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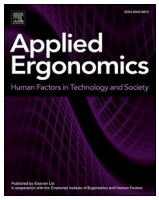

# The self-reported stress and stressors in tram and long-haul truck drivers

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ABSTRACT

Work stress may compromise professional drivers' health and driving capacity. Differences between driver groups in terms of on-duty stress are understudied. Therefore, we examined self-reported stress (Stockholm University Stress Scale) of shift-working tram and long-haul truck drivers (n = 75) across 2–3 weeks. Furthermore, stressors were self-reported retrospectively and categorised as related to the job, driving conditions, personal, or other causes. Stress levels were generally low, but moderate to high stress (≥6) was more frequently reported among the tram drivers. Stressors related to the job (54%) and driving conditions (19% of all shifts) were frequently reported among the tram and truck drivers, respectively. Moderate to high stress was associated with categorised stressors related to the job and other causes among the tram drivers, and all categorised stressors among the truck drivers. Altogether, self-reported stress and stressors differ by driver group, but the role of shift type is less significant.

## 1. Introduction

Work stress is associated with negative effects on both physiological (Bose et al., 2009; Steptoe and Kivimäki, 2012) and mental health (Aronsson et al., 2017; Harvey et al., 2017). Professional driving can be regarded as a stressful job due to high demands and low control (Karasek and Theorell, 1990). Accordingly, work stress has been reported to be common in this occupation (Carrère et al., 1991; de Croon et al., 2004; Orris et al., 1997; Tse et al., 2006). In addition to the detrimental effects on health, it has been linked with impaired driving performance and increased accident risk (Rowden et al., 2011; Tse et al., 2006; Useche et al., 2017). Therefore, examining the incidence and causes of work stress has wide implications for improving health, work well-being, and safety in the field of transportation.

Due to varying operational demands and working environments in the industry, some of the work stressors can be assumed to be rather commonplace, whereas others may apply only to specific groups (Useche et al., 2018). To better understand the complex aetiology of stress in terms of different negative outcomes, previous work has concentrated on professional drivers' perceptions of what makes them stressed at work (Murphy, 1996; Taylor and Dorn, 2006). Reported work stressors among professional drivers include time pressure, adverse driving conditions, and traffic (Crizzle et al., 2017; Filtness et al., 2019; Hege et al., 2019; Shattell et al., 2010; Tse et al., 2006). Unique to public transportation, having to drive the same route repeatedly and difficulties with passengers have been reported as causing stress (Chen and Cunradi, 2008; Crizzle et al., 2017; Filtness et al., 2019; Tse et al., 2006). Conversely, among long-haul truck drivers, social isolation is a commonly reported source of stress (Crizzle et al., 2017). Other factors associated with stress among long-haul truck drivers include very long driving bouts and irregular working hours (Hege et al., 2019).

Shift work is common in the field of transportation. Arranging working hours in such a way that a driver's sleep is curtailed and circadian drive for sleep is high results in decreased alertness and increased accident risk (Phillips et al., 2017; Åkerstedt, 2019). These influences may be exacerbated by several mechanisms related to poor work-life balance, insufficient recovery, or behavioral changes (Puttonen et al., 2010). High self-perceived sleepiness and reduced capacity to drive safely may be stressful, especially for drivers whose tight schedules impinge on their rest breaks. Accordingly, fatigue and lack of sleep are commonly reported stressors among professional drivers (Crizzle et al., 2017; Tse et al., 2006). Sleepiness may even mediate the link between high job strain and risky driving behaviour in professional drivers (Useche et al., 2017).

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Work stressors of tram (or trolley) drivers have been relatively seldom studied, despite the tram being a popular means of transport in densely populated areas. Limited prior research has shown that tram drivers experience several work stressors common to other public transport operators, such as time pressure (Gardell et al., 1982; Naznin et al., 2017). Sleep disorders (Karimi et al., 2013) and on-duty sleepiness (Onninen et al., 2021a) are other possible causes of stress in this occupation. Using still photographs from different scenarios, Tzouras et al. (2020) reported that delays, the volume of vulnerable road users, and the degree of separation of the tramway from other road users were linked to driving stress and perceived safety among tram drivers. Furthermore, since they are in constant interaction with the public, tram drivers are at a high risk for workplace violence (Isotalus and Saarela, 1999), indicating that work stress may be prevalent in this group.

To date, few studies have examined the differences between driver groups in terms of work stress or the association between work stressors and on-duty stress. One study reported higher prevalence of work stress in city bus drivers, compared to taxi drivers and inter-urban bus drivers (Useche et al., 2018). Ahlström et al. (2018) reported that bus drivers associated high levels of stress with the high number of passengers, running late, and dense traffic. A deeper understanding of these issues would be valuable for more targeted stress management across different occupations and for understanding the potency of work stressors on different outcomes. Therefore, we analysed the levels of self-reported stress and the frequency of self-reported stressors in different work shifts among tram and long-haul truck. We also sought to examine the differences between shift types and driver groups in terms of self-reported stress and stressors. Finally, we investigated the association between self-reported stress and stressors among these drivers. This is the first study to explore the on-duty stress and self-reported sources of stress among tram drivers on a day-to-day basis, and to compare the self-reported stress and stressors across two driver groups whose work tasks are distinct, but share certain similarities, such as working in shifts.

## 2. Methods

### 2.1. Participants

Participants were tram drivers (n = 23) operating in Helsinki, Finland, and long-haul truck drivers (n = 52) from four different Finnish haulage companies. The tram drivers worked rotating morning, day, and evening shifts whereas the truck drivers' working times included irregularly arranged daytime and night shifts. Written consent was obtained from all participants. Detailed information about the participants has been reported by Onninen and colleagues (2020; 2021a) and Pylkkönen et al. (2015). The study of tram drivers was approved by the Ethics Committee of the Finnish Institute of Occupational Health and that of the truck drivers by the Ethics Committee of the Helsinki-Uusimaa hospital district.

### 2.2. Measurements

Before the field measurements, all participants completed a questionnaire covering demographic, health, and sleep characteristics. The field measurements included recordings of the drivers' working hours, self-reported stress, and self-reported causes of stress. Data on sleep, subjective sleepiness and self-reported causes of sleepiness were collected simultaneously; these results have been reported elsewhere (Onninen et al., 2020, 2021a; Pylkkönen et al., 2015). The categorisation of the drivers' working hours into shift types (tram drivers: morning, day, and evening; truck drivers: morning, day or evening, and night shifts) was also done as described in our previous work. We measured subjective stress using the Stockholm University Stress Scale (SUS; Dahlgren et al., 2005) with verbal anchors at each point: 1 – extremely low stress (I feel extremely calm and relaxed), 2 – very low stress, 3 – low stress (I feel calm and relaxed), 4 – rather low stress, 5 – neither low nor high stress, 6 – some stress, 7 – high stress (a lot of tension and pressure), 8 – very high stress, 9 – extremely high stress (extreme tension and pressure). We instructed the drivers to rate their on-duty stress using a smartphone application in the beginning and at the end of their work shifts and rest breaks (tram drivers) or once every hour (truck drivers). To assess their stress while driving, the truck drivers were instructed to touch the screen of a cell phone attached to the dashboard. This allowed them to select an appropriate value within seconds after hearing an automated signal from the phone. The interface was designed so that only a glance at the screen was enough to complete the task. After each work shift, the drivers answered the question "If you felt stressed while driving, what do you think caused it?" using either a smartphone (tram drivers) or a diary (truck drivers). For the analyses, the self-reported stressors were then categorised into job-related, driving conditions, personal, and other stressors (Table 1).

### 2.3. Outcome measures

To investigate the self-reported stress based on shift type, the average SUS ratings were used as continuous variables. To investigate the self-reported stressors based on shift type, the occurrence of the categorised self-reported stressors (Table 1) was used as the outcome. In these analyses, day shifts (tram drivers) and day or evening shifts (truck drivers) were chosen as references. The truck drivers were chosen as a reference in the driver group-wise comparisons of the differences in the categorised self-reported stressors. To study the associations between self-reported stress and the categorised stressors, work shifts were classified as involving moderate to high stress when the maximum SUS rating was 6 or higher.

### 2.4. Statistical analyses

To analyse the differences in the outcome measures within and between driver groups, we used generalized estimating equations (GEE; Liang and Zeger, 1986). Correlation structure selection was based on the quasi-likelihood under the independence model criterion (Pan, 2001). We applied small–sample-related bias corrections as described in Fay and Graubard (2001), and Lunardon and Scharfstein (2017). Multilevel joint modelling multiple imputation (Carpenter and Kenward, 2012; Quartagno and Carpenter, 2019) was used to account for missing data (up to 8%). The resulting estimates and standard errors were pooled using Rubin's rules (Rubin, 1987). Pooled Wald test statistics for

**Table 1**
The response choices and categorisation of self-reported stressors by driver group.

| Self-reported stressors | | |
|---|---|---|
| Tram drivers | Truck drivers | Category |
| Long period of continuous driving | Long period of continuous driving | Job-related |
| Tight schedule | Tight schedule | |
| Passengers | Problems (un)loading the cargo | |
| Poor weather conditions | Poor weather conditions | Driving conditions |
| Poor condition of the tracks | Poor condition of the road | |
| Temporary traffic arrangements | Temporary traffic arrangements | |
| Other traffic | Traffic congestion | |
| | Other drivers' behavior | |
| Impaired performance (due to e.g., sleepiness, illness) | Impaired performance (due to e.g., sleepiness, illness) | Personal |
| Personal issues | Personal issues | |
| Poor condition of vehicle or vehicle malfunction | Poor condition of vehicle[a] | Other |
| | Vehicle malfunction[a] | |
| Other, what?[b] | Other, what?[b] | |

Note.
[a] Combined into "Vehicle malfunction".
[b] Open-ended response choice.

regression terms were obtained using Rubin's rules with adjusted degrees of freedom (Barnard and Rubin, 1999; van Buuren, 2018). Supplementary results and statistical analyses, and the data imputation procedure are provided in Appendix A (see also Onninen et al., 2021b). Significance level was set at 0.05. Although gender has been reported to affect driving-related stress (e.g., Hill and Boyle, 2007), mixed models revealed no statistically significant differences between males and females in any of the variables of interest (all $p > .05$, results not reported), and thus, gender was not included in the final analyses. Data were analysed using R 4.0.3 with packages *lme4* (Bates et al., 2015), *jomo* (Quartagno and Carpenter, 2017), *geepack* (Halekoh et al., 2006), *saws* (Fay and Graubard, 2001), and *BCgee* (Lunardon and Scharfstein, 2017).

## 3. Results

### 3.1. Driver and work shift characteristics

The tram and truck drivers in this study were 38–41 years old on average (Table 2).

### 3.2. Self-reported stress by shift type

#### 3.2.1. Tram drivers

Using the SUS, the average self-reported stress ranged from 2 to 4, indicating low stress, regardless of the shift type among the tram drivers (Fig. 1, see also Figure A.1). Rest breaks appeared to be associated with slight reductions in self-reported stress. There were no differences in the average self-reported stress between shift types (all $p > .05$, Table A.1). Moderate to high self-reported stress was observed in 38, 38, 34, and 36% of the morning, day, evening, and all shifts, respectively, and by 70% of all tram drivers at least once.

#### 3.2.2. Truck drivers

The truck drivers' average self-reported stress varied only little by hours working within typical shift durations (Fig. 1, see also Figure A.1). The SUS ratings generally indicated low stress. There were no differences in the average self-reported stress between shift types (all $p > .05$, Table A.1). Moderate to high self-reported stress was observed in 22, 18, 18, and 19% of the morning, day or evening, night, and all shifts, respectively, and by 64% of all truck drivers at least once. Of note was that very few SUS ratings signified high or extreme stress (Figure A.1).

### 3.3. Self-reported stressors by shift type

#### 3.3.1. Tram drivers

Among the tram drivers, tight schedule was the most commonly reported stressor (Fig. 2). It was reported in 37–58% of all shifts. Other traffic (25–31%) and passengers (16–28% of all shifts) were also among the three most commonly reported stressors. Long driving time was indicated as causing stress in one-fourth of day shifts. Impaired performance and personal issues were indicated in 9–12% of all shifts. Other stressors reported by the drivers included, e.g., malfunctioning ticket machines, pedestrians near the tracks, and lack of rest facilities. At least one stressor was reported in 79% of all shifts. Categorised stressors related to the job, driving conditions, personal, and other factors were self-reported in 54, 32, 20, and 10% of all shifts, and by 91, 83, 52, and 57% of all drivers at least once, respectively. None of the categorised self-reported stressors varied by shift type (all $p > .05$, see Tables A.2–A.5).

**Table 2**
Demographic characteristics of the drivers (mean ± SD).

| | Tram drivers | Truck drivers |
|---|---|---|
| Age, yr | 40.6 ± 11.4 | 38.1 ± 10.5 |
| Gender ratio | 11 females/12 males | 1 female/53 males |
| Body mass index, kg/m$^2$ | 26.5 ± 6.1 | 27.7 ± 4.4 |
| Work experience, yr | 10.6 ± 9.2 | 14.8 ± 10.0 |
| Has children <7 yr, % | 30 | 18 |

#### 3.3.2. Truck drivers

Adverse weather conditions were the most commonly reported stressor among the truck drivers (Fig. 2). They were reported in 8–13% of all shifts. Cargo loading or unloading (7–12%) and personal issues (8–12% of all shifts) were also relatively frequently reported. Other stressors reported by the drivers included delays or unexpected changes in the working hour arrangements, insufficient sleep, and strict hours-of-service regulations. At least one stressor was reported in 51% of all shifts. Categorised stressors related to the job, driving conditions, personal, and other factors were self-reported in 15, 19, 12, and 9% of all shifts, and by 54, 67, 35, and 46% of all drivers at least once, respectively. The categorised self-reported stressors did not vary by shift type (all $p > .05$, see Tables A.2–A.5).

### 3.4. Differences in categorised self-reported stressors between the driver groups

The tram drivers were over six times more likely to report job-related stressors than the truck drivers (OR = 6.60 [95% CI 3.21–13.57], $p < .001$) (Table 3). No significant differences between the driver groups were observed in reporting any of the other categorised stressors.

### 3.5. The association between moderate to high self-reported stress and categorised self-reported stressors

Categorised self-reported stressors related to the job (OR = 2.68 [95% CI 2.16–3.21], $p < .001$) and other factors (OR = 2.58 [95% CI 1.93–3.23], $p = .004$) were significantly associated with moderate to high SUS ratings among the tram drivers (Fig. 3, Table A.7). The association was not significant for categorised self-reported stressors related to driving conditions or personal stressors (all $p > .05$). The association was significant for all the categorised stressors among the truck drivers. That is, they were more likely to rate their stress as moderate to high in work shifts where they reported job-related, driving conditions, personal, or other stressors (ORs: 2.78–3.42, all $p < .01$).

## 4. Discussion

Here, we examined the on-duty stress and stressors as self-evaluated by tram and long-haul truck drivers. The self-reports of both driver groups indicated, on average, low stress level, independent of shift type. However, the tram drivers reported moderate to high stress twice as often as the truck drivers. The tram drivers commonly reported tight schedules, other traffic, and passengers as causing stress, whereas poor weather conditions, problems with the cargo, and personal issues were most frequently mentioned among the truck drivers. Out of the categorised stressors, tram drivers were over six times more likely to report job-related stressors than the truck drivers. Categorised stressors related to the job or other factors were associated with moderate to high stress in both driver groups. Associations were also observed for categorised stressors related to driving conditions and personal stressors among the truck drivers.

### 4.1. Self-reported stress

The overall levels of self-reported stress mostly corresponded to low stress. These observations are well in line with the average self-reported workday stress of bus drivers (Ahlström et al., 2018; Filtness et al., 2019) and public sector workers (Schiller et al., 2017). The truck drivers appeared to rate their stress higher during the last hours of extended non-night shifts. However, due to the small number of observations, this finding must be interpreted with caution. On-duty breaks appeared to be

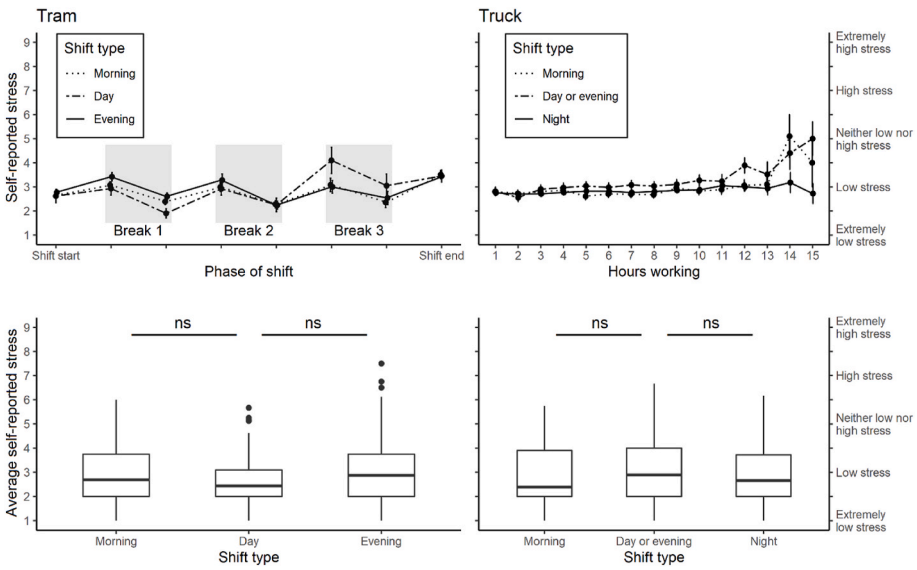


**Fig. 1.** Self-reported stress (Stockholm University Stress Scale) in different shift types by driver group. Left top panel: the tram drivers were instructed to rate their stress at the start and the end of their work shifts and rest breaks (grey rectangles). Graph not in proportion to actual shift or break durations. Right top panel: the drivers were instructed to rate their stress once per hour. Data presented as mean ± SE. Bottom panels: average self-reported stress and statistical comparisons, using day (tram) and day or evening shifts (truck drivers) as references. ns = p > .05.

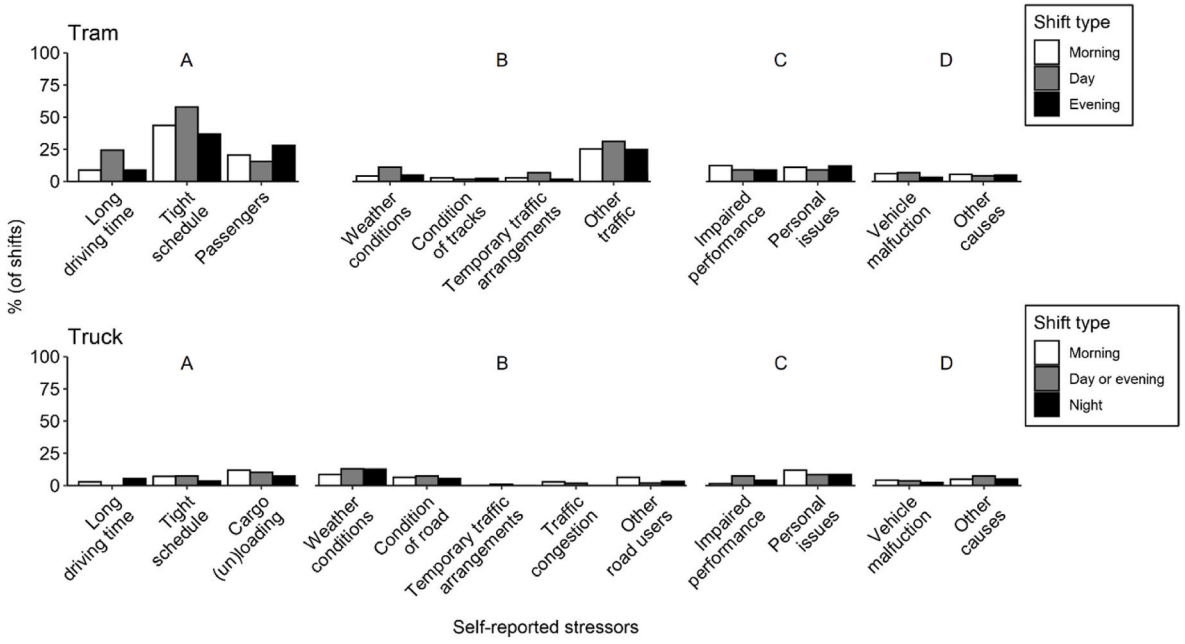


**Fig. 2.** Self-reported stressors in different shift types by driver group. The self-reported stressors are categorised as related to the job (A), driving conditions (B), personal (C), or other factors (D).

**Table 3**
GEE results for the odds ratios for the tram drivers to report different categorised stressors, compared to the truck drivers.

| Term | OR | 95% CI | | *p* |
|---|---|---|---|---|
| | | High | Low | |
| Job-related | 6.60 | 3.21 | 13.57 | 0.000 |
| Driving conditions | 1.95 | 0.99 | 3.82 | 0.052 |
| Personal | 1.88 | 0.81 | 4.33 | 0.138 |
| Other | 1.06 | 0.53 | 2.09 | 0.876 |

associated with reductions in the tram drivers' self-reported stress, conforming to the notion that rest breaks facilitate recovery (Trougakos and Hideg, 2009). Although not investigated in this study, the rest breaks of truck drivers are arguably similarly beneficial, although possibly disliked by some of these drivers because the driving time and rest periods are strictly regulated, leaving only little individual-based flexibility.

We found no differences in the average self-reported stress based on shift type among either the tram or the truck drivers. This observation is in agreement with Filtness et al. (2019), who reported a negligible difference between the average SUS ratings of morning and evening shifts among urban bus drivers. However, this finding should not be interpreted as suggesting that no times of the day are particularly stressful for the drivers; e.g., traffic peaks typically occur in the morning when the endogenous stress system is already active due to circadian influence (Manfredini et al., 2017) and in the afternoon in urban areas. Therefore, it might be more valuable to assess time of day rather than the type of work shift when investigating driver stress.

The driver groups did not appear to differ in terms of average self-reported stress. However, the tram drivers reported stress levels

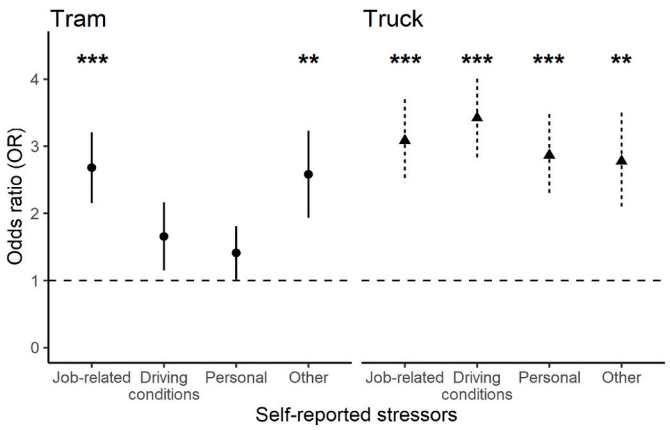


**Fig. 3.** Odds ratios with 95% confidence intervals of moderate to high self-reported stress (Stockholm University Stress Scale ≥6) associated with different categorised self-reported stressors by driver group. ** = p < .01, *** = p < .001.

corresponding to moderate to high stress roughly in twice as many shifts as the truck drivers. This is noteworthy given the shorter average work shift duration of the tram drivers (Onninen et al., 2021a) and the association between long working hours and stress (Härmä, 2006), although it should be noted that subjective stress ratings have been found to be unaffected by extending work days (Dahlgren et al., 2006). Moderate to high stress was reported in one third of all work shifts of the tram drivers but only in one fifth of all work shifts of the truck drivers. Notably, very high SUS ratings were practically absent among the truck drivers. This result suggests that acute stress reactions may be more prevalent and intense among the tram drivers, although significant levels of self-reported stress occur in both driver groups.

### 4.2. Self-reported stressors

Tight schedule was the leading self-perceived cause of stress among the tram drivers. This finding is understandable since whether the tram is running on time is continuously assessed, and daily hassles occurring frequently are likely to be assessed as more stressful (Vagg and Spielberger, 1999). Time pressure may also limit the duration and sufficiency of rest breaks, which our earlier study already highlighted as problematic from the tram drivers' perspective (Onninen et al., 2021a). Passengers being perceived as stressful is congruent with studies on other subgroups of public transportation (Chen and Cunradi, 2008; Crizzle et al., 2017; Filtness et al., 2019). Tending to passengers' safety at tram stops, dealing with disruptive or aggressive passengers, or even the biomechanical burden associated with boarding and alighting passengers (Albert et al., 2014) probably account for this. Stressors related to traffic were also commonly mentioned. Temporary traffic arrangements or poor condition of the tracks were rarely implicated as causing stress. Such circumstances would typically require driver–traffic controller communications, which have been documented as stressful among urban bus drivers (Maynard et al., 2021).

Among the truck drivers, poor weather conditions were one of the most frequently reported stressors. Conditions such as icy road surfaces or low visibility, which are relatively common in Finland during the winter months, clearly place heavy demands on the driver. This strengthens the notion by Chen et al. (2015) that more training would be beneficial to prepare long-haul truck drivers for varying weather conditions. The reports of stress related to problems loading or unloading the cargo are also in line with previous literature (Chen et al., 2015; Friswell and Williamson, 2013). Friswell and Williamson (2019) have recently proposed several issues and practices that may contribute to such experiences. Stressors related to the traffic were very rarely reported among the truck drivers, contrary to earlier reports that traffic congestion induces stress among professional drivers (Evans and Carrère, 1991; Shahrukh et al., 2020). This difference may be due to the participating truck drivers mostly driving on relatively uncongested main roads.

### 4.3. Differences in categorised self-reported stressors between the driver groups

Stressors intrinsic to the job (long driving time, tight schedule, and passengers/cargo) were more commonly reported among the tram drivers than the truck drivers. Tight schedule, strongly implicated as a stress-inducing factor among the tram drivers, clearly accounts for the observed difference. Although time pressure is recognized as a stressor among long-haul truckers as well (Shattell et al., 2010), truck drivers generally have more autonomy in timing their rest breaks, and events that individuals have more control over are generally perceived as less stressful (Dohrenwend, 2000; Karasek and Theorell, 1990). Previously, we found that insufficient rest breaks, i.e., long continuous driving time, was frequently reported as causing sleepiness among the tram drivers, compared to the truck drivers (Onninen et al., 2021a). In the present study, lack of suitable rest facilities was mentioned as causing stress.

### 4.4. The association between self-reported moderate to high stress and categorised stressors

Among the tram drivers, there was a positive association between moderate to high self-reported stress and self-reported stressors categorised as related to the job and to other causes. This finding suggests that the stressors related to driving conditions or personal matters are ones that the tram drivers can more easily cope with. Other causes reported by the tram drivers included malfunctioning ticket machines, which were new at the time. Since assisting passengers with the machines clearly impedes the drivers from their primary task and risks the tram running late, the association with high stress is understandable. The association was significant for all the categorised stressors among the truck drivers. One explanation may be that personal matters or feeling oneself unfit to drive are an equal source of stress compared to stressors related to the job or driving conditions among these drivers.

### 4.5. Considerations and future directions

The stress levels observed among the drivers in this study showed no significant peaks across their shifts. Therefore, it could be hypothesized that their on-duty stressors are momentary and, as such, only a limited threat to their long-term well-being. This is reflected in a survey of a larger sample of Finnish tram drivers (Sallinen et al., 2019), where it was concluded that recovery from work in this occupation is mostly at a satisfactory level. However, the tram drivers may still be at more risk for excessive workload based on the higher occurrence of elevated stress ratings, compared to the truck drivers. Raggatt and Morrissey (1997) also suggest that long-distance drivers may be affected by pre-shift stress from job demands relating to non-driving duties. Further research is needed to clarify how recurrent on-duty stress affects the drivers in the long term. Arguably, the healthy worker effect may distort the results, and prospective studies are needed elucidate this matter.

Since the drivers participating in this study work in shifts and have been found to frequently obtain less sleep than recommended (Onninen et al., 2020, 2021a; Onninen et al., 2021c; Pylkkönen et al., 2015), sleep loss may underlie the perceived stress among them. This is supported by the well-documented impairment of driving capacity as a result of insufficient sleep (Dawson et al., 2021), which the drivers can experience as harmful or stressful, and by the fact that insufficient sleep is linked to impaired mood and emotional processing (Dinges et al., 1997; Minkel et al., 2012), and increased levels of stress biomarkers (Åkerstedt, 2006; Holst and Landolt, 2021). Several studies have also connected sleepiness and sleep loss with driver stress (Magaña et al., 2020;

Miller et al., 2020; Serrano-Fernández et al., 2019; Shattell et al., 2010; Wise et al., 2019). Some drivers did explicitly state sleep loss as causing stress in the present study. Impaired capacity to drive as a self-reported cause of stress among the tram drivers appeared to vary based on shift type, with morning shifts standing out slightly. This mirrors our previous results showing that shortage of sleep is most pronounced in morning shifts (Onninen et al., 2020, 2021a). On the other hand, work stress may also disrupt subsequent sleep (Bartlang and Lundkvist, 2017; Linton et al., 2015; Puttonen et al., 2010; Åkerstedt et al., 2017), potentially creating a vicious circle. In all, the complex interplay of stress and sleep among professional drivers is pressing topic for further research.

Future research should include objective as well as subjective measurements of work stress and aim to quantify the duration of and exposure to the stressors. Considering the effect of the work shift schedule, or examining the coping strategies (Hennessy and Wiesenthal, 1997), crash history (Hill and Boyle, 2007), chronotype (Langford and Glendon, 2002; Manfredini et al., 2017), level of physical activity (Föhr et al., 2017; Taylor and Dorn, 2006), or other moderating individual factors would also be beneficial. The role of passengers as a cause of stress deserves further investigation. Finally, assessing the balance between the demands of the job and the aspects of control, recovery, and compensation is of decisive importance in planning healthier and safer work environments (Feldt et al., 2013; Härmä, 2006).

### 4.6. Strengths and limitations

The main strength of this study is the use of rich field data, which enabled us to study the self-evaluated levels and causes of stress considering the phase and timing of the work shift. The analyses were conducted using state-of-the-art techniques accounting for the clustered and unbalanced nature of the data as well as the sample size and missing observations. Key limitations of the present study are the information bias inherent to self-report data and selection bias related to convenience sampling. The present study did not examine stress related to workplace culture or management style, individual coping strategies, or individual predisposition to stress. Such factors may play a role in the extent to which daily hassles in the work environment affect self-perceived stress (Desmond and Matthews, 2009; Gulian et al., 1989; Hennessy and Wiesenthal, 1997; Lazarus, 1999; Lyyra and Parviainen, 2018; Rantanen et al., 2021). On-duty activities that might affect perceived stress, such as smoking (Parrott, 1995) or listening to music (Dalton and Behm, 2007), were not considered.

## 5. Conclusions

Self-reported stress showed little variation as a function of the phase or the type of work shift among city tram and long-haul truck drivers. The tram drivers frequently experience stress due to factors related to the nature of the task and surrounding traffic. Long-haul truck drivers typically experience stress caused by the driving conditions and difficulties with the cargo. Notably, while these stressors are in line with previous studies on professional drivers, they appear to be present regardless of the timing of the work shift. More research accounting for individual variation, and other types of working time arrangements and infrastructures is needed to confirm these results. In all, our results show that self-perceived stress, stressors, and the association between them differ by driver group, but the role of shift type seems to be less significant in this regard.

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## Data availability statement

Please see Onninen et al. (2021b).

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.17632/sc8bngcwsg.2.

## Abbreviations

GEE – Generalized estimating equations
SUS – Stockholm University Stress Scale

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