness absence among employees were included. Studies had to satisfy the following criteria: (i) *study design* (quantitative studies; observational and experimental designs), (ii) *type of participants* (all salaried persons, hired and self-employed), (iii) *type of measures/tests* (reporting results from one or more statistical tests of an association between alcohol consumption and sickness absence, (iv) *type of publication* (full-text research article published in scientific peer reviewed journal), (v) *language* (published in English or a Scandinavian (Norwegian, Swedish or Danish) language, and (vi) *time* (published year 1980 or later).

In order to be included in the meta-analysis, studies additionally had to satisfy the following criteria: (vii) reporting data on event/participants that could be converted to odds ratios (ORs) (i.e., reporting the number of alcohol drinking participants having sickness absence), and (viii) reporting results for at least two categories of alcohol intake levels (including a category of non-alcohol intake/occasional/low alcohol intake as a reference category, a category of moderate drinking, or a category of risky/problem/heavy drinking).

Databases and search strategy

A search strategy was developed and utilized in six scientific databases (Medline, Embase, Cinahl, PsycInfo, AMED, and Web of Science). Where appropriate, the strategy was adapted to each database to ensure comparability. The search strategy consisted of abstract-level text searches and MeSH terms (Medical Subject Headings, Topics, or similar terms), and comprised two thematic blocks: (i) alcohol consumption (drink* OR alcohol* OR drunk* OR hangover OR "hang over" OR alcohol drinking (MeSH) OR binge drinking (MeSH)), and (ii) sickness absence ("sick leave" OR "sickness absence" OR absenteeism OR "lost work days" OR "lost work hours" OR "leave of absence" OR "work absence" OR "illness days" OR absenteeism (MeSH) OR sickness absence (MeSH) OR sick leave (MeSH)) (S1 Table). The two search blocks were then combined (using the Boolean operator AND), and search results were transferred to EndNote.

Databases were searched through June 2020. Additionally, manual searches for potentially relevant studies were performed in Google Scholar and Research Gate, by two reviewers (NSH and MMT) in reference lists for the included studies (ancestry approach).

Study selection

Identified searches were screened for relevance on a title/abstract level, and potentially relevant studies were assessed in full-text format independently by two reviewers (NSH and AS). A third reviewer (RWA) served as a tiebreaker in case of disagreement. Next, two reviewers independently assessed all eligible studies for inclusion in the meta-analysis (NSH and JCS). Reviewers contacted studies' authors reporting odds ratios or risk ratios to get detailed data (according to criteria vii). Although a few authors responded, none of them had access to the asked information.

Data extraction

Relevant information was extracted independently by two reviewers for all studies (NSH and AS) and those deemed eligible for inclusion in the meta-analysis (NSH and JCS). Among studies reporting different types of sickness absence, results for alcohol use and sickness absence were extracted, but other types e.g., specific subgroups of injury/illness-related sickness absence (e.g., accident or mental disorder) were discarded. As the included studies used

somewhat dissimilar alcohol consumption measures, standardization was necessary. Therefore, alcohol consumption was converted into grams of ethanol per day by means of the following formula: 1 ml = 0.8 grams, and 1 standard drink (SD) = 10.0 grams/day [46]. Hence, the measure of alcohol consumption was defined using the following: light consumption (< 1 drink/day), moderate consumption (< 2 drinks/day), and risky consumption (≥ 2 drinks/day) [47, 48]. Abstainers were excluded as this information was not reported in all studies. Furthermore, as moderate drinking was not measured in all studies, alcohol consumption was categorized into two groups: low-risk (reference group; comprised light-to-moderate drinking) and risky drinking. Studies not reporting grams of alcohol (e.g., reporting units), were converted to grams according to each study's national guidelines [16].

Quality assessment

Quality of the included data were assessed independently by two reviewers (NSH and MMT). Quality assessments were performed on associations rather than on studies, as the included studies often tested more than one statistical association between alcohol consumption and sickness absence. This approach is in line with the procedures applied in earlier systematic reviews of relationships between alcohol consumption and occupational outcomes among employees [11, 39].

A modified version of the Newcastle-Ottawa Scales (NOS) was utilized [49, 50], and associations were assessed on five key domains: (i) representativeness of the sample (low quality = non-random sample or inadequate description; high quality = probability or non-probability sampling procedure), (ii) measure of alcohol consumption (low quality = non-validated self-reported measure or inadequate description; high quality = validated self-report instrument (e.g., AUDIT) or objective measure (e.g., CDT blood test)), (iii) measure of sickness absence (low quality = self-reported or inadequate description; high quality = record linkage (register data)), (iv) level of adjustment (low quality = unadjusted or unclear; high quality = adjusted for at least one individual (e.g., sociodemographic) and/or one environmental (e.g., work-related) factor), and (v) test description (low quality = inadequate description or missing key information (e.g., likelihood, *p*-value); high quality = adequate description of key information). The quality assessment procedure was piloted on a random sample of 10 associations and evaluated prior to quality assessment of all included data.

Analysis

An overall assessment on the association between alcohol consumption and sickness absence was conducted by looking into descriptive characteristics of the included studies. Tested associations between alcohol consumption and sickness absence reported by the included studies were analyzed descriptively in different subgroups based on:

- Type of design,
- Direction of associations (statistically significant positive; neutral (i.e., no association); statistically significant negative), which further were categorized based on direction (positive; negative) and statistical significance (significant; non-significant),
- Type of measurement/operationalization (alcohol: frequency and quantity, volume per day, average drinking per week, heavy episodic/binge drinking (i.e., six or more drinks on one occasion [4]), diagnosed problem drinking, and sales of pure alcohol; sickness absence: total number of absence days (i.e., total number of days of sickness absence per year), short-term absence (varied in studies from ≤ 3 days to < 7 days), and long-term absence (varied in studies from ≥ 3 days to ≥ 7 days)).

Eight studies including ten samples satisfying the additional inclusion criteria (criteria vii and viii above) were subjected to meta-analysis in the RevMan 5 software [43]. Due to heterogeneity between studies, a random-effects model was applied to calculate summarized odds ratios (OR) with 95% confidence intervals (CI) as an overall synthesized measure of pooled estimate [51]. All reported raw data, e.g., number of participants at risk (for each level of alcohol use) and number of events (participants at risk reporting sickness absence) were collected from the ten samples in the meta-analyses. Then it was possible to calculate effect measures as odds ratio or relative risk (RR), avoiding re-calculation between different effect measurements. The Cochrane handbook suggests using either OR or RR. Therefore, OR was chosen to be used rather than RR due to being often used in this field. The DerSimonian-Laird estimator implemented in the RevMan 5 software was used to calculate the between-study variance. Forest plots were created for risky drinking versus low-risk drinking. The L'Abbe plot [52] was used to compare studies' likelihood rates (log ORs) among low-risk and risky drinking employees. Heterogeneity across studies was explored using a chi-square statistic (χ^2) and I^2-test. Considerable heterogeneity was deemed present at $I^2 > 50\%$ [53].

The main results were extracted from the statistical subgroup analyses. Subgroup analyses were applied to identify sources of heterogeneity, as well as to explore the differences on the association between alcohol and sickness absence across different categories. These analyses were performed according to studies and participants' characteristics including type of study design, sickness absence measure, sickness absence duration, year of publication, and country. Sensitivity analyses were performed on both the descriptive part and meta-analysis part. For the meta-analysis part, sensitivity analyses were performed by omitting one study and calculating the pooled ORs for the remaining studies. Publication bias was examined running a funnel plot and by using a Harbord regression-based test to explore funnel plot asymmetry [54].

In studies reporting outcomes from independent groups (e.g., short- or long-term absences), each group was added as a separate sample in the meta-analysis. Additional tests (Harbord regression-based test) and the L'Abbe plot were performed with Stata version 16.0 [55].

Results

Overview of the evidence

A total of 3,644 studies were identified (Fig 1). After duplicate removal (n = 1,324) and excluding 2,080 studies that did not fulfill the inclusion criterion (e.g., no relevant test or study design), 240 articles were assessed for eligibility in full-text format, resulting in 55 included studies. Four more studies were included as a result of updated searches in June 2020. Finally, 59 studies were included in the systematic review. Eight studies met the inclusion criteria for meta-analysis [21, 33, 34, 56–62].

An overview of the eligible studies including the sample settings, study designs, measures of the predictor and outcome, along with the number of tested associations on alcohol consumption and sickness absence in each study can be seen in Table 1. Tested associations can be found in S2 Table using association IDs. Almost 91.5% of studies (54 out of 59) were observational studies (cross-sectional: n = 17; longitudinal: n = 37, including 29 cohort studies, 7 panel studies, and 1 case-control study) and the remaining five were based on experimental designs (randomized controlled studies: n = 1, and quasi-experimental (time-series) studies: n = 4) (Table 1). The 59 studies comprised a total sample size of 439,209 employees (ranging between 43 and 77,746). Studies originated from 15 different countries: Sweden (n = 12), Finland (n = 12), USA (n = 9), Norway (n = 7), Australia (n = 3), Denmark (n = 3), United Kingdom (n = 3), Brazil (n = 2), Belgium (n = 1), Japan (n = 2), Ethiopia (n = 1), France (n = 1), India

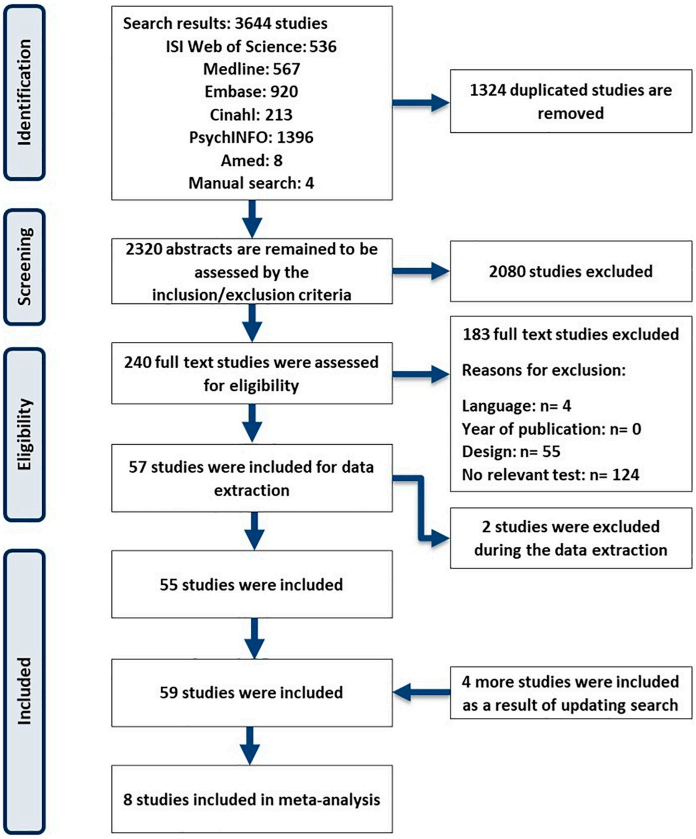

Fig 1. Flowchart for the search and study selection process.

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(n = 1), Netherlands (n = 1), and Uganda (n = 1). Type of working environments varied in included studies. Working environments consisted of participants employed in e.g., police stations [63, 64], transport services [56, 65], hospitals [66], farm industries [67], etc. A total of 162 associations between measures of alcohol consumption and sickness absence were tested in these 59 included studies.

Associations between alcohol consumption and sickness absence

Out of 162 tested associations, 148 (91%) indicated that higher levels of alcohol consumption were associated with higher levels of sickness absence (positive associations), while 14 (9%) indicated a negative relationship, i.e., that higher levels of alcohol consumption were associated with lower levels of sickness absence (Table 2 and S2 Table). About 63.5% (n = 94) of positive associations and none of negative associations were statistically significant. The majority of associations with positive and statistically significant results were based on longitudinal data (66 of 94, 70%).

Table 1. Overview of included studies (n = 59), associations (n = 162), and measurements.

Study (author, year)	Sample	Design	Alcohol measure	Sickness absence measure	Tested associations, *n* (association ID)
Jenkins (1986) [68]	UK: civil servants (*n* = 321)	Longitudinal (cohort)	Drinking during the last 7 days (frequency and quantity)	Company-registered certified and uncertified absence days	1 (1)
Persson & Magnusson (1989) [69]	Sweden: adult patients (*n* = 2,038)	Longitudinal (panel)	Excessive drinking (>280 g ethanol per week) / high alcohol level in blood / doctor diagnosis	National-registered sickness absence days during the 5 different years	2 (2, 3)
Marmot et al. (1993) [70]	UK: non-industrial civil servants (*n* = 10,314)	Longitudinal (cohort)	Frequency of drinking during the last year and last 7 days	Self-reported and registered short spells (<7 days) and long spells (>7days)	4 (4–7)
North et al. (1993) [71]	UK: non-industrial civil servants (*n* = 10,314)	Longitudinal (cohort)	Frequency of drinking during the last year and last 7 days	Self-reported and registered short spells (<7 days) and long spells (>7days)	4 (8–11)
Blum (1993) [72]	USA: employees (*n* = 136)	Cross-sectional	Drinking during the last 7 days (frequency and quantity)	Self-reported days of absence (last 2 weeks)	3 (12–14)
French et al. (1995) [73]	USA: employees in five different worksites (*n* = 1,664)	Cross-sectional	Number of drinks during the last year	Self-reported absence days during the last year	1 (15)
Vasse et al. (1998) [74]	Netherlands: employees in various occupations (*n* = 471)	Cross-sectional	Drinking during the last 6 months (frequency and quantity)	Self-reported sickness absence spells during the last 6 months (yes/no)	2 (16, 17)
Spak et al. (1998) [75]	Sweden: general population (*n* = 3,130)	Cross-sectional	Diagnosed problem drinking	National-registered days of absence during the last year	3 (18–20)
Upmark et al. (1999) [76]	Sweden: general population (*n* = 1,855)	Longitudinal (cohort)	Average of drinking during the last week/ problem drinking (CAGE score)	National-registered days of absence per year	8 (21–28)
Upmark et al. (1999) [77]	Sweden: mandatory conscripts (*n* = 8,122)	Longitudinal (cohort)	Problem drinking (>250 g ethanol per week)/ periods of frequent drunkenness	National-registered number of absence days	3 (29–31)
Richmond et al. (1999) [63]	Australia: police employees (*n* = 954)	Experimental (RCT)	Average weekly consumption (frequency and quantity) / binge drinking	Self-reported number of absence days	2 (32, 33)
Holder and Blose (1991) [78]	USA: manufacture employees (*n* = 3,656)	Longitudinal (cohort)	Diagnosed problem drinking	Registered number of absence days during the last year	1 (34)
Vahtera et al. (2002) [37]	Finland: municipal employees (*n* = 6,442)	Longitudinal (cohort)	Drinking (frequency and quantity)	Company-registered medically certified sickness absence days	1 (35)
Hermansson et al. (2002) [56]	Sweden: transport employees (*n* = 989)	Longitudinal (cohort)	Problem drinking: AUDIT[a] / CDT[b] (blood test) / GGT[c]	Company-registered sickness absence days	3 (36–38)
McFarlin & Fals-Stewart (2002) [79]	USA: employees in various occupations (*n* = 280)	Cross-sectional	Drinking days during the last month	Company-registered sickness absence days	3 (39–41)
Kivimäki et al. (2002) [36]	Finland: municipal employees (*n* = 2,991)	Longitudinal (panel)	Drinking (frequency and quantity) / alcohol intoxication	Company-registered sickness absence days	4 (42–45)
Bendtsen et al. (2003) [80]	Sweden: employees in various occupations (*n* = 1,075)	Cross-sectional	Frequency of alcohol intake/ increased consumption last year	Registered sickness absence days and spells	3 (46–48)
Morikawa et al. (2004) [81]	Japan and UK: employees (*n* = 8,794)	Longitudinal (cohort)	Average drinks per week	Registered long-term sickness absence days (>7 days)	4 (49–52)
Voss et al. (2004) [82]	Sweden: post employees (*n* = 3,470)	Cross-sectional	Alcohol consumption	Company-registered sickness absence days	2 (53, 54)
Cunradi et al. (2005) [33]	USA: municipal transit operators (*n* = 1,446)	Longitudinal (cohort)	Average alcohol intake / problem drinking CAGE	Self-reported short-term sickness absence	4 (55–58)
Floderus et al. (2005) [83]	Sweden: employees (*n* = 862)	Cross-sectional	Alcohol consumption	National-registered long-term sickness absence	1 (59)
Ovuga & Madrama (2006) [64]	Uganda: police officers (*n* = 104)	Cross-sectional	prevalence of probableAUD[d] and prevalence of alcohol use problems (AUP)	Self-reported sickness absence during the past 3 months	2 (60, 61)

(*Continued*)

Table 1. (Continued)

Study (author, year)	Sample	Design	Alcohol measure	Sickness absence measure	Tested associations, *n* (association ID)
Pidd et al. (2006) [84]	Australia: employees in various occupations (*n* = 11,608)	Cross-sectional	Frequency and amount of drinking	Self-reported sickness absence days	2 (62, 63)
Kondo et al. (2006) [57]	Japan: electronic employees (*n* = 1,183)	Longitudinal (panel)	Number of drinks per week	Self-reported sickness absence of 5 days or longer	2 (64, 65)
Kujala et al. (2006) [21]	Finland: employees (*n* = 3,725)	Longitudinal (cohort)	Amount of consumed alcohol per day (volume)	National-registered medically certified long-term sickness absence (>9 days)	2 (66, 67)
Norström (2006) [85]	Sweden: employees (*n* = not vailable)	Experimental (Quasi)	Alcohol consumption was gathered by sales of pure alcohol (100%) per capita	Self-reported and national registered sickness absence days	2 (68, 69)
Christensen et al. (2007) [86]	Denmark: employees (*n* = 5,020)	Longitudinal (cohort)	Alcohol consumption	National- registered long-term (>7 weeks) sickness absence	2 (70, 71)
Suominen et al. (2007) [87]	Finland: non-industrialized employees (*n* = 5,000)	Longitudinal (cohort)	Frequency of high alcohol consumption	National-registered sickness absence spells (> 8 days)	1 (72)
Johansson et al. (2009) [88]	Finland: general population (*n* = 5,000)	Longitudinal (panel)	Average of consumed units per week	Self-reported sickness absence during the last year	1 (73)
Laaksonen et al. (2009) [58]	Finland: municipal employees (*n* = 6,934)	Cross-sectional	Average of consumed units per week	Self-reported and registered sickness absence spells	4 (74–77)
Roche et al. (2008) [34]	Australia: employees (*n* = 13,582)	Cross-sectional	Frequency and amount of drinking during the last week	Self-reported and registered sickness absence (last 3 months)	2 (78, 79)
Salonsalmi et al. (2009) [89]	Finland: municipal employees (*n* = 6,509)	Longitudinal (cohort)	Average units per week / binge drinking / CAGE	Self-reported and national-registered sickness absence spells	12 (80–91)
Norström & Moan (2009) [90]	Norway: manual workers (*n* = not available)	Experimental (Quasi)	Alcohol consumption was gathered by sales of pure alcohol (100%) per capita	National-registered percentage of sickness absence days	2 (92, 93)
Bacharach et al. (2010) [65]	USA: transport employees (*n* = 470)	Longitudinal (cohort)	Frequency and average amount of drinking / binge drinking	Company-registered sickness absence days	2 (94, 95)
Balsa & French (2010) [91]	USA: general population (*n* = 6,015)	Experimental (Quasi)	Heavy drinking: intoxicating / alcohol dependence DSM-IV	Self-reported number of sickness absence days	3 (96–98)
Kirkham et al. (2015) [92]	USA: computer manufacturer employees (*n* = 17,089)	Longitudinal (cohort)	Problem drinking (CAGE)	Company-registered sickness absence days	1 (99)
Hensing et al. (2011) [59]	Sweden: sick listed and general population (*n* = 6,455)	Cross-sectional	Drinking during the last 12 months, problem drinking (AUDIT)	Self-reported absence spells	2 (100, 101)
Edvardsen et al. (2015) [93]	Norway: employees in various occupations (*n* = 2,437)	Cross-sectional	Self-reported consumption last 24 hours / oral fluid samples	Self-reported absence days	4 (102–105)
Lidwall & Marklund (2011) [94]	Sweden: employees in various occupations (*n* = not available)	Longitudinal (panel)	Amount of alcohol consumption	Self-reported and registered long-term sickness absence	2 (106, 107)
Chakraborty & Subramanya (2013) [66]	India: hospital employees in psychiatric department (*n* = 43)	Cross-sectional	Alcohol abuse/ dependence	Self-reported sickness absence days	1 (108)
Schou et al. (2014) [95]	Norway: young employees (*n* = 1,762)	Longitudinal (cohort)	Frequency of drinking / intoxication last year	Self-reported sickness absence (yes/ no)	2 (109, 110)
Ervasti et al. (2018) [96]	Finland, France, UK: employees in various occupations (*n* = 46,514)	Longitudinal (cohort)	Weekly alcohol consumption	Registered days of sickness absence per year	1 (111)
Ervasti et al. (2018) [97]	Finland, France, UK: employees in various occupations (*n* = 47,520)	Longitudinal (cohort)	Weekly alcohol consumption	Registered sickness absence days	1 (112)

(*Continued*)

Table 1. (Continued)

Study (author, year)	Sample	Design	Alcohol measure	Sickness absence measure	Tested associations, *n* (association ID)
Torvik et al. (2016) [98]	Norway: young employees (*n* = 2,178)	Longitudinal (cohort)	Alcohol use disorder (DSM-IV)	National-registered sickness absence days	1 (113)
Silva-Junior & Fischer (2014) [99]	Brazil: public social security branch (*n* = 385)	Longitudinal (case-control)	Problem drinking (AUDIT)	National-registered long-term sickness absence	1 (114)
Richmond et al. (2016) [100]	USA: employees in various occupations (*n* = 338)	Experimental (Quasi)	Problem drinking (AUDIT)	Self-reported sickness absence days	1 (115)
De Clercq et al. (2015) [101]	Belgium: employees (*n* = 24,402)	Longitudinal (cohort)	Alcohol consumption (more than 3 units of alcohol per day)	Company-registered absence at least 10 days in a 12-month period	1 (116)
Østby et al. (2016) [102]	Norway: young adult twins (*n* = 6,735)	Longitudinal (panel)	Frequency of alcohol use during the last 14 days / binge drinking	Registered sickness absence days	2 (117, 118)
Morois et al. (2017) [103]	France: French national electricity and gas company (*n* = 9,907)	Longitudinal (cohort)	Daily alcohol consumption (gram/day)	Company-registered short-term (<8 days), moderate (8–28 days), and long-term (>28days)	6 (119–124)
Ervasti et al. (2018) [104]	Finland: public sector employees (*n* = 5,809)	Longitudinal (cohort)	Weekly alcohol use	Registered short-term absence	4 (125–128)
Salonsalmi et al. (2015) [105]	Finland: middle-aged employees (*n* = 8,960)	Longitudinal (panel)	Weekly average consumption/ problem drinking (CAGE)	Self-reported and company registered sickness absence spells, self-certified and medically confirmed (4+ days)	8 (129–136)
Araujo et al. (2017) [106]	Brazil: employees (*n* = 342)	Longitudinal (cohort)	Weekly frequency of drinking	Self-reported sickness absence days	1 (137)
Schou & Birkelund (2015) [107]	Norway: young employees (*n* = 1,460)	Longitudinal (cohort)	Frequency of alcohol consumption / heavy drinking / intoxicating	National-registered sickness absence days	6 (138–143)
Kaila Kangas et al. (2018) [60]	Finland: general population (*n* = 3,666)	Longitudinal (cohort)	Amount of drinking/ alcohol use disorder	National-registered sickness absence days	2 (144, 145)
Jørgensen et al. (2017) [61]	Denmark: general adult population (*n* = 17,690)	Longitudinal (cohort)	Frequency and amount of drinking during the last week / binge drinking	National-registered sickness absence days	4 (146–149)
Jørgensen et al. (2019) [62]	Denmark: general adult population (*n* = 77,746)	Longitudinal (cohort)	Frequency and amount of drinking during the last week, problem drinking (CAGE-C)	National-registered sickness absence days	2 (150, 151)
Lund et al. (2019) [108]	Norway: employees (*n* = 1,870)	Cross-sectional	Binge drinking	Self-reported sickness absence days in the last 12 months	2 (152, 153)
Hambisa Mekonnen et al. (2019) [67]	Ethiopia: farm industry workers (*n* = 444)	Cross-sectional	Frequency and amount of drinking	Company registered sickness absence days	1 (154)
Landberg et al. (2020) [109]	Sweden: adult employees (*n* = 15,983)	Longitudinal (cohort)	Average weekly volume and frequency of heavy episodic drinking	Self-reported short-term and national-registered long-term (>14 days) sickness absence	8 (155–162)

[a] AUDIT: Alcohol Use Disorder Identification Test;

[b] CDT: Carbohydrate-Deficient Transferrin test;

[c] GGT: Gamma-glutamyl Transferase test;

[d] AUD: Alcohol Use Disorder.

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Regarding the type of alcohol measures, frequency, and quantity (39%) as well as problem drinking (27%) were the most frequently applied. More than half of the associations between frequency and quantity of alcohol consumption and sickness absence (36 of 63) were statistically significant (Table 2). Six out of eight (75%) associations on volume of drinking per day and likelihood of sickness absence revealed significant results. Nine of 15 associations (60%) exploring binge drinking and sickness absence reported significant associations. In terms of type of sickness absence measures, almost half of the associations (76 out of 162) used total

Table 2. Tested associations (n = 162) according to measurements of alcohol consumption and sickness absence.

Alcohol measure		Sickness absence measure					
		Total number of absence days		Short-term absence		Long-term absence	
		Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
Frequency and quantity	sig.	[1], [13], [14], [15], [29], [40], [53], [78], [79], [102], [104], [105], [109], [111], [138], [140], [147], [150], and [162]	None	[8], [9], [62], [125], [127], and [128]	None	[10], [35], [47], [48], [63], [106], [107], [112], [116], and [117]	None
	ns.	[12], [17], [39], [41], [42], [54], [94], [137], [142], and [146]	[16], [43], and [103]	[4] and [126]	[5]	[6], [11], [70], [71], [106], and [144]	[7], [59], [64], [65], [72], and [100]
Volume per day	sig.	[119] and [120]	None	[121] and [122]	None	[123] and [124]	None
	ns.	None	[67]	None	None	None	[66]
Average drinking per week	sig.	[21], [22], [32], and [73]	None	[57], [74], [75], [80], [129], [154], and [155]	None	[50], [52], [86], [158], and [159]	None
	ns.	[23] and [24]	None	[56], [81], and [130]	None	[49], [51], [76], [77], [87], [133], and [134]	None
Heavy episodic / binge drinking	sig.	[33] and [95]	None	[82], [83], [156], and [157]	None	[88], [118], and [160]	None
	ns.	[148] and [149]	None	[152]	None	[89], [153], and [161]	None
Diagnosed problem drinking	sig.	[2], [3], [18], [19], [20], [30], [34], [44], [61], [98], [108], [110], [115], [139], [143], and [151]	None	[55], [58], [84], [85], and [131]	None	[36], [90], [91], [101], [114], and [145]	None
	ns.	[26], [27], [28], [31], [45], [60], [97], [99], and [141]	[25] and [96]	[132]	None	[37], [38], [113], [135], and [136]	None
Drinking based on sales of pure alcohol	sig.	[68] and [92]	None	None	None	None	None
	ns.	[69] and [93]	None	None	None	None	None

[numbers] = association IDs; Pos. = positive direction; Neg. = negative direction; ns = non-significant association; sig. = significant association; For instance: association [1] (upper left in the table) was a statistically significant positive association between sickness absence (measured in terms of total number of absence days) and alcohol consumption (measured in terms of frequency and quantity).

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number of absence days to measure sickness absence. Roughly 33% ($n = 54$) of associations used long-term and the remaining 20% ($n = 32$) used short-term absences. More than half of associations (44 of 76) between alcohol measures and total number of reported absence days were significant. Three-quarters of the associations (24 of 32) on alcohol and short-term absences and almost half of associations (26 of 54) on alcohol and long-term absences were significant.

Likelihood of sickness absence among risky drinking employees versus those with low-risk drinking

Altogether, 10 samples (from eight studies) were included in the meta-analysis. A synthesis of samples showed that risky drinking was associated with an increased odd of sickness absence (OR: 2.34, 95% CI: 1.17–4.65), see Fig 2. Very high levels of heterogeneity existed between studies included in the overall estimate ($\chi^2 = 1450.43$, $P < .00001$, $I^2 = 99\%$).

As shown in the L'Abbé plot (Fig 3), seven samples were above the no effect line, suggesting that the likelihood of sickness absence was higher among risky drinking employees than those with low-risk drinking, compared to the sample below the line.

Subgroup analyses. Subgroup analyses indicated that sickness absence was more likely among the risky drinking employees than low-risk ones in studies employing cross-sectional designs (OR: 8.28, 95% CI: 6.33–10.81), self-reported absence data (OR: 5.16, 95% CI: 3.16–

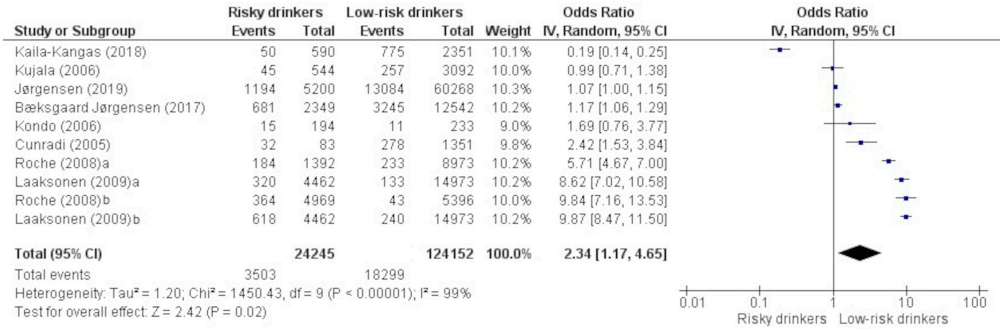

Fig 2. Pooled odds estimate for sickness absence among risky drinking employees versus those with low-risk drinking.

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8.45), short-term absence data (OR: 4.84, 95% CI: 2.73–8.60), as well as studies conducted in the USA (OR: 2.42, 95% CI: 1.53–3.84) and Australia (OR: 7.41, 95% CI: 4.15–13.21) (Table 3 and S1–S5 Figs).

Sensitivity analyses. Omitting each study in turn did not change the tendency of the ORs. However, after omitting one (Roche (2008b) of the 10 samples from the meta-analysis, the pooled estimate was rendered non-significant (OR: 1.99, 95% CI: 0.98–4.05). This sample was based on the association between consumption during single drinking occasions (episodic drinking) and sickness absence. This sample had an approximately equal proportion of risky drinkers and low-risk drinkers (Fig 2), while in the other samples the higher proportion were low-risk drinkers. Moreover, one study was based on all-cause sickness absence (e.g., certified sickness absence due to mental- or musculoskeletal disorder) [60]. Conducted sensitivity analysis found stronger alcohol-absence association after omitting this study (OR: 3.10, 95% CI: 1.56–6.17).

In addition, five out of 59 included studies measured sickness absence using self-reported alcohol-related sickness absence [34, 73, 84, 95, 107]. After omitting these studies, still the majority of the tested associations (140 of 162) indicated that higher levels of alcohol consumption were associated with higher levels of sickness absence and about 61.4% of them (86 of 140) were statistically significant.

Publication bias. Visual inspection of the funnel plot indicated a symmetric shape around the weighted average effect size, yielding little support for publication bias, see Fig 4. Only two samples resided within the pseudo 95% CI. Furthermore, the Harbord regression-based test suggested no statistical evidence of small-study effects or publication bias ($P = 0.901$).

Quality of the evidence

The quality assessment revealed that all the 162 tested associations had an adequate description of the statistical procedure, see Fig 5. Almost all of the (160 out of 162 (98%)) associations used probability or non-probability sampling techniques, and 41% of the associations (67 out of 162) measured alcohol using validated instruments such as AUDIT, or CDT blood test. About 57% of associations (38 of 67) using validated instruments and 59% of associations (56 of 95) using non-validated instruments were statistically significant. Around 64% of associations measured sickness absence by registry data (e.g., company or national registers), and the rest

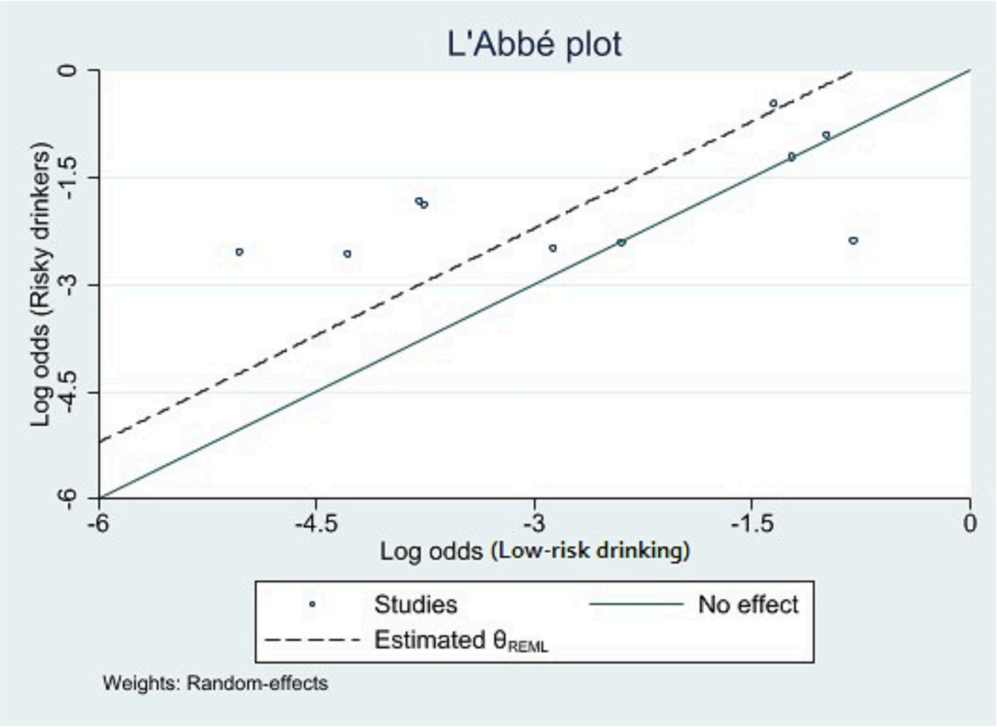

Fig 3. L'Abbé plot of comparing likelihood rates in low-risk and risky drinking employees.

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of them were self-reported absences. Among the 162 associations, 129 (80%) were adjusted for individual or/and environmental factors.

Discussion

The aim of this systematic review and meta-analysis was to explore and uncover the relationship between alcohol use patterns and sickness absence by looking at differences in type of design (cross-sectional vs. longitudinal), type of data (self-reported vs. registered data), and type of sickness absence (long-term vs. short term). The following findings will be discussed: (i) revealed evidence for supporting a positive association between alcohol consumption patterns and sickness absence, (ii) high variability of measurements and study designs assessing alcohol consumption and sickness absence in the literature, and (iii) a diversity in social benefit and organizational factors, which might challenge generalization of the results in other countries and settings.

Both pooled estimates and descriptive evaluation, showed that higher levels of alcohol consumption are associated with higher levels of sickness absence, and that risky drinking patterns (as opposed to a low-risk pattern) are associated with a statistically significant increase in likelihood of sickness absence. These results are consistent with earlier reviews [39–41]. However,

Table 3. Pooled odds ratio (OR) and 95% CI for alcohol intake and likelihood of sickness absence, stratified by selected covariates.

Factors	Number of studies	OR (95% CI)	I^2 (%)	*P*-value [a]
All studies	10	2.34 (1.17–4.65)	99.0	$P < .00001$
Study design				
Cross-sectional	4	8.28 (6.33–10.81)	98.8	$P < .00001$
Longitudinal	6	0.94 (0.64–1.39)		
Sickness absence measurement				
Self-reported	5	5.16 (3.16–8.45)	91.3	$P < .0001$
Registered	5	1.16 (0.57–2.36)		
Sickness absence duration				
Long-term	4	1.80 (0.32–10.32)	92.0	$P < .00001$
Short-term	4	4.84 (2.73–8.60)		
Number of days	2	1.11 (1.03–1.21)		
Year of publication				
2000–2008	5	3.02 (1.28–7.12)	0.0	$P = .45$
2009–2019	5	1.83 (0.70–4.83)		
Region				
USA	1	2.42 (1.53–3.84)	92.2	$P < .00001$
Japan	1	1.69 (0.76–3.77)		
Australia	2	7.41 (4.15–13.21)		
Finland	4	2.01 (0.35–11.56)		
Denmark	2	1.11 (1.03–1.21)		

[a] Test for subgroup differences.

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the results of the association between alcohol consumption, risky drinking and sickness absence in this review likely depend on a range of factors, one of which may be high variability of measurements and study designs assessing alcohol consumption and sickness absence.

In recent meta-analyses, Amiri and Behnezhad [40], as well as Marzan et al. [41] concluded that consuming alcohol constitutes a risk factor for sickness absence, but did not distinguish

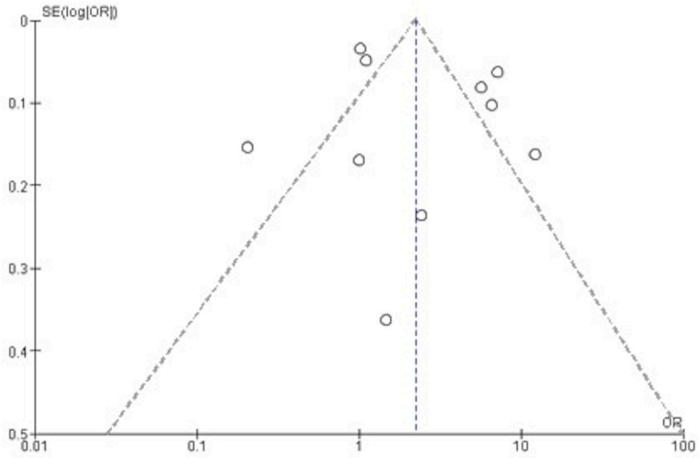

Fig 4. Funnel plot of publication bias.

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Fig 5. Quality of the associations on five key domains.

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between short-term and long-term absences. In the current meta-analysis, the pooled estimates yielded a statistically significant association between risky drinking and short-term sickness absence, which might be explained by injury or hang-over one day absence [72]. Although, Schou and Moan [39] did not conduct a meta-analysis, they also found stronger support for the association between alcohol consumption and short-term absence than between alcohol consumption and long-term absence. While long-term sickness absence has been reported to be a better indicator of ill health than short-term absence [110, 111], being on long-term sickness absence was shown to reduce individuals' alcohol consumption [83]. Moreover, it is likely that there is a broader range of potential causes of long-term absences, which may not hold true for short-term absences [39, 112, 113].

In their review, Schou and Moan [39], found positive associations between alcohol consumption and sickness absence from 28 studies, but the associations were mainly retrieved from cross-sectional data. In the current review, the vast majority of associations indicating positive and statistically significant results were based on longitudinal data (66 of 94, 70%), implying a possible causal relation between total alcohol consumption and sickness absence. The causal relations were also found in three of the included studies using time-series analyses [85, 90, 91]. However, from the pooled estimates considering risky versus low-risk drinking, only cross-sectional studies were able to find the risky drinking-sickness absence association.

One may assume that the cross-sectional study designs not only impede the establishment of causal inference but may also be influenced by the data measurements as they are mostly conducted on self-reported data. In the current meta-analysis, studies using cross-sectional design were mainly based on self-reported sickness absence data, which can be assumed to be less reliable [35]. However, although self-reported sickness absence, which is mostly short-term, is based on individual's self-assessment, and registered/certified sickness absence (mostly long-term) is generally based on the general practitioner's assessment, whether an individual asks for medical help depends on the individual's own decision. Therefore, self-assessment of one's health may affect a person's evaluation about when seeking help for sickness absence is really needed, which in turn may influence employees' absence type (self-reported and certified) and absence duration (short-term and long-term) [28], and may further influence the direction and significance of study designs.

Current meta-analysis found risky drinking-sickness absence association in studies using self-reported absence data, which can be explained by the above-mentioned notion. Moreover, since sickness absence was assessed differently when comparing risky and low-risk drinking (e.g., varying from $\geq$ 1 day [34] to $\geq$ 10 days [60]) throughout the included studies, this

estimate does not provide details concerning the exact length of the sickness absence. Regarding the alcohol consumption and sickness absence in general, most of the samples in the review measured sickness absence by using registry data (103 of 162, 64%), and accordingly the percentages of significant associations were higher among samples using registry data than self-reported data (60% vs. 40%). Keeping administrative registries of sickness absence data is common in some countries, particularly in the Nordic countries, which offers the opportunity to easily access information and explore the association between alcohol and working populations in detail [61, 114].

Furthermore, between-country variation in sickness absence including benefits and often how the social health protection (SOCPRO) systems in each country are organized may influence the type and duration of sickness absence [42]. For instance, comparing two included Nordic countries, the likelihood of sickness absence was significantly higher for all studies conducted in Norway [90, 93, 95, 98, 102, 107, 108], compared to studies from Denmark [61, 62, 86]. These rates might be affected by the existing sickness absence benefit systems in each country. In Norway, for example, it is rarely possible to lay off an employee due to long-term sickness absence, while being absent for more than 120 days within a year in Denmark could lead to lay off. Therefore, in general, Norway reports a higher rate of long-term sickness absence and in contrast lower rate of short-term sickness absence than Denmark [27].

In addition, individuals' decisions about drinking alcohol and whether to take sickness absence or attend work are influenced by systematic and organizational factors in the workplace [115]. Blum et al [72], Bacharach et al. [65], and Cunradi et al. [33] showed that the degree to which drinking alcohol may serve as a precursor of sickness absence, depends on a few key factors, one of which may be the existing relation between individuals and their supervisors and work-related stressors (e.g., job burnout). In these studies, risky drinking was more likely to be observed among employees who had conflicts with their co-workers and supervisors, or employees reported job burnout. One may assume that the potential for predicting sickness absence by alcohol consumption may be reduced among employees whose supervisors tend to focus on attendance. In this regard, such employees are more likely to resort to presenteeism rather than being absent, in order to avoid being labeled as a troubled worker [65, 72].

Implications

Overall, evidence supports that higher levels of alcohol consumption and risky drinking may increase the likelihood of sickness absence. Research has shown that, as a policy implication, reducing per capita alcohol consumption results in a reduction in both the sickness absence costs, as well as the imposed economic costs for industries and societies [90].

Earlier research suggests that workplace interventions that target environmental (e.g., supportive work environment) and individual (e.g., alcohol skill training, and stress management) factors should be implemented, as they most likely will promote healthier lifestyles [33, 116–118]. Further research is needed for exploring whether other nuanced conditional factors (e.g., age, smoking, obesity, and work stress), which were measured unevenly across the included studies, can affect the direction of the association between alcohol consumption and sickness absence, as either a mediator or moderator. Moreover, to find out the causal inference between alcohol and sickness absence, research should review longitudinal designed studies using registered data. In addition, focusing on short-term sickness absence in efforts of reducing and preventing injuries and hang-over one-day alcohol-related sickness absence may be beneficial. Future research may be benefited from having abstainers as a reference group against moderate and risky drinkers as the most recent systematic review and meta-analysis has found a

higher risk of sickness absence among both abstainers and heavy drinkers when compared to moderate drinkers [41].

Strengths and limitations

The present study holds some strengths. A major strength was the search strategy which ensured an up-to-date selection and review of potential studies, up until June 2020. Furthermore, we were able to do subgroup analyses of the studies eligible for meta-analyses based on pertinent characteristics of the studies. This enabled a more fine-grained investigation into to accumulated research regarding alcohol consumption and sickness absence.

The present study also holds some limitations. First, studies published prior to 1980 were not included in this review. Although it is likely that studies pre-dating our inclusion period are few and potentially not relevant for the present-day association between alcohol consumption and sickness absence due to changes in alcohol culture at work, sickness absence policies, cultural aspects, and working life in general, this limitation should be borne in mind when interpreting our results. Second, our eligibility criteria may have introduced a bias related to which studies we included. The eligibility criteria chosen were based on our knowledge of the research field and present an effort to ensure some degree of comparability between the included studies. Regardless, the criteria chosen, and procedures followed are well-documented, which makes it possible to reproduce and critically assess each step of the review process. Third, included studies were based on self-reported alcohol use. There is evidence that individuals having risky drinking patterns tend to underreport their alcohol consumption or avoid participating in health surveys [119, 120]. Hence, the estimates may not reflect the real alcohol consumption of respondents in the included studies and the alcohol consumption measures are likely underestimated. However, there is a difference between measuring mere consumption and measuring risky drinking or potential alcohol-related problems. The latter is commonly measured by means of self-reported composite instruments (e.g., AUDIT) [121]. Such instruments take into account that the relationship between alcohol and health is multifaceted, and their potential to screen alcohol consumption and related risks in primary care settings are well documented [122, 123]. Forth, although converting the alcohol drinking units were based on each study's national guideline, the existing variations both in low-risk drinking guidelines and accepted standard drink among countries [17], may affect the definition of risky drinking, as well as prevention efforts. For example, while a standard drink is defined as 14 grams/day by the U.S. drinking guidelines, this amount is defined as 8 grams/day and 19.75 grams/day in the UK and Japan, respectively [17]. Fifth, the included studies used different operationalizations of sickness absence. Accordingly, some of the variations in the estimates may be affected by variations in sickness absence operationalization. Sixth, the studies included in meta-analysis were highly heterogeneous, precluding strong conclusions regarding the estimated association between alcohol consumption and sickness absence, and this is further emphasized in the sub-group analyses.

Conclusion

Sickness absence is an important welfare scheme giving economical job security when sick, but also large consequences for employees. It is associated with a variety of occupational outcomes when related to alcohol consumption (e.g., economic loss, productivity loss, or a risk of exclusion from work). This systematic review and meta-analysis supported, but also challenged the available evidence regarding the association between alcohol consumption and sickness absence among employees. This study revealed how certain types of design, data, and type of sickness absence may produce different, and even large effects. Therefore, treating the

association between alcohol use and sickness absence differently also on an individual level within workplace health promotion programs for reducing and controlling alcohol intake, as well as identifying and addressing individuals' and work settings' conditions may help in preventing different types of sickness absence targeting employees.

Supporting information

S1 File. PRISMA checklist.
(DOC)

S1 Table. Primary database search strategy (based on search in Medline).
(DOCX)

S2 Table. Overview of the association tests (n = 162) between alcohol consumption and sickness absence measures.
(DOCX)

S1 Fig. Pooled odds estimates and forest plots for sickness absence among risky drinking versus low-risk drinking employees, stratified by study design.
(TIF)

S2 Fig. Pooled odds estimates and forest plots for sickness absence among risky drinking versus low-risk drinking employees, stratified by sickness absence measures.
(TIF)

S3 Fig. Pooled odds estimates and forest plots for sickness absence among risky drinking versus low-risk drinking employees, stratified by sickness absence duration.
(TIF)

S4 Fig. Pooled odds estimates and forest plots for sickness absence among risky drinking versus low-risk drinking employees, stratified by year of publication.
(TIF)

S5 Fig. Pooled odds estimates and forest plots for sickness absence among risky drinking versus low-risk drinking employees, stratified by geographical region of the studies.
(TIF)

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3-5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3-5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5-6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6-7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6-7, S2 Table
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7-8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5-8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8-9
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	9-10
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	9-10

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	10
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	10
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	11, Fig 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	11-17, Table 1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	21-22, Fig 5
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	11, 17-19, Tables 1 and 2, S3 Table
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	19, Fig 2
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	21, Fig 4
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	19-21, Fig 3, Table 3, S4-S8 Figs
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	22-26
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	26-27
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	27-28
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	28

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

S2 Table. Primary database search strategy (based on search in Medline)

	Thematic blocks	**Search#**	**Query**	**Search type**	**Search level**
Exposure	*Alcohol consumption*	1	alcohol*	Text	Abstract
		2	drink*	Text	Abstract
		3	drunk*	Text	Abstract
		4	hangover	Text	Abstract
		5	"hang over"	Text	Abstract
		6	alcohol drinking	MeSH	-
		7	binge drinking	MeSH	-
		8	**1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7**		
Outcome	*Sickness absence*	9	"sick leave"	Text	Abstract
		10	"sickness absence"	Text	Abstract
		11	absenteeism	Text	Abstract
		12	"lost work days"	Text	Abstract
		13	"lost work hours"	Text	Abstract
		14	"leave of absence"	Text	Abstract
		15	"work absence"	Text	Abstract
		16	"illness days"	Text	Abstract
		17	absenteeism	MeSH	-
		18	sickness absence	MeSH	-
		19	sick leave	MeSH	-
		20	**9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19**		
		21	**8 AND 20**		

Note. This primary database search strategy was applied in Medline. When applied in the other databases (Embase, Cinahl, PsycInfo, AMED, and Web of Science), the strategy was adapted to each database.

S3 Table. Overview of the association tests (n=162) between alcohol consumption and sickness absence measures

Association ID	Study	Gender	Significance P-value/CI	Direction P/N [a]	Adjustment	Sickness absence measure [b]
1	Jenkins (1986)	Both	$p < .005$	P	No	ND
2	Persson & Magnusson (1989)	Both	$p < .001$	P	No	ND
3	"	Both	$p < .001$	P	No	ND
4	Marmot et al. (1993)	Male	CI: 0.97-1.12	P	Age and grade of employment	S
5	"	Female	CI: 0.84-1.06	N	Age and grade of employment	S
6	"	Male	CI: 0.96-1.30	P	Age and grade of employment	L
7	"	Female	CI: 0.60-1.03	N	Age and grade of employment	L
8	North et al. (1993)	Male	CI: 1.58-2.20	P	Age, smoking, frequency of alcohol consumption, work characteristics, social circumstances outside work and demographic factors	S
9	"	Female	CI: 1.13-2.75	P	"	S
10	"	Male	CI: 1.46-3.07	P	"	L
11	"	Female	CI: 0.51-2.90	P	"	L
12	Blum (1993)	Male	$p > .05$	P	No	ND
13	"	Male	$p < .01$	P	No	ND
14	"	Male	$p < .05$	P	No	ND
15	French et al. (1995)	Both	$p < .05$	P	No	ND
16	Vasse et al. (1998)	Both	$p > .05$	N	Socio-demographic variables, smoking and work stressors	ND
17	"	Both	$p > 0.10$	P	"	ND
18	Spak et al. (1998)	Female	CI: 6.32-33.25	P	No	ND
19	"	Female	$P < 0.01$	P	Socio-economic	ND
20	"	Female	$P < 0.01$	P	Socio-economic	ND
21	Upmark et al. (1999)	Male	CI: 0.5-1.9	P	Age, socioeconomic status, smoking habits, and self-rated health	ND
22	"	Male	CI: 1.4-5.4	P	"	ND
23	"	Female	CI: 0.6-1.8	P	"	ND
24	"	Female	CI: 0.7-4.5	P	"	ND
25	"	Male	CI: 0.0-1.6	N	"	ND
26	"	Male	CI: 0.8-4.3	P	"	ND
27	"	Female	CI: 0.4-3.0	P	"	ND
28	"	Female	CI: 0.6-12.9	P	"	ND
29	Upmark et al. (2) (1999)	Male	CI: 2.0-2.8	P	Psychosocial factors from conscription and for criminality	ND

30	"	Male	CI: 1.2-2.2	P	No	ND
31	"	Male	CI: 0.9-1.5	P	No	ND
32	Richmond et al. (1999)	Both	p <0.05	P	No	ND
33	"	Both	p <0.05	P	No	ND
34	Holder and Blose (1991)	Both	p < 0.001	P	No	ND
35	Vahtera et al. (2002)	Both	p <0.001	P	Socio-demographics, behavioral and biologic risk factors, psychosocial risk factors, and cardiovascular diseases	L
36	Hermansson et al. (2002)	Both	p = 0.047	P	No	L
37	"	Both	p = 0.85	P	No	L
38	"	Both	p = 0.15	P	No	L
39	McFarlin & Fals-Stewart (2002)	Male	p > .05	P	Socio-demographic and background variables, and worksite	ND
40	"	Male	p <.01	P	"	ND
41	"	Male	p > .05	P	"	ND
42	Kivimäki et al. (2002)	Male	ns	P	No	ND
43	"	Female	ns	N	No	ND
44	"	Male	p <.001	P	No	ND
45	"	Female	ns	P	No	ND
46	Bendtsen et al. (2003)	Female	CI: 0.46-1.71	P	Age	L
47	"	Female	CI: 1.31-3.61	P	Age	L
48	"	Female	CI: 1.39-3.07	P	Age	L
49	Morikawa et al. (2004)	Male	CI: 0.82-1.35	P	Age	L
50	"	Male	CI: 0.69-0.84	P	"	L
51	"	Male	CI: 0.78-1.19	P	"	L
52	"	Male	CI: 0.65-0.80	P	"	L
53	Voss et al. (2004)	Male	CI: 1.5-3.8	P	Age	ND
54	"	Female	CI: 0.5-2.8	P	Age	ND
55	Cunradi et al. (2005)	Both	p < .01	P	Age, gender, race/ethnicity, marital status, income, education, and seniority	S
56	"	Both	CI: 0.56-3.15	P	"	S
57	"	Both	p < .05	P	"	S
58	"	Both	p < .01	P	"	S
59	Floderus et al. (2005)	Both	CI: 0.54-1.36	N	Gender and sick leave diagnosis	L

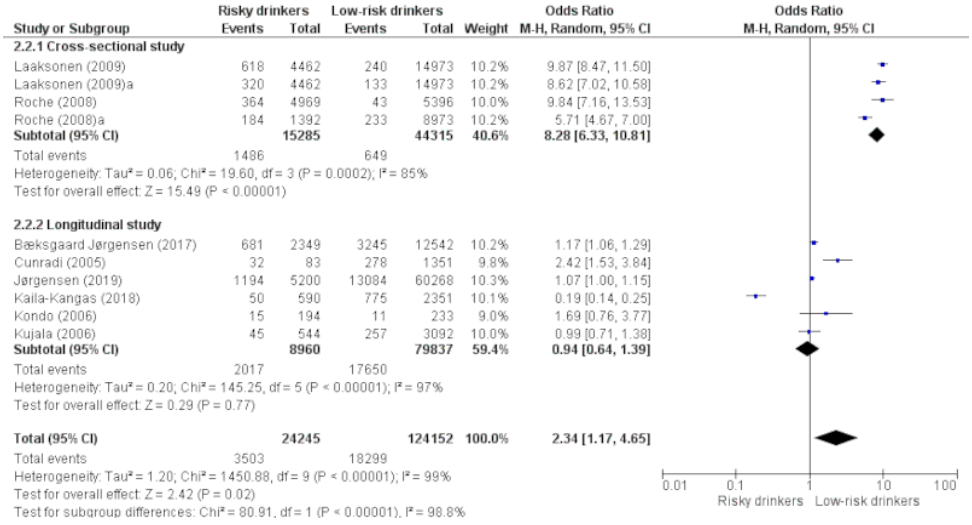
60	Ovuga & Madrama (2006)	Both	CI: 0.7-12.5	P	No	ND
61	"	Both	CI: 1.02-12.00	P	No	ND
62	Pidd et al. (2006)	Both	CI: 0.25-0.44	P	Age and gender	S
63	"	Both	CI: 0.25-0.44	P	Age and gender	L
64	Kondo et al. (2006)	Both	CI: 0.14-1.23	N	Gender, age, education completed, occupation, and daily tobacco consumption,	L
65	"	Both	CI: 0.23-1.95	N	"	L
66	Kujala et al. (2006)	Male	CI: 0.46-1.67	N	Work-related, family structure, lifestyle, living condition, and behavior characteristics	L
67	"	Female	CI: 0.53-1.55	N	"	ND
68	Norstrom (2006)	Male	p <0.05	P	No	ND
69	"	Female	ns	P	No	ND
70	Christensen et al. (2007)	Male	CI: 0.85-1.98	P	Family status, socio economic status, education, and diagnosed disease	L
71	"	Female	CI: 0.76-1.83	P	"	L
72	Suominen et al. (2007)	Both	CI: 0.72-1.20	N	Age, socioeconomic status	L
73	Johansson et al. (2009)	Both	p <.001	P	Age, gender, marital status, education	ND
74	Laaksonen et al. (2009)	Male	CI: 1.01-1.55	P	Age	S
75	"	Female	CI: 1.06-1.26	P	Age	S
76	"	Male	CI: 0.87-1.52	P	Age	L
77	"	Female	CI: 0.94-1.21	P	Age	L
78	Roche et al. (2008)	Both	CI: 3.04-5.98	P	Age, gender and marital status	ND
79	"	Both	CI: 4.46-12.08	P	Age, gender and marital status	ND
80	Salonsalmi et al. (2009)	Female	CI: 1.12-1.54	P	Age	S
81	"	Male	CI: 0.97-1.53	P	Age	S
82	"	Female	CI: 1.34-2.10	P	Age	S
83	"	Male	CI: 1.27-2.33	P	"	S
84	"	Female	CI: 1.23-1.43	P	"	S
85	"	Male	CI: 1.14-1.58	P	"	S
86	"	Female	CI: 1.06-1.60	P	"	L
87	"	Male	CI: 0.93-1.67	P	"	L
88	"	Female	CI: 1.24-2.17	P	"	L
89	"	Male	CI: 0.91-1.93	P	"	L

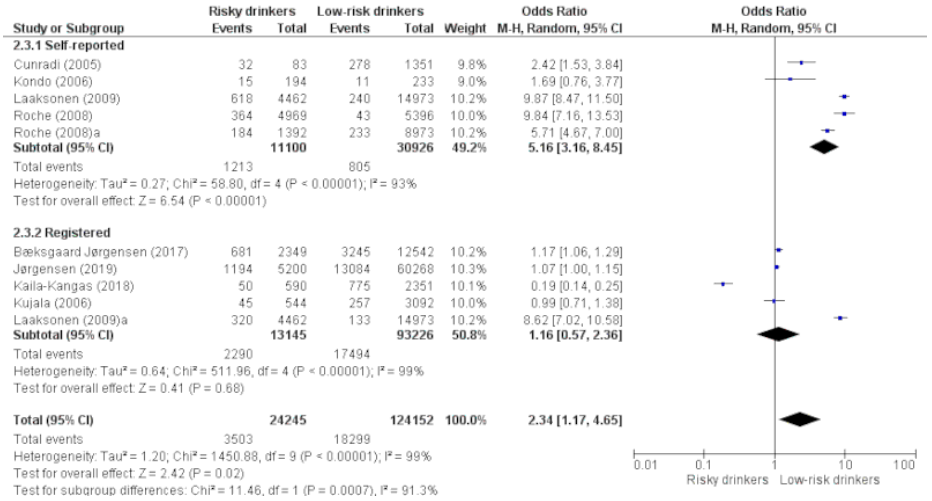
90	"	Female	CI: 1.09-1.32	P	"	L
91	"	Male	CI: 1.15-1.72	P	"	L
92	Norstrom & Moan (2009)	Male	p <0.05	P	Unemployment rate	ND
93	"	Female	ns	P	"	ND
94	Bacharach et al. (2010)	Both	ns	P	Gender, age, marital status, tenure, household income, average hours worked per week	ND
95	"	Both	p <0.01	P	"	ND
96	Balsa & French (2010)	Both	ns	N	Behavioral health and job characteristics	ND
97	"	Both	ns	P	"	ND
98	"	Both	p <0.01	P	"	ND
99	Kirkham et al. (2015)	Both	p = 0.22	P	Age group, region of residence, gender, work type, business unit, shift work, insurance plan, and exempt status	ND
100	Hensing et al. (2011)	Male	p = 0.703	N	Age, Income, level of perceived symptoms	L
101	"	Female	p <.001	P	"	L
102	Edvardsen et al. (2015)	Both	p <.001	P	No	ND
103	"	Both	p = 0.916	N	No	ND
104	"	Both	p <.05	P	No	ND
105	"	Both	p <.001	P	No	ND
106	Lidwall & Marklund (2011)	Male	p <.001	P	Calendar month	L
107	"	Female	p <.001	P	Calendar month	L
108	Chakraborty & Subramanya (2013)	Both	p <.005	P	No	ND
109	Schou et al. (2014)	Both	CI: 4.63-15.44	P	No	ND
110	"	Both	CI: 6.00-22.10	P	No	ND
111	Ervasti et al. (2018)	Both	CI: 1.16-1.66	P	Age, socio-economic status, smoking, body mass index and physical and mental morbidity	ND
112	Ervasti et al. (2018)	Both	CI: 1.03-1.70	P	Age, socio-economic status, smoking and body mass index	L
113	Torvik et al. (2016)	Both	CI: 0.9-1.6	P	Gender, age, and parental education	L
114	Silva-Junior & Fischer (2014)	Both	CI: 1.18-85.63	P	Age	L
115	Richmond et al. (2016)	Both	p <0.01	P	Clinical mediators	ND
116	De Clercq et al. (2015)	Both	CI: 1.024-1.125	P	Gender, age, education, occupational status, and health perception	L
117	Østby et al. (2016)	Both	CI: 2.42–4.71	P	Gender	L
118	"	Both	CI: 1.58–3.72	P	Gender	L

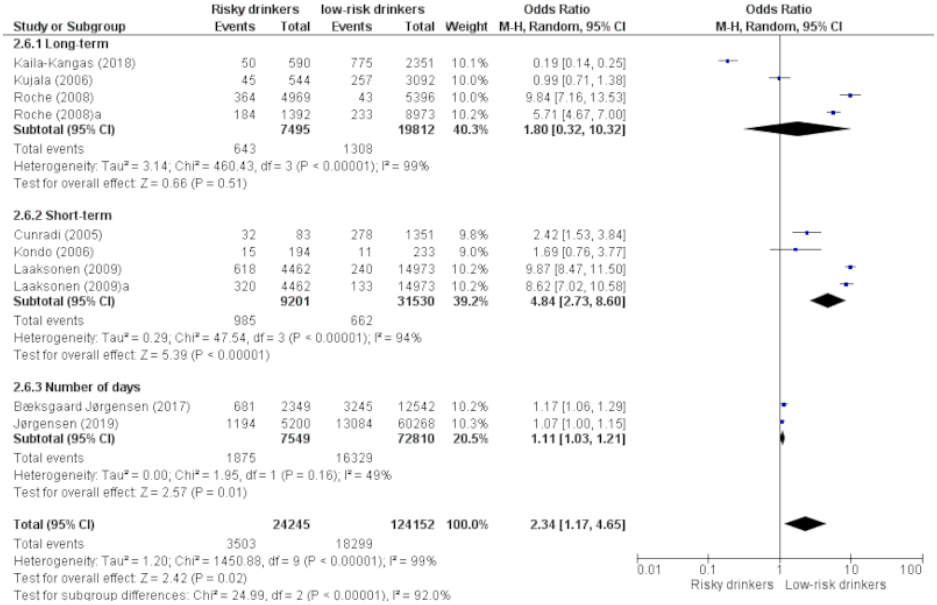
119	Morois et al. (2017)	Male	p <.01	P	Age and socio-professional categories at hiring	ND
120	"	Female	p <.01	P	"	ND
121	"	Male	p <.01	P	"	S
122	"	Female	p <.01	P	"	S
123	"	Male	p <.01	P	"	L
124	"	Female	p <.01	P	"	L
125	Ervasti et al. (2018)	Male	CI: 1.23-2.23	P	No	S
126	"	Female	CI: 0.99-1.30	P	No	S
127	"	Male	CI: 1.19-2.21	P	Smoking, BMI, and physical inactivity	S
128	"	Female	CI: 1.00-1.33	P	Smoking, BMI, and physical inactivity	S
129	Salonsalmi et al. (2015)	Female	CI: 1.11 -1.75	P	Age and marital status	S
130	"	Male	CI: 0.78–1.38	P	"	S
131	"	Female	CI: 1.17–1.43	P	"	S
132	"	Male	CI: 0.98–1.62	P	"	S
133	"	Female	CI: 0.94–1.64	P	"	L
134	"	Male	CI: 0.85–1.51	P	"	L
135	"	Female	CI: 0.97–1.23	P	"	L
136	"	Male	CI: 0.89–1.47	P	"	L
137	Araujo et al. (2017)	Both	CI: 0.13–11.64	P	Gender, retirement age, income, sleep quality, and low back pain	ND
138	schou & Birkelund (2015)	Both	p < 0.001	P	Age, gender, education, working size, income	ND
139	"	Both	p < 0.01	P	"	ND
140	"	Male	p < 0.01	P	Age, education, working size, income	ND
141	"	Male	ns	P	"	ND
142	"	Female	ns	P	"	ND
143	"	Female	p < 0.01	P	"	ND
144	Kaila Kangas et al. (2018)	Both	CI: 0.98-1.35	P	Age	L
145	"	Both	CI: 1.19-1.76	P	Age	L
146	Jorgensen et al. (2017)	Female	p =0.20	P	Age, cohabitation status, education, smoking, region	ND
147	"	Male	p = 0.02	P	"	ND
148	"	Female	p = 0.24	P	"	ND

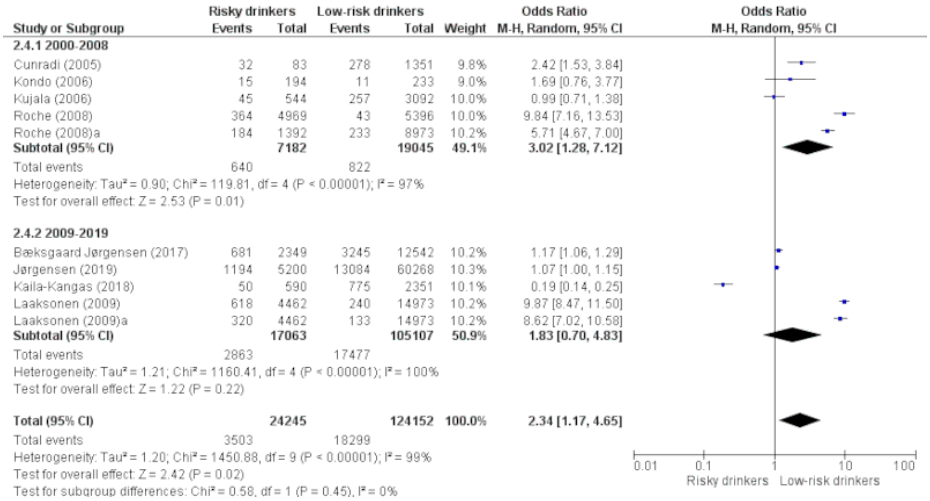
149	"	Male	$p = 0.89$	P	"	ND
150	Jørgensen et al. (2019)	Both	CI: 1.17-1.43	P	Age, gender, cohabitation status, educational level, mental illness and disorders, smoking behavior, geographic region, and labor market status	ND
151	"	Both	CI: 1.12-1.34	P	"	ND
152	Lund et al. (2019)	Both	p =0.147	P	Age and education	S
153	"	Both	$p = 0.991$	P	Age and education	L
154	Hambisa Mekonnen et al. (2019)	Both	CI: 1.06–1.40	P	Age and country of birth	S
155	Landberg et al. (2020)	Male	CI: 1.06–1.38	P	"	S
156	"	Female	CI: 1.11–1.59	P	"	S
157	"	Male	CI: 1.18–1.88	P	"	S
158	"	Female	CI: 1.05–2.74	P	"	L
159	"	Male	CI: 1.01–2.36	P	"	L
160	"	Female	CI: 1.27–3.58	P	"	L
161	"	Male	CI: 0.81–2.06	P	"	L
162	"	Female	p <.005	P	Gender, age, marital status, education, and BMI	ND

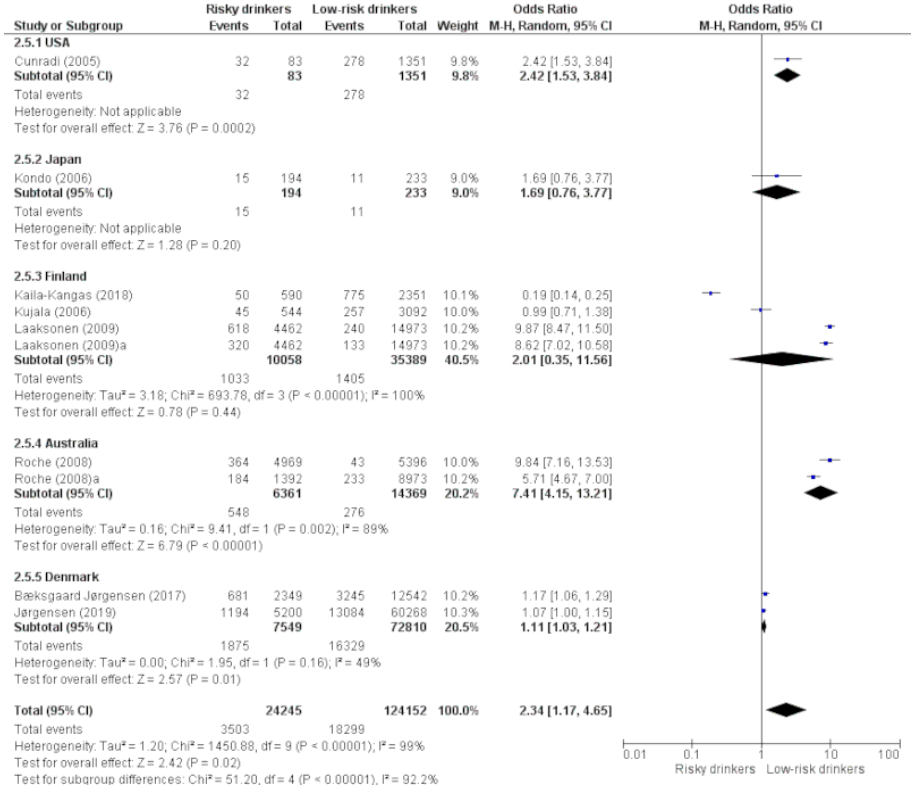
[3] S = short-term; L = long-term; ND = number of absence days
[5] P = positive direction; N = negative direction




Risky drinkers
Low-risk drinkers
Odds Ratio
Odds Ratio
Study or Subgroup
Events Total Events Total Weight M-H, Random, 95% CI
M-H, Random, 95% CI
2.3.1 Self-reported
Cunradi (2005) 32 83 278 1351 9.8% 2.42 [1.53, 3.84]
Kondo (2006) 15 194 11 233 9.0% 1.69 [0.76, 3.77]
Laaksonen (2009) 618 4462 240 14973 10.2% 9.87 [8.47, 11.50]
Roche (2008) 364 4969 43 5396 10.0% 9.84 [7.16, 13.53]
Roche (2008)a 184 1392 233 8973 10.2% 5.71 [4.67, 7.00]
Subtotal (95% CI) 11100 30926 49.2% 5.16 [3.16, 8.45]
Total events 1213 805
Heterogeneity: Tau² = 0.27; Chi² = 58.80, df = 4 (P < 0.00001); I² = 93%
Test for overall effect: Z = 6.54 (P < 0.00001)
2.3.2 Registered
Bæksgaard Jørgensen (2017) 681 2349 3245 12542 10.2% 1.17 [1.06, 1.29]
Jørgensen (2019) 1194 5200 13084 60268 10.3% 1.07 [1.00, 1.15]
Kaila-Kangas (2018) 50 590 775 2351 10.1% 0.19 [0.14, 0.25]
Kujala (2006) 45 544 257 3092 10.0% 0.99 [0.71, 1.38]
Laaksonen (2009)a 320 4462 133 14973 10.2% 8.62 [7.02, 10.58]
Subtotal (95% CI) 13145 93226 50.8% 1.16 [0.57, 2.36]
Total events 2290 17494
Heterogeneity: Tau² = 0.64; Chi² = 511.96, df = 4 (P < 0.00001); I² = 99%
Test for overall effect: Z = 0.41 (P = 0.68)
Total (95% CI) 24245 124152 100.0% 2.34 [1.17, 4.65]
Total events 3503 18299
Heterogeneity: Tau² = 1.20; Chi² = 1450.88, df = 9 (P < 0.00001); I² = 99%
Test for overall effect: Z = 2.42 (P = 0.02)
Test for subgroup differences: Chi² = 11.46, df = 1 (P = 0.0007), I² = 91.3%
0.01 0.1 1 10 100
Risky drinkers Low-risk drinkers


Risky drinkers
low-risk drinkers
Odds Ratio
Odds Ratio
Study or Subgroup
Events Total Events Total Weight M-H, Random, 95% CI
M-H, Random, 95% CI
2.6.1 Long-term
Kaila-Kangas (2018) 50 590 775 2351 10.1% 0.19 [0.14, 0.25]
Kujala (2006) 45 544 257 3092 10.0% 0.99 [0.71, 1.38]
Roche (2008) 364 4969 43 5396 10.0% 9.84 [7.16, 13.53]
Roche (2008)a 184 1392 233 8973 10.2% 5.71 [4.67, 7.00]
Subtotal (95% CI) 7495 19812 40.3% 1.80 [0.32, 10.32]
Total events 643 1308
Heterogeneity: Tau² = 3.14; Chi² = 460.43, df = 3 (P < 0.00001); I² = 99%
Test for overall effect: Z = 0.66 (P = 0.51)
2.6.2 Short-term
Cunradi (2005) 32 83 278 1351 9.8% 2.42 [1.53, 3.84]
Kondo (2006) 15 194 11 233 9.0% 1.69 [0.76, 3.77]
Laaksonen (2009) 618 4462 240 14973 10.2% 9.87 [8.47, 11.50]
Laaksonen (2009)a 320 4462 133 14973 10.2% 8.62 [7.02, 10.58]
Subtotal (95% CI) 9201 31530 39.2% 4.84 [2.73, 8.60]
Total events 985 662
Heterogeneity: Tau² = 0.29; Chi² = 47.54, df = 3 (P < 0.00001); I² = 94%
Test for overall effect: Z = 5.39 (P < 0.00001)
2.6.3 Number of days
Bæksgaard Jørgensen (2017) 681 2349 3245 12542 10.2% 1.17 [1.06, 1.29]
Jørgensen (2019) 1194 5200 13084 60268 10.3% 1.07 [1.00, 1.15]
Subtotal (95% CI) 7549 72810 20.5% 1.11 [1.03, 1.21]
Total events 1875 16329
Heterogeneity: Tau² = 0.00; Chi² = 1.95, df = 1 (P = 0.16); I² = 49%
Test for overall effect: Z = 2.57 (P = 0.01)
Total (95% CI) 24245 124152 100.0% 2.34 [1.17, 4.65]
Total events 3503 18299
Heterogeneity: Tau² = 1.20; Chi² = 1450.88, df = 9 (P < 0.00001); I² = 99%
Test for overall effect: Z = 2.42 (P = 0.02)
Test for subgroup differences: Chi² = 24.99, df = 2 (P < 0.00001), I² = 92.0%
0.01 0.1 1 10 100
Risky drinkers Low-risk drinkers


Risky drinkers
Low-risk drinkers
Odds Ratio
Odds Ratio
Study or Subgroup
Events Total Events Total Weight M-H, Random, 95% CI
M-H, Random, 95% CI
2.4.1 2000-2008
Cunradi (2005) 32 83 278 1351 9.8% 2.42 [1.53, 3.84]
Kondo (2006) 15 194 11 233 9.0% 1.69 [0.76, 3.77]
Kujala (2006) 45 544 257 3092 10.0% 0.99 [0.71, 1.38]
Roche (2008) 364 4969 43 5396 10.0% 9.84 [7.16, 13.53]
Roche (2008)a 184 1392 233 8973 10.2% 5.71 [4.67, 7.00]
Subtotal (95% CI) 7182 19045 49.1% 3.02 [1.28, 7.12]
Total events 640 822
Heterogeneity: Tau² = 0.90; Chi² = 119.81, df = 4 (P < 0.00001); I² = 97%
Test for overall effect: Z = 2.53 (P = 0.01)
2.4.2 2009-2019
Bæksgaard Jørgensen (2017) 681 2349 3245 12542 10.2% 1.17 [1.06, 1.29]
Jørgensen (2019) 1194 5200 13084 60268 10.3% 1.07 [1.00, 1.15]
Kaila-Kangas (2018) 50 590 775 2351 10.1% 0.19 [0.14, 0.25]
Laaksonen (2009) 618 4462 240 14973 10.2% 9.87 [8.47, 11.50]
Laaksonen (2009)a 320 4462 133 14973 10.2% 8.62 [7.02, 10.58]
Subtotal (95% CI) 17063 105107 50.9% 1.83 [0.70, 4.83]
Total events 2863 17477
Heterogeneity: Tau² = 1.21; Chi² = 1160.41, df = 4 (P < 0.00001); I² = 100%
Test for overall effect: Z = 1.22 (P = 0.22)
Total (95% CI) 24245 124152 100.0% 2.34 [1.17, 4.65]
Total events 3503 18299
Heterogeneity: Tau² = 1.20; Chi² = 1450.88, df = 9 (P < 0.00001); I² = 99%
Test for overall effect: Z = 2.42 (P = 0.02)
Test for subgroup differences: Chi² = 0.58, df = 1 (P = 0.45), I² = 0%
0.01 0.1 1 10 100
Risky drinkers Low-risk drinkers


Risky drinkers
Low-risk drinkers
Odds Ratio
Odds Ratio
Study or Subgroup
Events Total Events Total Weight M-H, Random, 95% CI
M-H, Random, 95% CI
2.5.1 USA
Cunradi (2005) 32 83 278 1351 9.8% 2.42 [1.53, 3.84]
Subtotal (95% CI) 83 1351 9.8% 2.42 [1.53, 3.84]
Total events 32 278
Heterogeneity: Not applicable
Test for overall effect: Z = 3.76 (P = 0.0002)
2.5.2 Japan
Kondo (2006) 15 194 11 233 9.0% 1.69 [0.76, 3.77]
Subtotal (95% CI) 194 233 9.0% 1.69 [0.76, 3.77]
Total events 15 11
Heterogeneity: Not applicable
Test for overall effect: Z = 1.28 (P = 0.20)
2.5.3 Finland
Kaila-Kangas (2018) 50 590 775 2351 10.1% 0.19 [0.14, 0.25]
Kujala (2006) 45 544 257 3092 10.0% 0.99 [0.71, 1.38]
Laaksonen (2009) 618 4462 240 14973 10.2% 9.87 [8.47, 11.50]
Laaksonen (2009)a 320 4462 133 14973 10.2% 8.62 [7.02, 10.58]
Subtotal (95% CI) 10058 35389 40.5% 2.01 [0.35, 11.56]
Total events 1033 1405
Heterogeneity: Tau² = 3.18; Chi² = 693.78, df = 3 (P < 0.00001); I² = 100%
Test for overall effect: Z = 0.78 (P = 0.44)
2.5.4 Australia
Roche (2008) 364 4969 43 5396 10.0% 9.84 [7.16, 13.53]
Roche (2008)a 184 1392 233 8973 10.2% 5.71 [4.67, 7.00]
Subtotal (95% CI) 6361 14369 20.2% 7.41 [4.15, 13.21]
Total events 548 276
Heterogeneity: Tau² = 0.16; Chi² = 9.41, df = 1 (P = 0.002); I² = 89%
Test for overall effect: Z = 6.79 (P < 0.00001)
2.5.5 Denmark
Bæksgaard Jørgensen (2017) 681 2349 3245 12542 10.2% 1.17 [1.06, 1.29]
Jørgensen (2019) 1194 5200 13084 60268 10.3% 1.07 [1.00, 1.15]
Subtotal (95% CI) 7549 72810 20.5% 1.11 [1.03, 1.21]
Total events 1875 16329
Heterogeneity: Tau² = 0.00; Chi² = 1.95, df = 1 (P = 0.16); I² = 49%
Test for overall effect: Z = 2.57 (P = 0.01)
Total (95% CI) 24245 124152 100.0% 2.34 [1.17, 4.65]
Total events 3503 18299
Heterogeneity: Tau² = 1.20; Chi² = 1450.88, df = 9 (P < 0.00001); I² = 99%
Test for overall effect: Z = 2.42 (P = 0.02)
Test for subgroup differences: Chi² = 51.20, df = 4 (P < 0.00001), I² = 92.2%
0.01 0.1 1 10 100
Risky drinkers Low-risk drinkers

Paper II

Hashemi NS, Thørrisen MM, Skogen JC, Sagvaag H, Gimeno Ruiz de Porras D, Aas RW. Gender Differences in the Association between Positive Drinking Attitudes and Alcohol-Related Problems. The WIRUS Study. Int J Environ Res Public Health. 2020;17(16):5949. doi:10.3390/ijerph17165949

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Article

Gender Differences in the Association between Positive Drinking Attitudes and Alcohol-Related Problems. The WIRUS Study

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Abstract: *Background:* Alcohol consumption is deeply integrated in people's social- and work lives and, thus, constitutes a serious public health challenge. Attitudes toward drinking stand out as important predictors of drinking, but have to date been sparsely studied in employee populations. This study explores the association of employees' attitudes toward drinking with their alcohol-related problems, and whether this association is moderated by gender and employment sector. *Methods:* Cross-sectional data were collected from a heterogeneous sample of employees (N = 4094) at 19 Norwegian companies. Drinking attitudes were assessed using the Drinking Norms Scale. The AUDIT (Alcohol Use Disorders Identification Test) scale was then used to assess any alcohol-related problems. Data were analyzed using chi-square tests, analysis of covariance (ANCOVA), and multiple logistic regression. *Results:* Employees with predominantly positive drinking attitudes were almost three times as likely to report alcohol-related problems compared to employees with more negative drinking attitudes (OR = 2.75; 95% CI: 2.00–3.76). Gender moderated the association between positive drinking attitudes and alcohol-related problems (OR = 3.30; 95% CI: 2.10–5.21). The association was stronger in women (OR = 5.21; 95% CI: 3.34–8.15) than in men (OR = 3.10; 95% CI: 2.11–4.55). Employment sector did not moderate the association between drinking attitudes and alcohol-related problems. *Conclusions:* Employee attitudes toward alcohol should be monitored to better enable early workplace health promotion interventions targeting alcohol problems. These interventions might need to be gender-specific.

Keywords: alcohol attitudes; norms; gender differences; public health; occupational health; workplace interventions; sick leave; presenteeism

1. Introduction

Alcohol consumption is deeply integrated in social and work life in many societies [1], and thus constitutes a major public health challenge. A recent study by the Global Burden of Disease Project

suggests that alcohol-related consequences are more severe than previously assumed with alcohol consumption being a leading risk factor for mortality and disability-adjusted life years (DALYs) in the global population aged 15 to 49 years [2]. In this age group, approximately 12% of deaths in men and 4% in women can be attributed to alcohol consumption [1]. Risky drinking, i.e., a drinking pattern that raises the likelihood of medical, social, occupational, and economic problems [3], may have adverse consequences on people's lives, the health care system, workplace productivity, and global economic burden [4,5]. Therefore, reducing harmful drinking is a key issue to ensure greater personal and economic well-being [1,6].

Several authors have emphasized that alcohol consumption in work-related settings can help facilitate efforts for teambuilding and bonding with clients [7,8]. On the other hand, employees' alcohol consumption is also associated with productivity decrements, such as absenteeism [9] and presenteeism (i.e., reduced on-the-job performance) [10]. Given that the majority of adults spend considerable time at work [11] and that the majority of workers consume alcohol regularly [12,13], there may be a large percentage of employees characterized as risky drinkers who could benefit from preventive interventions [14]. And the workplace may be an ideal setting for such interventions [15].

Alcohol consumption may not be same for all groups of workers, suggesting that intervention may need to be specific for different target groups. For instance, gender differences in alcohol consumption have been previously reported [16–18] indicating that men drink more frequently and more heavily than women, while women are overrepresented among abstainers [18]. Hence, due to a dose-response relationship between alcohol consumption and alcohol-related problems [19], men are more prone than women to experiencing alcohol-related problems [17]. This finding may indicate endogenous gender differences, and yet, gender-specific drinking patterns may also be heavily influenced by sociocultural factors. For instance, the magnitude of gender differences in consumption is not consistent by country [18]. Countries with higher gender equality (e.g., the Nordic countries) tend to have smaller gender discrepancies in drinking patterns than countries with lower gender equality [20,21]. For example, in Norway, a drinking pattern convergence between the genders has been observed such as women's drinking levels has gradually moved toward that of men [22].

Individuals are never totally isolated from their sociocultural surroundings. Sociocultural structures can affect drinking, also affecting gender differences in drinking, and the processes of internalizing social and cultural norms [23]. Drinking cultures exist on different levels (e.g., on national and workplace levels) and generally prescribe what is considered to be appropriate consumption levels, the purposes for drinking and its settings, how to behave during drinking situations, and how to appraise and evaluate different alcohol-related phenomena [7,24,25]. Thus, each culture influences its own alcohol-related perceptions and attitudes differently [26–28]. In addition, the distinction between "wet" and "dry" drinking cultures [29] also constitutes a framework that can be influential when understanding drinking cultures. "Wet" cultures are characterized by frequent drinking, high total per capita total consumption, but yet a quite low prevalence of heavy drinking. In contrast, "dry" cultures tend to frequent drinking and lower total per capita consumption, but still a markedly higher occurrence of heavy/binge drinking. At the workplace level, an organization's drinking culture (i.e., organized set of shared values and understandings about alcohol consumption) may impact the drinking level of its workers [30–33]. Drinking cultures may vary by work organization and occupation [34], with each occupational culture holding its own structure (e.g., formal and informal), social organization, norms, rituals, history, and beliefs [25,34]. For example, Ames, Grube and Moore studied the same occupational group within two large manufacturing plants showing that differences in internal organizational cultures can considerably affect workers' attitudes towards drinking with one of the workplaces reporting a more positive attitude towards alcohol drinking than its counterpart [30]. Further, a 2019 report from the Norwegian Institute of Public Health found notable differences in private- versus public-sector employees in Norway with private-sector employees reporting more alcohol intake, more alcohol-related problems, and more positive attitudes towards alcohol than public-sector

employees [35]. Moreover, some studies indicated a notable attitude-drinking relationship among employees in different occupations [34,36].

These prior findings stress the importance of sociocultural norms and the related perceptions and attitudes in regards to modifying alcohol-related behaviors. Thus, sociocultural norms prescribe what is considered appropriate in a certain situation [23], subjective norms reflect individuals' perceptions of these sociocultural prescriptions, and certain attitudes may be considered even more idiosyncratic and all together comprises individuals' evaluations or appraisals of a certain behavior [37]. One may also assume that "the more favorable the attitude and subjective norm with respect to a behavior, and the greater the perceived behavioral control, the stronger should be an individual's intention to perform the behavior" ([37], p. 188). The crucial term here is "attitude", which is a key component of major health behavior theories [38–40]. Indeed, attitudes have been identified as potent predictors of drinking quantity, getting drunk, and choosing binge drinking [41]. Individuals who have positive attitudes toward alcohol tend to drink more than individuals who have more negative drinking attitudes [42–47]. The relative importance of attitudes when predicting behavior may also vary according to gender. Men and women may hold different attitudes, and the association between their attitudes and their behavior may also be different. Although some studies have explored gender differences in the extent to which drinking attitudes predict drinking behaviors, the results have been inconclusive. Whereas some studies indicated a stronger attitude-drinking relationship among women [41,48], others found just the opposite [49–51].

Knowledge of the different associations between drinking attitudes and alcohol-related consequences among adult workers, and whether such associations differ by gender, is important to better understand and prevent alcohol-related problems in the workforce. Adults (age 18 and above) are found to be proper subjects for assessing such attitudes, due to their having more experience with alcohol [41,52,53]. This knowledge may be pertinent when designing and evaluating workplace health promotion programs. Although the existing evidence of an association between drinking attitudes and alcohol consumption in non-work settings is rather robust, that evidence may not be readily applicable to workplace settings for the following reasons: (i) there is a lack of research examining working samples as opposed to college students, which have been predominant in the prior literature [42,43,47,48]; (ii) there are no recent studies; (iii) drinking attitudes have been measured using non-validated items rather than validated instruments, or have measured alcohol consumption in combination with other substance use behaviors [54,55]; and, (iv) examining whether the association between drinking attitudes and alcohol-related problems in workers is moderated by gender and/or employment sector have been not explored in detail. Critically, although previous studies among college students could have some applicability to working populations, findings from those studies could be biased by student peers' risky behaviors, which have been found to be driven by these individuals' (mis)perception of their peers' behavior, regardless of how accurate those perceptions are [56–58]. Students normally overestimate the actual drinks as well as the amount of approved alcohol use by others and do not display their real attitudes [43,59,60]. Although adult workers may not be free of such (mis)perceptions, younger populations, like college students, could be more affected by it than older individuals due to not being completely aware of their peer's normal consumption patterns [61–63]. Using a heterogeneous adult working sample and internationally validated instruments, the present study intended to extend the existing literature.

Study Aim

The aims of this study were to explore the association between employees' positive or negative drinking attitudes and alcohol-related problems, and whether this association is moderated by gender and/or employment sector.

2. Materials and Methods

2.1. Design

This study is part of the Norwegian national Workplace Interventions Preventing Risky Alcohol Use and Sick Leave (WIRUS) project and was designed as a cross-sectional study of employees in 19 companies in Norway.

2.2. Sample and Data Collection

Employees were recruited between 2014 and 2019 from private (n = 7) and public (n = 12) companies in Norway. The recruitment strategy sought to gather a heterogeneous sample of employees and workplaces. Hence, the 19 companies were recruited based on geographical, sector and industry diversity, representing the following economic activities: Transportation/storage, education, manufacturing, public administration, human health/social work activities, and accommodation/food service. Individual-level criteria for inclusion were: (i) age 16–72; (ii) employee status (salaried-employees in any blue, white or pink-collar occupations); (iii) basic understanding of the Norwegian language; and, (iv) provided written informed consent.

All employees in the 19 companies (n = 17,855) were invited to participate via their employer-provided e-mail address. Altogether, 5076 employees (28.5%) agreed to participate. However, only those participants who responded to all items (n= 4094) were included in the current analyses. As shown in Table 1, the sample was predominantly female (n = 2696; 65.9%), more than two-thirds were age 40 or older, and 70% had completed a university/college education. Men, when compared to women, were somewhat older, more likely to have primary/lower secondary education as their highest educational attainment, more likely to have a full-time position, and less likely to be employed in the public sector (all $p < 0.001$). Comparisons between the study sample and the invited sample (all eligible employees in the 19 selected companies) revealed a somewhat higher proportion of employees age ≥40 in the study sample (68.9% versus 64.1%), but showed no significant difference in gender distribution.

Table 1. Sample characteristics of all employees (N = 4094) and stratified by gender (men: n = 1398; women: n = 2696).

Variables	All Employees	Men	Women	
	n (%)	*n* (%)	*n* (%)	*p*-Value [1]
Age				<0.001
18–29	422 (10.3)	127 (9.1)	295 (10.9)	
30–44	1440 (35.2)	469 (33.5)	971 (36.0)	
≥45	2232 (54.5)	802 (57.4)	1430 (53.0)	
Cohabitation Status				0.143
Living alone	589 (14.4)	204 (14.6)	385 (14.3)	
Living with others	3505 (85.6)	1194 (85.4)	2311 (85.7)	
Educational Attainment				<0.001
Primary/lower secondary	105 (2.6)	56 (4.0)	49 (1.8)	
Upper secondary	928 (22.7)	331 (23.7)	597 (22.1)	
University/college	3061 (74.7)	1011 (72.3)	2050 (76.0)	
Fraction of full-time work				0.001
10–50%	110 (2.7)	25 (1.8)	85 (3.2)	
>50–90%	663 (16.2)	97 (6.9)	566 (21.0)	
100%	3320 (81.1)	1276 (91.3)	2044 (75.8)	
Employment sector				<0.001
Private sector employees	394 (9.6)	310 (22.2)	84 (3.1)	
Public sector employees	3700 (90.4)	1088 (77.8)	2612 (96.9)	

[1] Differences between men and women tested with chi-square tests of independence.

2.3. Measurements

2.3.1. Drinking Attitudes

Drinking attitudes were measured using the Drinking Norms Scale (DNS) [31], a 7-item scale focused on attitudes toward drinking in general (three items) and work-related drinking (four items). Responses were coded on a 4-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree). The seven DNS items demonstrated acceptable internal consistency (Cronbach's α = 0.71). For descriptive analyses, item scores were dichotomized to distinguish between respondents who disagreed (scores 1/2) and those who agreed (scores 3/4) with the statement. To compute the DNS summary scale, negatively worded items (i.e., items 6 and 7) were reversed scored, and a mean score for all seven items was calculated so that the higher score the more positive/liberal drinking attitudes. For the analyses, the mean score was dichotomized based on a median split into "predominantly negative drinking attitudes" (scores < 2.14) and "predominantly positive drinking attitudes" (scores ≥ 2.14).

2.3.2. Alcohol-Related Problems

Alcohol-related problems were assessed using the 10-item Alcohol Use Disorders Identification Test (AUDIT) [3,64]. The AUDIT is a screening instrument used for measuring alcohol consumption and related problems, and it has been implemented in a wide range of settings and populations demonstrating measurement properties often superior to other alcohol-screening instruments [65]. Each item is scored in scale from 0 to 4, resulting in a sum score with a range of 0 to 40. Studies have supported the use of AUDIT as a unidimensional measure of alcohol-related problems [66], and a threshold of ≥8 scores has been recommended as an indication of alcohol-related problems [3,67]. The AUDIT demonstrated acceptable internal consistency (Cronbach's α = 0.71). For the analyses, the sum score was dichotomized as recommended into two groups: employees with alcohol-related problems (score ≥ 8) and without them (scores 0–7).

2.3.3. Moderators

Two variables were used as moderators in the study. Gender and Employment sector. Employment sector was constructed based on information about which branches (i.e., work divisions) the sample where employed. Branches were categorized using the European Classification of Economic Activities (Eurostat) [68], and further sorted into two groups of employment sectors: private-sector employees, which constituted the branches 'transportation and storage', 'accommodation and food service activities', and 'manufacturing'; and public-sector employees, which constituted 'public administration', 'education', and 'human health and social work activities'. Private companies with novation agreement from the public [69] (e.g., one company in human health and social work branch, which is part of the private sector but it is doing public duties) were included in the public sector employees' group.

2.3.4. Covariates

Based on prior research [70,71], age, gender, educational attainment, cohabitation status, occupational level (i.e., work position) and fraction of full-time work were considered potential confounders. To avoid over-adjustment, covariates were chosen based on a series of bivariate non-parametric correlation analyses (Spearman's *rho*). A potential confounder was included as a covariate in adjusted analyses if (i) its bivariate association with the outcome (alcohol-related problems) displayed a *p*-value of <0.20, and (ii) it did not correlate highly (*rho* = ≤70) with another potential confounder [72]. Consequently, the following were included as covariates: *age* (18–29 years; 30–44 years; ≥45 years), *gender* (male; female), *cohabitation status* (living alone; living with others), *educational attainment* (primary/lower secondary; upper secondary; university/college), and *fraction of full-time work* (10–50%; >50–90%; 100%).

2.4. Analysis

Employees' drinking attitudes, stratified by gender, were explored using descriptive statistics. Frequencies (*n*) and proportions (%) for agreement/disagreement with each attitude item and for employees with predominantly negative/positive attitudes were computed; means (*M*) and standard deviations (*SD*) were calculated for the DNS scale. Gender differences were tested using bivariate chi-square tests of independence and adjusted one-way analysis of covariance (ANOVA), controlling for age, cohabitation status, and educational attainment. The prevalence of alcohol-related problems was the proportion of employees who scored ≥8 on the AUDIT. Differences in the prevalence of alcohol-related problems between employees with predominantly negative drinking attitudes versus employees with more positive attitudes were examined with chi-square tests of independence.

Multiple unconditional logistic regression models were built to obtain the odds ratios (OR), and corresponding 95% confidence intervals, of the association between drinking attitudes (predominantly negative versus positive) and alcohol-related problems for all employees, adjusted for age, gender, cohabitation status, educational attainment, fraction of full-time work, and employment sector (Model 1). An interaction term (continuous mean DNS scale score x gender) was included in Model 1 to determine whether gender moderated the association between drinking attitudes and alcohol problems. To determine whether the association varied by employment sector group, a two-way attitude variable × employment sector interaction was examined. Since the interaction with gender was statistically significant, we ran additional gender-stratified regression models (Model 2 for men, and Model 3 for women). To provide an indication of the amount of variation in alcohol-related problems explained by the model, the Cox & Snell R^2 as well as the Nagelkerke R^2 values were added to the model. All analyses were performed using IBM SPSS, Version 25, and statistical significance was set at $p < 0.05$.

2.5. Ethics

Participants were informed about the study's aims and assured that their participation was voluntary. All participants provided written informed consent prior to participation and were informed

told they could withdraw their consent at any given time without any consequences. The study was approved by the Regional Committees for Medical and Health Research in Norway (REK) (Reference Number 2014/647).

3. Results

3.1. Employees' Attitudes toward Alcohol

Overall, a majority of the participants (61.5%) reported predominantly positive drinking attitudes. Table 2 shows that a higher proportion of men than women (68.2% versus 58.0%) reported predominantly positive drinking attitudes, and the mean attitude score was higher ($p < 0.001$) in men ($M = 2.23$; $SD = 0.48$) than in women ($M = 2.10$; $SD = 0.44$).

Table 2. Employees' drinking attitudes, stratified by gender.

Drinking Attitudes	Men (n = 1398)		Women (n = 2696)		p-Value
	Disagree [1]	Agree [2]	Disagree [1]	Agree [2]	
	n (%)	n (%)	n (%)	n (%)	
Drinking Norms Scale statements					
S1: Having a drink or two at home after work is a harmless way to relax and unwind	917 (65.6)	481 (34.4)	1933 (71.1)	763 (28.3)	<0.001 [5]
S2: Getting together for drinks once in a while after work with co-workers can improve employees' morale	554 (39.6)	844 (60.4)	1396 (51.8)	1300 (48.2)	<0.001 [5]
S3: Drinking with clients or customers is good for business	890 (63.7)	508 (36.3)	2191 (81.3)	505 (18.7)	<0.001 [5]
S4: Supervisors miss key information if they don't socialize with colleagues over a drink	1062 (76.0)	336 (24.0)	2354 (87.3)	342 (12.7)	<0.001 [5]
S5: A drink or two a day is good for a person's health	1059 (75.8)	339 (24.2)	2251 (83.5)	445 (16.5)	<0.001 [5]
S6 (Reversed score): The more frequently people are exposed to alcohol, the more likely they are to develop a drinking problem	237 (17.0)	1161 (83.0)	623 (23.1)	2073 (76.9)	<0.001 [5]
S7 (Reversed score): Serving alcohol at company social events sets a bad example for employees	982 (70.2)	416 (29.8)	1957 (72.6)	739 (27.4)	<0.001 [5]
Drinking Norms Scale (continuous scores) [3]					<0.001 [6]
Mean (SD)	2.23 (0.48)		2.10 (0.44)		
Drinking Norms Scale (dichotomized scores) [4]					<0.001 [5]
Negative, n (%)	444 (31.8)		1131 (42.0)		
Positive, n (%)	954 (68.2)		1565 (58.0)		

[1] Response categories "strongly disagree" and "disagree"; [2] Response categories "strongly agree" and "agree"; [3] Composite (mean) score of the seven Drinking Norms Scale items, potential range = 1–4, higher score indicates positive attitudes; [4] Dichotomization of mean scale score based on median split: negative < 2.14, positive = scores ≥ 2.14; [5] Gender differences tested with chi-square test of independence; [6] Differences tested using a one-way analysis of covariance (ANCOVA), adjusted for age, cohabitation status, and educational attainment.

3.2. Employees' Alcohol Problems and Attitudes toward Alcohol

Overall, one out of ten employees (10.9%) reported alcohol-related problems (men = 18.1%; women = 7.2%; $p < 0.001$) (Table 3). Alcohol-related problems were more prevalent ($p < 0.001$) among those employees with predominantly positive drinking attitudes (15.4%), than among those with predominantly negative attitudes (3.7%).

Table 3. Alcohol-related problems by drinking attitudes.

Alcohol-Related Problems [2]	Drinking Attitudes [1]		Total *n* (%)
	Predominantly Negative *n* (%)	Predominantly Positive *n* (%)	
No	1517 (96.3)	2130 (84.6)	3647 (89.1)
Yes	58 (3.7)	389 (15.4)	447 (10.9)

[1] Dichotomization of mean scale score based on median split: negative < 2.14, positive = scores ≥ 2.14; [2] Sum score, based on AUDIT—Alcohol Use Disorders Identification Test: scores 0–7 = No, scores 8–40 = Yes.

For all employees (adjusted for gender, age [as a continuous variable], cohabitation status, educational attainment, fraction of full-time work [as a continuous variable], employment sector, and the interaction between drinking attitudes and gender; Table 4, Model 1), employees with predominantly positive drinking attitudes were almost three times as likely to report alcohol-related problems, compared to those with predominantly negative drinking attitudes (OR = 2.75; 95% CI: 2.00–3.76). Model 1 explained between 8.5% and 17.1% of the variation in alcohol-related problems (Cox & Snell $R^2 = 0.085$; Nagelkerke $R^2 = 0.171$). Gender moderated the association between drinking attitudes and alcohol-related problems (interaction term DNS x gender: OR = 3.52; 95% CI: 2.24–5.55), but employment sector did not (OR = 1.03; 95% CI: 0.90–1.17).

After adjusting for age, cohabitation status, educational attainment, fraction of full-time work, and employment sector, the association between drinking attitudes and alcohol-related problems was stronger for women (Table 4, Model 3: OR = 5.21; 95% CI: 3.34–8.15) than for men (Table 4, Model 2: OR = 3.10; 95% CI: 2.11–4.55). Additional models adjusting for age in the three categories shown in Table 1 did not result in any meaningfully different results than those presented in Table 4.

Table 4. Associations (OR and 95% CI) between drinking attitudes and alcohol-related problems, overall (Model 1) and stratified by gender (Models 2 and 3).

Variables		Model 1	Model 2	Model 3
		All Employees	Men	Women
		n = 4094	*n* = 1398	*n* = 2696
Drinking Attitudes (Positive vs. Negative [Ref.])	(OR_{crude})	(4.77)	(3.46)	(5.91)
	$OR_{adjusted}$	2.75	3.1	5.21
	95% CI	2.00–3.76	2.11–4.55	3.34–8.15
	p-value	<0.001	<0.001	<0.001
Gender (female vs. male [Ref.])	$OR_{adjusted}$	0.02		
	95% CI	0.01–0.07	-	-
	p-value	<0.001		
Age (in years)	$OR_{adjusted}$	0.97	0.97	0.97
	95% CI	0.96–0.98	0.96–0.98	0.95–0.98
	p-value	<0.001	<0.001	<0.001

Table 4. *Cont.*

Variables		Model 1	Model 2	Model 3
		All Employees	**Men**	**Women**
		***n* = 4094**	***n* = 1398**	***n* = 2696**
Cohabitation Status (Living with others vs. Living alone [Ref.])	$OR_{adjusted}$	0.49	0.49	0.47
	95% CI	0.37–0.64	0.35–0.71	0.33–0.67
	p-value	<0.001	<0.001	<0.001
Educational Attainment (Upper secondary and University/college vs. Primary/lower secondary [Ref.])	$OR_{adjusted}$	0.84	0.81	0.85
	95% CI	0.46–1.54	0.40–1.62	0.24–2.97
	p-value	0.58	0.56	0.8
	$OR_{adjusted}$	0.71	0.63	0.8
	95% CI	0.39–1.31	0.31–1.28	0.23–2.77
	p-value	0.28	0.2	0.73
Fraction of full-time work (in percent)	$OR_{adjusted}$	1	1.01	0.99
	95% CI	0.99–1.01	0.99–1.02	0.99–1.00
	p-value	0.62	0.14	0.69
Employment Sector (Public vs. Private employees [Ref.])	$OR_{adjusted}$	0.71	0.76	0.59
	95% CI	0.52–0.97	0.52–1.11	0.30–1.12
	p-value	<0.05	0.16	0.11
Interaction attitudes x Gender	$OR_{adjusted}$	3.3	-	-
	95% CI	2.10–5.21		
	p-value	<0.001		
Cox & Snell R^2		0.085	0.071	0.049
Nagelkerke R^2		0.171	0.116	0.122

OR_{crude} = odds ratio, bivariate association; $OR_{adjusted}$ = adjusted OR for the other variables included in the model; CI = 95% confidence intervals. Ref. = Reference category.

4. Discussion

4.1. Discussion of Main Findings

This study, conducted with a heterogeneous employee sample, aimed to explore whether there is an association between drinking attitudes and alcohol-related problems among workers, and if this association was moderated by gender and/or employment sector. Our main findings were as follows: (i) predominantly positive (i.e., liberal) drinking attitudes were much more frequent than negative attitudes, and much frequently in men than in women, (ii) one out of ten employees reported alcohol-related problems, and employees with predominantly positive drinking attitudes were almost three times as likely to report alcohol-related problems than those with predominantly negative attitudes, (iii) the association between drinking attitudes and alcohol-related problems was considerably stronger for women than it was for men, but (iv) there were no differences by employment sector (public vs. private employees).

Discovering a higher prevalence of positive drinking attitudes among employees was not surprising since alcohol consumption is deeply integrated in the larger society, as well as in the occupational domain. Employees are regularly exposed to alcohol in work-related settings, e.g., when bonding with colleagues after work hours, at employer-sponsored social events, during work-related travels, and while entertaining clients and business associates [8,73]. Employees develop normative assumptions about behaviors framed within the appropriate organization's drinking culture. Such normative

assumptions within a work-related setting can influence the employees' beliefs and the level of engagement in a behavior [25,74]. As such, alcohol does play an important role in workplace and work-related rituals as a marker of social belonging to the work group [75]. Male employees reported more positive drinking attitudes than their female counterparts, a finding that is consistent with earlier studies on non-working populations [49,76]. However, prior studies were conducted in a culture where drinking alcohol by females was not so socially acceptable. These prior studies focused in the individual's drinking attitudes regarding their reference group and not, as we did, the individual's personal attitudes toward drinking. Estimating one's perception of others' attitudes towards alcohol drinking may be affected by misperception and over- or underestimate others' beliefs and actual drinking behaviors [56–59]. Norms that apply to men also tend to be more supportive of alcohol consumption [32]. Although it has become more socially acceptable for women to drink [77], especially in countries where gender roles have gradually realigned and become more equal [78], men still consume alcohol more frequently and more heavily than women [18]. In fact, being male is identified as a significant predictor for risky drinking [14] and more specifically for binge drinking [79]. Such pointed differences could explain the found less favorable drinking attitude by women.

Our findings showed an association between drinking attitudes and alcohol-related problems among employees. This association is consistent with earlier research, which found that individuals with positive drinking attitudes tend to drink more than individuals with more negative attitudes towards drinking [42–47]. Attitudes generally predict behavior, in particular when attitudes remain stable over time [39]. Having favorable attitudes toward a behavior increases the likelihood of actually performing that behavior [37]. In fact, one out of ten employees reported alcohol-related problems, and these problems were more prevalent in men than in women, which is in agreement with earlier studies [14,33,80–83].

Although both the positive drinking attitudes and alcohol-related problems were more frequent in men than in women, in accordance with prior findings [41], we also found that the association between drinking attitudes and alcohol-related problems was stronger for women than for men. Our data, however, do not reveal the mechanisms behind this finding. It may be that drinking attitudes at work are much more important predictors of alcohol-related problems for women than for men. In addition, men's drinking may be more affected by external social pressures and masculinity concerns [84], while women may be somewhat more sensitive to internal factors such as drinking expectancies [85]. Drinking norms have also traditionally been more strict for women than for men [32], and women may, therefore, be more mindful of their internalized norms (attitudes) to avoid potential social sanctions. Our finding is in contrast with some of prior studies that found stronger attitude-drinking association among men. But these earlier findings may have been affected by either an overrepresentation of males (72% male) [51], or by a culture whereby male drinking is more often tolerated than female drinking [49]. Further research is needed to disentangle the complex relationship between gender, drinking attitudes and health.

We were also interested in the role of the norms at different type of industries and branches in shaping one's attitudes and behaviors toward drinking. Each work setting, based on job duties, position, and workload, may have unique cultural dimensions [25,30]. We, however, did not find differences by employment sector in the association between drinking attitudes and alcohol-related problems. Our finding is at odds with earlier studies, which reported differences by type of work setting [30,31,34,36,86]. However, our study was conducted in Norway and prior studies reported different traditional organizational cultures and regulations of drinking alcoholic beverages (e.g., drinking before or during work shifts) than those found in Norway. Further, Norway has a strict alcohol policy, and it is uncommon to find people working under the influence of alcohol in most Norwegian workplaces [87]. Excessive alcohol consumption can be regarded as a serious infringement of approved company regulations and norms [75], regardless of one's occupation or industry setting. Still, external factors may become unwritten rules, including workers' pre-existing attitudes and behaviors as well as cultural and social norms in the workers' wider community. All these factors should be noted whenever

considering the relationship between workplace and alcohol drinking patterns and the forming of attitudes and beliefs within a work culture [88]. Values and cultures can both be co-created through a process of socialization in a work setting as a set of shared understandings [89]. Differences in those factors could explain the disparities between our findings and prior studies.

4.2. Methodological Issues

This study has several strengths. It was based on a large heterogeneous sample of employees, and it measured drinking attitudes and alcohol-related problems using validated instruments (i.e., the Drinking Norms Scale [31] and the Alcohol Use Disorders Identification Test [3,64]). However, there are methodological consideration to take into account when interpreting our findings.

First, the cross-sectional nature of our study precludes drawing causal inferences about the relationships between social drinking attitudes and alcohol-related problems. The association between drinking attitudes and alcohol-related problems could be interpreted as attitudes leading to drinking behaviors and, subsequently, these to alcohol problems. But, as others have suggested, it may also be that behavior precedes attitudes [38], such as heavy drinking behaviors form more positive drinking attitudes. However, we think this explanation is not as likely as the assumption that attitudes precede behavior as mainstream health behavior models assume [40].

Second, although the sample for this study was relatively large (N = 4094), the response rate was low (23.0%). Lower response rates, however, are part of general declining participation rates in surveys [90]. Further, comparisons between the study sample and the target population (public and private salaried-employees in any blue, white or pink-collar occupations) indicated no differences in gender (p = 0.613) and only a few percent points of difference in the proportion of employees age ≤39, who were underrepresented in our sample (difference in percentage points = 4.9; $p < 0.001$). Thus, our analytical sample should be considered a fair representation of our target population. Compared with the composition of overall Norwegian workforce, our sample had an overrepresentation of women, employees age ≥40, employees with university/college education, and somewhat higher proportion of employees in the public/state sector. Nevertheless, our sample was not intended to represent the workforce of Norway so we caution generalizations of our findings to the Norway working population.

Third, all the data for this study was self-reported. As such, our results may have been affected by recall bias and social desirability. However, for some of our main variables of interest (i.e., attitudes), there's no direct measurement alternative. Moreover, all data were collected using validated measurements instruments, with good reliability and validity. These instruments help ensure that the measures collected were in fact measuring what they were supposed to measure.

4.3. Implications

Findings from our study suggest that drinking attitudes should be considered when designing and conducting alcohol preventive interventions targeting employees. These interventions may target attitudes at the individual level or, perhaps better, at a group level addressing workplace drinking cultures. Attitudes are learned through socialization [91] and the socialization sources may be the various sociocultural levels to which individuals are exposed to. An important level may be the individual's workplace. Intervention can be aimed to establish a "discouraging" workplace drinking culture, taking into account factors such as actual alcohol availability and workplace social control [25,30–32,92,93]. Emphasizing the role of drinking attitudes for interventions may be of particular importance for those workplaces where women are well represented, insofar that the actual association between drinking attitudes and alcohol-related problems may be stronger for women than for men.

Further research on the relationships between drinking attitudes and alcohol-related problems is definitely warranted. That effort would benefit from utilizing research designs that allow further

exploration of development in study variables over time (e.g., prospective cohort studies), as well as by investigating a broader range of potential moderating and mediating variables.

5. Conclusions

Harmful alcohol consumption is indeed a major public health challenge, and drinking by employees is associated with detrimental occupational outcomes (e.g., absenteeism and presenteeism, that is, reduced on-the-job performance). This study highlights the role of drinking attitudes in alcohol-related problems among employees and that the impact of drinking attitudes on alcohol problems may vary across genders. The results of this study underscore the complexities that exist in the intersections between individual and sociocultural domains, and that attitudes should be emphasized for alcohol preventive interventions targeting employees.

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Paper III

Do differences in drinking attitudes and alcohol-related problems explain differences in sick leave? A multilevel analysis of 95 work units within 14 companies from the WIRUS-project

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Abstract

Background: Systematic reviews have shown a strong relationship between alcohol consumption and sick leave. Depending on the nature of the work, alcohol may affect sick leave differently. While attitudes towards drinking may also impact sick leave rates, the contribution of attitudes to sick leave is poorly understood. Moreover, alcohol-related problems and drinking attitudes may be influenced by the broader sociocultural contexts of the organizational units where people work.

Objectives: This study aimed to examine the relationship between alcohol-related problems, drinking attitudes and sick leave, while taking into account the nesting of employees within working units within companies.

Method: Data from the WIRUS-screening study were linked to company-registered sick leave data for 2,560 employees from 95 different work units in public (n=9) and private companies (n=5) in Norway. Three-level (employee, work unit, and company) negative binomial regression models were estimated to examine the association of alcohol-related problems and drinking attitudes with four measures of sick leave within 12 months (one-day, short-term, long-term, and overall sick leave days). Models were adjusted for gender, age, cohabitation status, educational attainment, work position, and employment sector.

Results: Alcohol-related problems and drinking attitudes were not associated with sick leave. Higher variations of one-day, short-term, and overall sick leave days were found between companies than between work units within companies (15%, 12%, and 30% versus 0%, 5%, and 8%, respectively). Including drinking attitudes and alcohol-related problems did not explain these differences.

Conclusion: Alcohol-related problems and drinking attitudes are not associated with sick leave in our sample. Our findings suggest the overall importance of between company-level differences over within company differences in relation to sick leave. Future studies will need to examine if specific company policies, practices, or social norms may explain this.

Keywords: Alcohol consumption, workforce, public health, attitudes, absenteeism, presenteeism.

INTRODUCTION

Sick leave imposes practical as well as financial burdens for individuals, businesses, and societies (1-3). Employees may face layoff consequences. Businesses may be forced to reschedule or reassign work duties to other existing employees or may need to recruiting temporary workers to mitigate the effect of a missing worker. The welfare system may need to absorb the cost of the leave (4-6).

Health-related leaves have been linked to lifestyle behaviors, with alcohol consumption playing a major role (3, 7-11). Risky alcohol use increases the risk of long-standing illnesses and injuries (12-14) as well as mortality. For instance, the proportion in Europe is about 800 alcohol-attributable deaths per day (15). Further, alcohol consumption diminishes work performance (i.e., presenteeism) (9, 16), increases the risk of work-related injuries (17), and sick leave (18-20). The impact of alcohol consumption can be related to sick leave for one or just a few days due to alcohol intoxication and hangovers. For instance, employees reporting consuming alcohol the night before are more likely to take sick leave from work the day after (21-23). The impact can also be related to long-term sick leave due to negative health and social effects of alcohol consumption over time (24, 25). However, the evidence on the relationship between alcohol consumption and sick leave is mixed. Several studies have found sick leave to be more likely to occur among individuals with alcohol-related problems (11, 26-37), others report U-shaped associations (8, 24, 38, 39), and others have found no association (40-43) or negative association (44). That is, less sick leave is common among those with higher levels of alcohol consumption. Some of the disparity in findings may be due to differences in the operationalization of sick leave or in adjustment for potential confounders.

Sick leave spells/days as their duration and length may be affected by a wide range or individual characteristics, including health, working conditions and the nature of the work (45-47). Still, workers' decisions about their illness behavior may be affected by the ability to attend due to poor health but also by organizational values (48, 49). The workplace provides a significant cultural and social context in which, through the social interaction process, workers share and acquire knowledge regarding the behaviors and attitudes expected for effective participation in a work setting (50, 51). The interactions between characteristics of individuals and characteristics of working groups matter (52-54). The effect of group social norms is such that workgroup norms and attitudes towards drinking predict drinking behaviors (55-57) and work impairment (58). Workgroup culture regarding attendance predicts sick leave behaviors (59-61). Given this evidence, it is surprising that the majority of the prior research has focused mainly on the role of individual determinants. To fully understand the relationship between alcohol behavior and sick leave, it is important to assess determinants at the individual (e.g., sociodemographic, drinking behaviors) and group levels (e.g., social norms and attitudes towards drinking). In addition, sick leave may also vary by business given differences in workplace's policies and practices regarding accruing and use of sick leave. Thus, there is a need to consider individual, group, and employer-level differences when examining the relationship between alcohol and sick leave.

Moreover, differences in sick leave also exist by country. These differences are related to variation in the definition of sick leave, culturally determined behaviors, and sick leave benefits schemes, which makes international comparisons challenging (62, 63). Even between Scandinavian countries, known by their similar approach to the welfare state (64), there are also differences, with Norway showing the highest rate of sick leave (4). In fact, in the second quarter of 2020, Norway had the highest sick leave rate in the EEA/European Union (5.7%) (65, 66). Further, binge drinking is also frequent in Norway, which is a risk factor for short- and long-term health issues and social problems (15). The most recent study in Norway estimated that alcohol-related absence constitutes about 1% of the total sick leave and about 3% of short-term sick leave (67). However, no recent research has explored the relationship between drinking attitudes and sick leave in Norway.

Therefore, given the gaps identified in the literature, this study aimed to examine the relationship between alcohol-related problems, drinking attitudes and sick leave, while taking into account the nesting of employees within working units within companies.

MATERIALS AND METHODS

Design

This study is part of the Norwegian national WIRUS project (Workplace Intervention preventing Risky Use of Alcohol and Sick leave) and was designed as a cohort study on a sample of employees in 14 companies in Norway. More details and other results from the WIRUS project are published elsewhere (9, 16, 55, 68-76).

Sample and Data Collection

Employees (blue, white, or pink-collar worker, or manager, i.e., a salaried worker) from different work units (n = 95), were recruited from public (n = 9) and private (n = 5) companies in Norway. These companies were categorized in accordance to the European Classification of Economic Activities (77) including: transportation and storage (n = 1), manufacturing (n = 3), public administration (n = 5), health care service (n = 3), accommodation (n = 1), and education (n = 1). The average work unit size (mean) was 27 employees (min. 10, max. 50) for the study sample.

A total of 17,855 employees from 19 companies were invited to participate in a web-based survey via their employer-provided e-mail addresses. Altogether, 5,076 employees accepted to complete the survey (28.5% response rate). However, 5 companies including 1,794 employees were excluded due to not having data on sick leave. The final sample included 2,560 employees (50.4%) from 14 companies having valid information on key variables (e.g., alcohol-related problems, drinking attitudes, and sick leave). Characteristics of the study sample is presented in Table 1.

The participants in the final sample were predominantly female (n = 1,685; 65.8%); more than two-thirds were aged 40 or older; and 14% of employees were living alone. Three of four had completed a university/college education, and approximately two out of ten employees were categorized as managers. The majority of the respondents in the final sample (89.3%) were employed within the nine public sector companies (manufacturing, public administration, health care, and education), while the remaining were employed within the five private sector companies (transport, manufacturing, public administration, and health care). After comparing the study sample and the invited sample (all eligible employees in the 14 selected companies), the proportion of employees age ≥40 was found to be somewhat higher in the study sample (69.5% versus 64.5%), but no significant difference in gender distribution was observed.

Measures

Alcohol-related problems

The ten-item Norwegian translation of the Alcohol Use Disorders Identification Test (AUDIT) were used to measure alcohol-related problems. The AUDIT was developed by the World Health Organization (WHO) and is widely used to assess alcohol consumption and related problems in a wide range of settings and populations (78, 79). Each of the ten item is scored from 0 to 4, so the total score can range from 0 to 40. AUDIT is supported to be used as a unidimensional measure of alcohol-related problems (70). The AUDIT demonstrated acceptable internal consistency in the present sample (Cronbach's α = 0.78). For the analyses, a continuous version (sum score) of the AUDIT was employed. Higher scores indicate higher levels of alcohol-related problems.

Drinking attitudes

Drinking attitudes were measured using the Drinking Norms Scale (DNS) (80). The DNS is a 7-item scale addressing attitudes toward drinking in general (three items) and work-related drinking (four items). Each item was coded on a 4-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = agree; 4 = strongly agree). Negatively worded items (i.e., items 6 and 7) were reverse scored, and the total score for all seven items was calculated so that the higher score the more positive/liberal drinking attitudes. For the analyses, a continuous version of the drinking attitudes was employed. The DNS demonstrated acceptable internal consistency in the present sample (Cronbach's $\alpha = 0.73$).

Sick leave

Company-registered sick leave occurring within 12 months after the baseline WIRUS-screening was obtained from the employers in each company. Leaves due to maternity, pregnancy-related reasons, and non-health reasons (e.g., vacation) were excluded. We created four measures on count of sick leave days (i.e., length of sick leave): one-day (i.e., sick leave hours that only lasted one day, n = 1081 (42.0%), median: 11.0, IQR: 8.0-19.0), short-term (i.e., ≤ 14 days, n = 1607 (62.7%), median: 6.0, IQR: 3.0-16.0), long-term (i.e., ≥ 15 days, n = 348 (13.6%), median: 42.0, IQR: 21.0-89.0), and total number of sick leave days of any durations (n = 1632 (63.0%), median: 7.0, IQR: 3.0-25.0).

For one-day hours and short-term days, we calculated an approximate number of days at risk (for having sick leave), i.e., for one-day hours 365 minus total number of days of sick leave lasting longer than one day, and for short terms days 365 minus total number of days of sick leave lasting longer than 14 days.

Covariates

Based on prior research on predictors for sick leave (81-84), we included the following variables: gender (male, female), age (continuous), cohabitation status (living alone, living with others), educational attainment levels (primary/lower secondary, upper secondary, university/college), work position (employee, middle manager or senior executive), and employment sector (public, private).

Analysis

Descriptive statistics are presented as frequencies and percentages for categorical variables, as means and standard deviations (SDs) for symmetrically distributed continuous variables, and as medians and interquartile ranges (IQRs) for asymmetric continuous variables.

Negative binomial (NB) regression models, crude and adjusted for gender, age, cohabitation status, educational attainment, work position, and employment sector, were used to assess the associations between alcohol-related problems and drinking attitudes and sick leave, estimating incidence rate ratios (IRRs) with corresponding 95% confidence intervals (CIs). Three-level random intercepts models were used to allow for intra-cluster correlation resulting from clustering of individuals within work units within companies. Random intercept variance, and 95% CIs of sick leave days between work units within companies and between companies were estimated with multi-level models. Supplementary analyses were performed for one-day and short-term sick leave days by including the approximate number of days at risk as an exposure variable. In addition, the same analyses were performed for sick leave spells (or episodes (85)).

All descriptive analyses were performed using IBM SPSS, version 26. Multi-level regression models were running in Stata. version 17.0 (86), with function *menbreg*. Statistical significance was set at $p<0.05$.

Ethics

The study was approved by the Regional Committees for Medical and Health Research Ethics in Norway (approval no. 2014/647). Respondents were treated according to the World Medical Association's Declaration of Helsinki (87), and were thoroughly informed about the study's aim and confidentiality, re-assured that participation was voluntary, and gave written informed consent to participate in the study.

RESULTS

The average numbers of one-day-, short-term-, long-term-, and overall sick leave days predicted for work units with low, medium, and high sick leave rates are presented in Table 2. For one-day, the 10th percentile work unit is expected to have a mean of 3.6 hours per employee per year, while on the other end of the spectrum the 90th percentile work unit will have a mean of 12.0 hours sick leave per employee. Similarly, for short-term days, expected sick leave varies between 5.4 and 11.7 days per employee per year and for long-term days between 5.4 and 16.2 days. Moreover, the 10^{th} percentile work unit had an expectation of 8.5 total sick leave days per employee, and the 90^{th} percentile a mean of 29.0 sick leave days per employee per year.

The sick leave regression models are presented in **Error! Reference source not found.** (and Supplementary Table 1). Adjusted for gender, age [as a continuous variable], cohabitation status, educational attainment, work position and employment sector, alcohol-related problems showed no association with one-day (IRR = 1.00; 95% CI: 0.97-1.04), short-term (RR = 0.99; 95% CI: 0.98-1.01), long-term (RR = 0.96; 95% CI: 0.89-1.03), or overall sick leave days (IRR = 0.98; 95% CI: 0.95-1.00) on work units within companies.

Drinking attitudes, adjusted for gender, age [as a continuous variable], cohabitation status, educational attainment, and work position, showed no association with one-day (RR = 0.99; 95% CI: 0.96-1.04), short-term (RR = 0.99; 95% CI: 0.96-1.01), and long-term days (RR = 0.94; 95% CI: 0.88-1.01) on work units within companies. However, we found a slightly negative association between higher scores on drinking attitudes and taking sick leave (RR = 0.97; 95 % CI: 0.95-0.99), indicating that one-unit higher score on drinking attitude was associated with 3% less sick leave days.

Adjusting for days at risk did not affect the results noticeably (data not shown). Additional models adjusting for age in two categories (shown in Table 1) did not result in any meaningfully different results than those presented in **Error! Reference source not found.**. Using sick leave spells as the outcome measure rather than days did not affect the results considerably (Supplementary Table 2).

One-day, short-term, and overall sick leave days showed statistically significant variations across companies, as well as work units within companies (Supplementary Table 3). However, variation across companies was not statistically significant for long-term sick leave days. For companies, one-day, short-term, and overall sick leave days (empty model) explained 15.0%, 12.0%, and 30.0% of the variance in the model, respectively. For work units within companies, these amounts were 0.0%, 5.0%, and 8.0%, respectively. After entering control variables (gender, age, cohabitation status, educational attainment, work position, and employment sector), all variances explained by the models decreased substantially, for both companies and the work units within companies. When also including alcohol-related variables, explained variances were not changed comparing to the control variables model. The same results were obtained when adjusting for days at risk (data not shown).

DISCUSSION

This study aimed to examine the relationship between alcohol-related problems, drinking attitudes and sick leave, while taking into account the nesting of employees within working units within companies.

The following main findings will be discussed: (i) sick leave explained about 12-30% of the variance between companies, but only 0-8% between work units within companies, (ii) alcohol-related problems showed no association with higher levels of one-day-, short-term-, long-term-, and overall sick leave days, and (iii) drinking attitude showed no association with higher levels of one-day-, short-term-, and long-term days, but showed a slightly negative association between higher scores on drinking attitudes and overall sick leave days between work units within companies.

The observed higher variation of sick leave between companies than between work-units within companies may be explained by the concepts of sick leave culture (i.e., self-awareness of others' or one's own attendance behavior or being agreed on a proper level of absence (88)) and social context, outside and inside the workplace (63, 89). Consistent with this notion, shared beliefs about absence and employment, and cultural salience (e.g., absence control system, existing technology, social ecology, friendship patterns, and communication) may be sensible reasons for variation in sick leave (89). For instance, employees having lower empowerment in their positions are found to have more feeling of external control, and accordingly have a concrete perception of taking sick leave, compared to those having higher empowerment in their positions (89, 90). This notion can be viewed as societal dimension affecting sick leave culture. However, as organizational dimensions, colleagues' and supervisors' behavior (7, 8, 91-93), physical and mental workload (94, 95), industrial downsizing (10), ethnic group (96), job satisfaction (97), and psychiatric morbidity (98) may explain the reasons for variation in sick leave between and within companies and their work units. Moreover, some of these factors may affect sick leave indirectly through the influence of health behaviors. For instance, studies have shown that colleagues' and supervisors' behavior, as well as job stress, can affect the amount of consumed alcohol and accordingly increase sick leave (7, 93).

Although several studies have explored the association between organizational cultures and attitudes and sick leave (61, 99, 100), to date, this study is the first to explore the association between drinking attitudes and sick leave. However, alcohol-related individual differences (i.e., both alcohol-related problems and drinking attitudes) were not able to explain sick leave in our study sample and even drinking attitudes showed a slightly negative association with overall sick leave. Discovering no association between alcohol-related problems and sick leave contrasts with the available prior literature reporting an alcohol-sick leave association among Norwegian employees (22, 23, 28, 30) and other populations (29, 31-37). However, our results are in overall agreement with other studies reporting no alcohol-sick leave association (40-43). Such discrepancies in findings may be attributed to several factors, of which may be the way in which exposure and outcome variables are measured, type of the studied organizations, and different study populations, which also make any direct national or international comparisons complicated.

Compared to other studies, different results could be expected as various alcohol drinking levels and sick leave duration models were employed while referring to the same measure. For instance, in studies reporting an alcohol-sick leave association, short-term sick leave was measured differently ranging from ≤ 3 days (32) to ≤ 7 days (33, 34), or reports were based on self-reported sick leave (22, 30, 32), or were combined with other health issues as mental disorders (31), or in some cases although sick leave measure was similar to this study, alcohol consumption was measured differently, e.g., average weekly volume (29).

Another reason for the existing discrepancy in the results and possible explanation for the lack of association between alcohol-related individual differences and sick leave in this study could be the work settings being focused. Some of the studies reporting an association between alcohol consumption and sick leave were using a sample of manual employees (28), non-industrial civil servants (33), police officers (35, 36), farm industry employees (37), or public sector employees (32). Although the present study used a sample from a wide variety of work settings, almost nine out of ten employees were employed within a public sector. In this regard, it is stated that some specific work settings may attract individuals with certain attitudes, or the other way around, some shared attitudes and behaviors may

form in such settings (61). Moreover, work settings reporting an alcohol-sick leave association may also be affected by the existing alcohol policies in place, birth cohort effect, social regulations, or alcohol availability at work.

Furthermore, participation rate is another possible reason for the lack of association between alcohol-related individual differences and sick leave in the present study, which is worth considering. The response rate was quite low in this study. It is suggested that non-responders in health surveys are generally less healthy than responders (101), and are typically those with drinking problems (102). Moreover, self-reported alcohol consumption is found to be notably lower than actual alcohol sales (103). Therefore, this study's results may be affected by the underrepresentation of employees having alcohol-related problems, as well as those with positive/liberal attitudes towards drinking.

Methodological Consideration

This study has several strengths. First, this study contributes to a better understanding of sick leave variation by employing multilevel analysis, which allowed us for grouping of sick leave within work units and companies. Second, using company-registered sick leave data, which is known as a "golden standard" (104-107) and is found to be valid and more reliable than self-reported sick leave data (4, 104, 108) is a major strength. However, there are some limitations to consider when interpreting the results.

First, although a large sample (N = 2,560) was included in this study, the response rate was quite low (14.3%). Such an unintentional non-representativeness may happen in studies including random population samples (109). Comparing study sample and invited sample showed no differences in gender distribution ($p = 0.431$). Individuals in the study sample were, however, older when compared to the invited sample (difference in percentage points = 5.0; $p < 0.001$). In line with previous studied samples in WIRUS project (9, 55, 72, 76), an overrepresentation of females, employees with university/college education, employees age ≥40, and employees in the public sector was evident in this study compared to the overall Norwegian workforce. Studies state that health surveys have generally been skipped or underreported by (younger) men, individuals with lower socioeconomic status, and those having drinking problems (110-112), which may lead to an underestimation of the effect of alcohol on sick leave.

Second, alcohol-screening data was self-reported. As such, our findings may have been affected by social desirability responses (SDR) as people tend to display a favorable image of themselves on questionnaires (113). However, SDR behavior does not undervalue employed validated and reliable alcohol measurement instruments (e.g., AUDIT). Another issue that may affect self-reported alcohol-related surveys is recall bias. Although by having a short reference period, respondents may provide more precise answers, one may not be able to find out one's typical alcohol consumption through a year (79, 114-116). Therefore, when designing a research study exploring individual-level alcohol consumption and alcohol-related problems, it is recommended to employ a longer reference period (e.g., one year) (114, 115), and that is how this study was benefited from using AUDIT instrument.

Third, although the results out of this study were adjusted for the recommended confounders, findings may be affected by other notable unmeasured factors including mental health, diet, smoking, stress, and work conflict (7, 24, 117, 118).

Implications for Future Research

This study highlights the need for more refined measures. Additional research measuring other unmeasured factors would need to confirm the lack of associations between alcohol-related problems, drinking attitudes and sick leave. Also, one may clarify whether the existing sick leave is work-related

or not. Knowing this difference may have significant implications not only for occupational risk prevention but also for the reduction of sick leave-related economic outcomes.

Moreover, more work is likely to be required considering interaction between the type of employment, as well as the type of job position and sick leave. In this regard, some studies have stated that permanent employees tend to report more sick leave than non-permanent employees (45, 119), and employees in managerial positions report less sick leave, but more presenteeism, than other employees without such positions and responsibilities (120).

Further research is encouraged since the most recent study on the changes in alcohol consumption, among Norwegians, during the COVID-19 pandemic, has found a notable increase in proportion of heavy drinkers (121).

CONCLUSIONS

Sick leave, depending on multiple individual and contextual factors, is an indispensable part of occupational health care, which represents a high socio-economic burden. This study highlights the importance of between company-level differences over between work-units within company differences in relation to sick leave. The observed lack of associations between alcohol-related individual differences and sick leave needs further investigation, while taking into consideration specific company policies and contextual factors.

DECLARATIONS

Data Availability Statement

Data from the present study is available from the project owner (University of Stavanger, Faculty of Health Sciences, Department of Public Health) by principal investigator and project manager R.W.A. on reasonable request.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. The authors declare that they have no competing interests.

Author Contributions

Conceptualization, R.W.A.; methodology, N.S.H, I.D, R.W.A; validation, N.S.H., I.D., and R.W.A.; formal analysis, N.S.H. and I.D.; data curation, N.S.H. and I.D.; writing-original draft preparation, N.S.H.; writing—review and editing, all authors.; supervision, R.W.A., J.C.S. and H.S.; project administration, R.W.A.; funding acquisition, R.W.A. All authors have read and agreed to the published version of the manuscript.

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675

676 **Table 1. Study sample characteristics (N = 2,560)**

Characteristics	Study sample *n* (%)
Gender	
Male	875 (34.2)
Female	1685 (65.8)
Age	
≤ 39	780 (30.5)
≥ 40	1780 (69.5)
Cohabitation Status	
Living alone	357 (14.0)
Living with others	2203 (86.0)
Educational Attainment	
Primary/lower secondary	66 (2.6)
Upper secondary	568 (22.2)
University/college	1926 (75.2)
Work position	
Worker [a]	2062 (80.5)
Middle manager/senior executive	498 (19.5)
Branches	
Transport	62 (2.4)
Manufacturing	184 (7.2)
Public administration	1647 (64.3)
Health care services	528 (20.6)
Accommodation	26 (1.0)
Education	113 (4.5)
Employment sector	
Private	275 (10.7)
Public	2285 (89.3)

[a] Including blue, white- and pink-collar workers.

677

678 **Table 2. Percentiles* (10th, 50th, and 90th) of the average number of sick leave days of work units within companies**

Sick leave type	10th percentile (95% CI)	50th percentile (95% CI)	90th percentile (95% CI)
One-day (hours)	3.6 (3.1-4.1)	6.9 (6.1-7.8)	12.0 (10.4-13.2)
Short-term days	5.4 (4.9-5.7)	7.9 (7.3-8.6)	11.7 (11.1-12.3)
Long-term days	5.4 (4.4-5.7)	7.5 (6.7-8.2)	16.2 (13.6-16.2)
Overall sick leave days	8.5 (7.3-9.1)	15.2 (13.3-17.3)	29.0 (23.6-34.0)

* Empirical Bayes estimates

679

680 **Table 3.** Relationship of alcohol-related problems and attitudes with sick leave in different types of one-day, short-term,
681 long-term, and overall sick leave days, for n=2,560 employees in 95 work units within 14 companies

Alcohol-related variables		**One-day (hours)**	**Short-term days**	**Long-term days**	**Overall sick leave days**
Alcohol-related problems (continuous scores)[a]	(IRR_{crude})	(1.01)	(0.98)	(0.95)	(0.97) *
	$IRR_{adjusted}$	1.00	0.99	0.96	0.98
	95% CI	0.97-1.04	0.96-1.01	0.89-1.03	0.95-1.00
	Likelihood ratio X^2	72.57 <.001	111.41 <.001	19.82 <.05	97.87 <.001
Drinking-attitudes (continuous scores)[b]	(IRR_{crude})	(0.99)	(0.98)	(0.94)	(0.96)**
	$IRR_{adjusted}$	0.99	0.99	0.94	0.97
	95% CI	0.96-1.02	0.96-1.01	0.88-1.01	0.95-0.99
	Likelihood ratio X^2	72.64 <.001	111.90 <.001	20.34 <.05	99.76 <.001

Results from multilevel Negative binomial regression analyses; IRR_{crude} = incidence rate ratio, bivariate association; $IRR_{adjusted}$ = incidence rate ratio, adjusted association; CI = confidence intervals. Adjusted for gender, age, cohabitation status, educational attainment, work position, and employment sector; *p < .05; **p < .01; ***p < .001; [a] Composite score of the ten AUDIT items, potential range = 0-40, higher score indicates presence of alcohol-related problems; [b] Composite score of the seven DNS items, higher score indicates positive/liberal drinking attitudes.

682

Supplementary Material

Supplementary Table 1. Sick leave model adjusted for control variables, for all employees nested in work units within companies

Variables		One-day (hours)	Short-term days	Long-term days	Overall sick leave days
Gender	$IRR_{adjusted}$	1.56	1.70	2.24	1.66
	95 % CI	1.27-1.92	1.44-2.00	1.61-3.11	1.46-1.89
Age	$IRR_{adjusted}$	0.98	1.00	1.02	0.99
	95 % CI	0.98-0.99	0.98-0.99	1.01-1.03	0.99-1.00
Cohabitation status	$IRR_{adjusted}$	1.03	0.95	1.24	1.00
	95 % CI	0.78-1.36	0.81-1.11	0.84-1.83	0.86-1.18
Educational Attainment	$IRR_{adjusted}$	2.77	2.06	1.19	1.97
	95 % CI	1.47-5.21	1.44-2.93	0.49-2.89	1.37-2.83
	$IRR_{adjusted}$	1.64	1.63	1.30	1.58
	95 % CI	1.22-2.20	1.39-1.91	0.88-1.93	1.35-1.86
	$IRR_{adjusted}$	1.52	1.31	1.23	1.30
	95 % CI	1.21-1.91	1.15-1.50	0.88-1.72	1.14-1.48
Work position	$IRR_{adjusted}$	0.69	0.71	0.74	0.72
	95 % CI	0.53-0.91	0.60-0.83	0.50-1.10	0.61-0.84
	$IRR_{adjusted}$	0.61	0.54	0.54	0.54
	95 % CI	0.33-1.16	0.36-0.80	0.19-1.50	0.36-0.80
Employment sector	$IRR_{adjusted}$	0.62	0.62	0.61	0.62
	95 % CI	0.41-0.92	0.45-0.85	0.27-1.40	0.45-0.86
Likelihood ratio X^2		72.43 <.001	165.91 <.001	45.00 <.001	158.45 <.001

Results from multilevel negative binomial regression analyses; IRR_{crude} = incidence rate ratio, bivariate association; $IRR_{adjusted}$ = incidence rate ratio, adjusted association; CI = confidence intervals. Adjusted for gender, age, cohabitation status, educational attainment, work position, and employment sector.

Supplementary Table 2. Relationship of alcohol-related problems and attitudes with sick leave in different types of one-day, short-term, long-term, and overall sick leave spells, for n=2,560 employees in 95 work units within 14 companies

Alcohol-related variables		One-day	Short-term days	Long-term days	Overall sick leave days
Alcohol-related problems (continuous scores)[a]	(IRR_{crude})	(1.00)	(0.99)	(0.97)	(0.99)
	$IRR_{adjusted}$	1.00	0.99	0.98	0.99
	95% CI	0.97-1.02	0.98-1.01	0.94-1.03	0.98-1.01
	Likelihood ratio X^2	143.63 <.001	165.90 <.001	45.45 <.001	157.56 <.001
Drinking-attitudes (continuous scores)[b]	(IRR_{crude})	(0.99)	(0.98)	(0.96)	(0.98)
	$IRR_{adjusted}$	0.99	0.98	0.97	0.98
	95% CI	0.97-1.01	0.97-1.00	0.93-1.01	0.97-1.00
	Likelihood ratio X^2	143.93 <.001	167.25 <.001	46.40 <.001	159.04 <.001

Results from multilevel Negative binomial regression analyses; IRR_{crude} = incidence rate ratio, bivariate association; $IRR_{adjusted}$ = incidence rate ratio, adjusted association; CI = confidence intervals. Adjusted for gender, age, cohabitation status, educational attainment, work position, and employment sector; *p < .05; **p < .01; ***p < .001; [a] Composite score of the ten AUDIT items, potential range = 0-40, higher score indicates presence of alcohol-related problems; [b] Composite score of the seven DNS items, higher score indicates positive/liberal drinking attitudes.

Supplementary Table 3. Sick leave variation across companies and work units within companies

	RI variance (95% CI) across companies				RI variance (95% CI) across work units within companies			
	One-day (hours)	Short-term days	Long-term days	Overall days	One-day (hours)	Short-term days	Long-term days	Overall days
Model 0[a]	0.15 (0.04-0.56)	0.12 (0.04-0.40)	0.30 (0.06-1.40)	0.30 (0.11-0.83)	0.00 (-----)	0.05 (0.01-0.15)	0.00 (-----)	0.08 (0.03-0.22)
Model 1[b]	0.03 (0.00-0.64)	0.04 (0.01-0.18)	0.19 (0.03-1.26)	0.19 (0.06-0.55)	0.00 (-----)	0.02 (0.00-0.17)	0.00 (-----)	0.07 (0.03-0.21)
Model 2a[c]	0.03 (0.00-0.62)	0.04 (0.01-0.18)	0.18 (0.03-1.27)	0.19 (0.06-0.56)	0.00 (-----)	0.02 (0.00-0.17)	0.00 (-----)	0.07 (0.02-0.21)
Model 2b[d]	0.03 (0.00-0.69)	0.04 (0.01-0.18)	0.18 (0.02-1.27)	0.18 (0.06-0.54)	0.00 (-----)	0.02 (0.00-0.17)	0.00 (-----)	0.07 (0.02-0.21)
Model 3[e]	0.03 (0.00-0.67)	0.04 (0.01-0.18)	0.17 (0.02-1.27)	0.18 (0.06-0.54)	0.00 (-----)	0.02 (0.00-0.17)	0.00 (-----)	0.07 (0.02-0.21)

RI = random intercept; CI = confidence intervals; [a] Empty model; [b] Adjusted for control variables: gender, age [continuous], cohabitation status, educational attainment, work position, and employment sector; [c] Adjusted for control variables and alcohol-related problems variables; [d] Adjusted for control variables and drinking attitudes variable; [e] Adjusted for control variables and drinking-related problems and drinking attitudes variables.