



The impact of the SARS-CoV-2 pandemic on health and working conditions of Swiss bus drivers

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ABSTRACT

Introduction: For decades, bus drivers (BDs) have been recognized as one of the most exposed occupational groups worldwide. Yet, BDs' health issues have not attracted sufficient attention. During the SARS-CoV-2 pandemic, BDs were part of essential workers and experienced additional occupational exposures related to the pandemic crisis.

Method: We conducted a nationwide cross-sectional study among Swiss BDs to assess the impact of these exposures on their working and health conditions. The latter were treated as dichotomous variables, assessed using a self-administered online questionnaire. The questionnaire was distributed via all three unions active in the public transport sector in Switzerland since 40% of BDs are unionized. Data were analyzed using linear and logistic regression models adjusted for socio-professional and demographic characteristics of BDs.

Results: The study sample included 916 participants. The overall response rate was 21%. The average age was 48.2 years (SD = 9.7) and the driving seniority was 11.5 years (SD = 9.7). Most BDs felt sufficiently protected. However, 58% and 42% of BDs, respectively, had to replace their colleagues on short notice and worked extra hours. For 41% of BDs, these constraints negatively impacted their physical or mental health. BDs graded their companies' management of SARS-CoV-2 crisis at 4.1 (SD = 1.2) on a 6-point scale. This grade was associated with shortening of rest phase and impact on health. Exposure and its impact on health varied across geographic regions and unions. In Eastern Switzerland, BDs' satisfaction rates were lower than in Espace Mitteland and with a stronger pandemic impact on working conditions and health. Part-time work was associated with lower pandemic impact and higher BD's satisfaction rate regarding working conditions.

Conclusion: Assessment of BDs' work conditions and their changes associated with the pandemic is necessary to insure a better crisis management in the future, especially in regions and unions with low satisfaction rates.

1. Introduction

Bus drivers (BDs) are exposed to a large array of occupational hazards, including irregular and long working hours (Kompier and Vittorio, 1995; Tse et al., 2006), difficult traffic conditions (Kompier and Vittorio, 1995; Montoro et al., 2018; Schneider, 2011), poor workplace ergonomics (Kompier and Vittorio, 1995; Schneider, 2011; Yasobant et al., 2015), and psychosocial stressors arising from

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contact with passengers (Ferguson et al., 2022; Kompier and Vittorio, 1995; Montoro et al., 2018; Schneider, 2011). Moreover, BDs are exposed to many physical and chemical hazards, such as noise and vibration (Golinko et al., 2020; Kompier and Vittorio, 1995; Schneider, 2011; Yasobant et al., 2015), and air pollutants, in particular, exhaust gases and particles (Golinko et al., 2020; Schneider, 2011). In the past decades, BDs have faced exposure to emergent hazards such as light-emitting diodes (LED) (Zalesinska, 2018) and electromagnetic fields (Chiaramello et al., 2019; Sagar et al., 2018). Since 2020, biological hazards, namely the pathogenic airborne microorganisms, such as influenza and coronaviruses, and the organizational and psychological factors related to the SARS-CoV-2 crisis management were added to the list of BDs' occupational exposures. Organizational factors included, for instance, a shortage of the workforce due to an increasing number of sick leaves (Genet, 2021) and consequently, an increased workload on the remaining bus drivers (May et al., 2021). The psychological factors included among others the fear of a new virus with potentially serious health consequences, exposure to it while driving and transporting potentially contagious passengers, and virus transmission to their family (Fielbaum et al., 2023; May et al., 2021). It also included social isolation due to the lack of contact between colleagues (Gartland et al., 2022). Indeed, since the beginning of the SARS-CoV-2 pandemic, BDs have been considered essential workers over the world. In contrast to the non-essential workers, BDs have had to continue operating the bus service, despite a high infectious risk and related lockdowns (Baker et al., 2020; Sim, 2020; The, 2020).

Many studies have addressed the prevalence and risk of contracting SARS-CoV-2 and identified BDs at a higher risk of SARS-CoV-2 infection (Dahlman and Anund, 2022; Lan et al., 2021; Magnusson et al., 2021; Mutambudzi et al., 2021; Rhodes et al., 2022), even in low-incidence areas (Dahlman and Anund, 2022; De Matteis et al., 2022). Furthermore, some studies showed the negative health impacts of the SARS-CoV-2 pandemic, mainly on the mental health of essential workers (Gold, 2020; Lan et al., 2021; May et al., 2021; Spiller et al., 2022). Nevertheless, few authors addressed the effect of this pandemic on work conditions, especially beyond the healthcare sector (Fielbaum et al., 2023; May et al., 2021; Vindrola-Padros et al., 2020).

There are no statistics on the SARS-CoV-2 seroprevalence among BDs in Switzerland. However, there is empirical evidence that some bus companies had to reduce the number of buses on the road and manage the supply on a day-to-day basis because a large proportion of their staff were ill (Genet, 2021). This suggests that changes in BDs' work conditions can be attributable to the pandemic, deserving a more objective assessment.

This study aimed to assess the consequences of the health crisis on BDs' working conditions during the SARS-CoV-2 pandemic. We also aimed to assess the BDs' satisfaction rate with respect to the pandemic management in their companies.

2. Materials and methods

2.1. Study design

This nationwide study is cross-sectional by design, with data collected in the frame of an anonymous online survey.

2.2. Participants and recruitment method

The study sample included active BDs aged between 18 and 67 years old, who voluntarily participated in the survey. The upper age limit corresponds to two years after the official retirement age, as some Swiss BDs continue to work after retirement. The source population was the BDs affiliated with any of the three unions active in public road transport in Switzerland. A total of 4324 potentially eligible participants were identified based on the unions' records and contacted by email by the union's representatives to invite them to participate in the survey. The survey took place between February 22 and April 6, 2022. The reminders to complete the survey were sent twice, after one month and one week before the end. Prior to the survey distribution, the unions organized a joint survey promotion campaign (Sancey, 2022). Moreover, a link and a QR code to the survey were published in the monthly newsletter of the three unions and distributed to all union members and all bus companies.

The participants were not paid nor received any kind of compensation. The survey responses were anonymous. The study protocol was submitted to the competent ethics committee, which waived the need for a participants' informed written consent (CER-VD decision number 2021-01089).

2.3. Measures

The survey was based on a multilingual questionnaire created in RedCap (Harris et al., 2009, 2019). The questionnaire was developed in collaboration with the three unions based on their experience of health crisis management and working conditions (Supplementary material File 1). The questionnaire contained four parts, but in this study, we used only the two parts concerning the SARS-CoV-2 pandemic. The other parts concerning BDs' health and working conditions were presented in an accompanying article (Remy and Guseva Canu, 2023).

2.3.1. Socio-professional and demographic characteristics

Socio-demographic characteristics included sex, age, education attainment, apprenticeship, and canton of residence. The professional characteristics included working company, BD's seniority within the company, working rate, and whether BD had worked in another company before and his/her seniority there.

2.3.2. SARS-CoV-2 crisis management

This part of the questionnaire consisted of four questions. The first three questions were: "In your opinion, did your employer react quickly enough at the beginning of the pandemic (i.e., in early 2020) to protect you against the coronavirus at your workplace?"; "From your point of view, are you today sufficiently protected against the coronavirus at your workplace?" and "In your opinion, are the concepts of protection against the coronavirus well applied at your workplace?". The possible answers to these questions were Yes or No. There was also a question "How would you rate your employer's management of the coronavirus crisis after two years of the pandemic? Rate from 1 (No performance) to 6 (Excellent)". In this question, BDs were asked to grade their satisfaction with the crisis management in their company using a 6-point Likert scale. This scale was chosen as it corresponds to the Swiss school system's grading scale and is thus familiar to most bus drivers.

2.3.3. SARS-CoV-2 crisis impacts on work conditions

In this part of the questionnaire, BDs were asked to indicate whether they had experienced any changes in working conditions or health since the beginning of the pandemic. The specific questions were as follows: "Have you had to work a lot of extra hours because of the coronavirus (e.g., to replace colleagues)?"; "Have you ever had to take over shifts from your colleagues at short notice because of the coronavirus?"; "Has your workload increased overall because of the coronavirus?"; "Has the extra work resulting from the pandemic led to a shortening of your rest phases?" and "Has the increased workload had an impact on your psychological or physical state?" The possible answers to these questions were Yes or No.

2.4. Data management and statistical analysis

The database with responses to questionnaires was downloaded from RedCAP software and examined for completeness and erroneous values. This allowed us to compare the study sample characteristics with the demography of BDs using the official statistics

Table 1

Socio-professional and demographic characteristics of the Swiss bus drivers participating in the study and demographic characteristics of the target population (Swiss bus drivers).

	Sample		Target population
	N	%	%
Total	916	100	100
Sex			
Male	772	84.3	86.8
Female	129	14.1	13.2
Missing	15	1.6	–
Age group			
<30 ans	32	4.4	3.6
30-39 ans	185	21.0	16.3
40-49 ans	195	22.1	28.4
>50 ans	465	52.6	46.7
Missing	32	3.5	–
Region			
Espace Mitteland	298	32.5	20.6
Northwestern Switzerland	63	6.9	11.0
Eastern Switzerland	60	6.6	16.0
Lake Geneva Region	228	24.9	22.8
Ticino	104	11.4	4.6
Central Switzerland	85	9.3	11.6
Zurich	60	6.6	13.4
Missing	18	2.0	–
Union			
Union1	511	55.8	–
Union2	187	20.4	–
Union3	151	16.5	–
Missing	67	7.3	–
Education level			
Mandatory	373	40.7	–
Secondary	314	34.3	–
University	209	22.8	–
Missing	20	2.2	–
Apprenticeship			
Yes	671	73.3	–
No	205	22.4	–
Missing	40	4.4	–
Work rate			
Part time	135	14.7	–
Full time	759	82.9	–
Missing	22	2.4	–

and to address the potential non-response issue. As the number of missing data in other variables was small, we did not use the usual techniques recommended for handling missing data, such as mean substitution or imputation. We simply omitted these data and analyzed the remaining data.

Descriptive statistics including mean, standard deviation [M±SD], and frequency distribution [n, %] were computed to describe socio-professional and demographic characteristics, SARS-CoV-2 crisis management, and impacts on work conditions and health of BDs.

Multivariate logistic regression models were then developed to investigate the socio-professional and demographic factors that influenced BDs' appraisal of SARS-CoV-2 crisis management and the changes in their working and health conditions. Multivariate linear regression models were developed to investigate the socio-professional and demographic factors, the appraisal of crisis management, and the crisis consequences on working conditions that might be related to the grading of crisis management by their companies.

The significance level was set at 0.05 and the p-values were two-tailed. Data management and descriptive analysis were performed using R version 3.1, 1093 (Team, 2020). Logistic regression analyses were conducted using Stata 17 (StataCorp, 2021).

For the sake of confidentiality with respect to the bus companies and their workers, the presented results were aggregated at the regional and union levels.

3. Results

3.1. Characteristics of the study sample

Overall, 916 BDs completed the questionnaire. The survey response rate was 21.2%, while the non-response rate of the various survey sections varied between 1.6% and 7.3%. Socio-professional and demographic characteristics of the sample and target population are summarized in Table 1. Only 14.1% of the drivers were female. The average age was 48.2 years (SD = 9.7) and the driving seniority was 11.5 years (SD = 9.7). Most BDs were from the bilingual region Espace Mitteland (32.5%) and the French-speaking region of Lake Geneva (24.9%) (Fig. 1). Union 1 and Union 2 were present in all the regions, whereas Union 3 was only represented in German-speaking region of Switzerland. The highest education level of nearly half of the workers was mandatory school (40.7%). Three-quarters of the drivers made an apprenticeship before becoming BD (73.3%). Less than a fifth of the drivers (14.7%) worked part-time. However, female BDs were as threefold more (38.8%) to work part-time than males (11.0%). When comparing the characteristics of the target (Swiss BDs) and study populations, we observe similar sex and age distributions (p-value >0.05, chi-square test). However, with respect to the geographic distribution of BDs, we observed an underrepresentation of the German-speaking region of Switzerland (52% of Swiss BDs and 23% in our sample) and an overrepresentation of the Western Switzerland and Ticino (48% of Swiss BDs in Western Switzerland and Ticino and 68.6% in our sample).

3.2. SARS-CoV-2 crisis management and impacts on working conditions and health

The appraisal of the health crisis management and its consequences on working conditions by BDs are presented in Fig. 2. Three-quarters of the bus drivers (71.8%) felt sufficiently protected. A third of BDs (31.2%) evaluated the SARS-CoV-2 crisis management in their companies as good (Grade 5), 28.9% as sufficient (Grade 4), and 3.2% as no performance (Grade 1). The average grade was 4.1

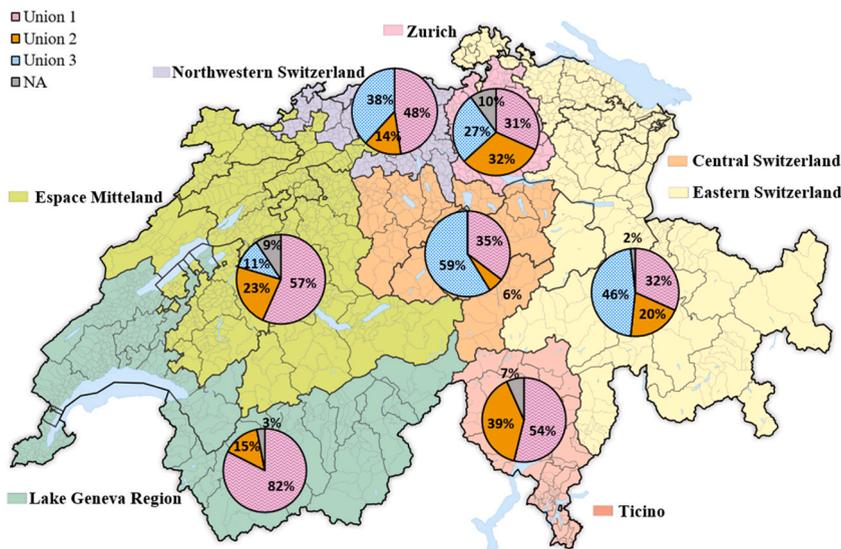


Fig. 1. Distribution of unions and participants per region.

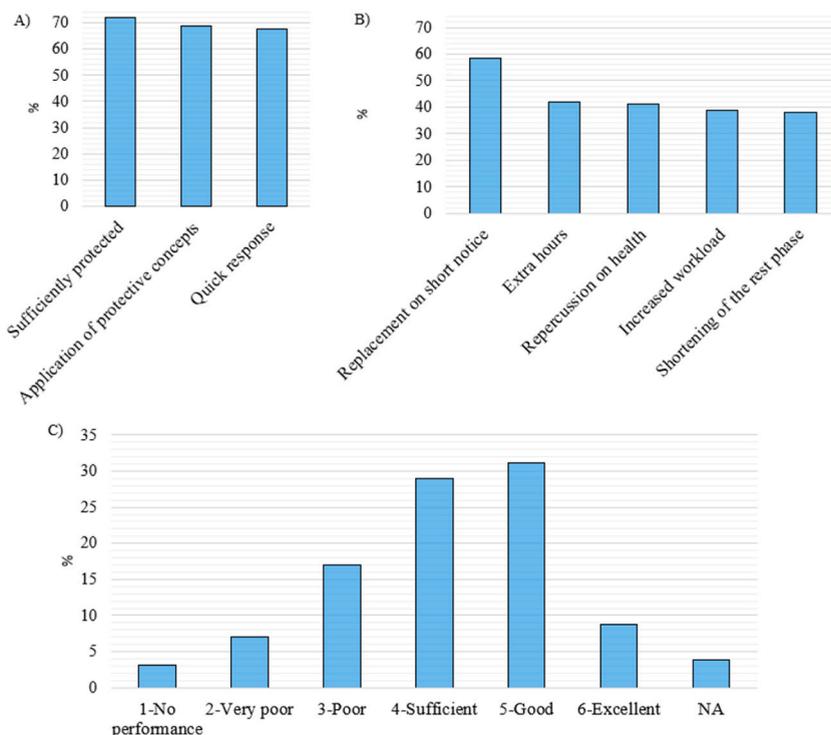


Fig. 2. A) Appraisal of the SARS-CoV-2 crisis management in bus transport companies, percentage of satisfied workers, B) Consequences of the SARS-CoV-2 crisis on bus drivers’ work conditions and health, percentage of workers reporting a change in their working conditions, C) Distribution of the grade attributed to the company for the SARS-CoV-2 crisis management.

(SD = 1.2), corresponding to a sufficient performance.

The three most frequent negative consequences of the SARS-CoV-2 crisis management were short-term replacements (58.3%), extra hours (42.0%), and the negative consequences on physical or mental health (41.3%).

3.3. Associations between appraisal of SARSCoV-2 crisis management and socio-professional and demographic characteristics

Table 2 presents the results of multivariate logistic regression analyses, summarized as odd ratios (OR) and associated 95%

Table 2
Association between SARS-CoV-2 crisis management within bus companies and socio-demographic characteristics of bus drivers.

	Quick response			Sufficiently protected			Application of protective concepts		
	OR	95% C.I.	p-value	OR	95% C.I.	p-value	OR	95% C.I.	p-value
Sex: female	0.72	0.43,1.21	0.220	1.33	0.73,2.41	0.356	0.96	0.57,1.63	0.891
Age (per year)	1.02	1.00,1.04	0.036	1.00	0.98,1.02	0.798	1.02	1.00,1.04	0.117
Seniority (per year)	0.97	0.95,1.00	0.016	0.99	0.97,1.01	0.330	0.99	0.97,1.01	0.257
Espace Mittelland	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Northwestern CH	1.69	0.70,4.12	<0.001	1.14	0.50,2.61	0.001	0.74	0.35,1.53	<0.001
Eastern CH	0.21	0.11,0.42		0.47	0.23,0.97		0.24	0.12,0.49	
Lake Geneva R.	0.24	0.15,0.38		0.65	0.40,1.05		0.43	0.27,0.69	
Ticino	0.74	0.40,1.38		1.42	0.74,2.74		0.60	0.33,1.09	
Central CH	0.99	0.47,2.08		1.26	0.57,2.78		1.64	0.70,3.80	
Zurich	0.45	0.22,0.95		0.42	0.20,0.87		0.37	0.18,0.78	
Union 1	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.			
Union 2	0.45	0.29,0.71	<0.001	0.42	0.27,0.65	<0.001	0.53	0.34,0.82	0.004
Union 3	0.85	0.48,1.51	0.577	1.14	0.63,2.07	0.672	1.28	0.72,2.29	0.401
Mandatory school	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Secondary school	0.81	0.54,1.20	0.285	0.89	0.58,1.36	0.578	0.80	0.54,1.19	0.270
Superior school	0.82	0.51,1.32	0.412	0.59	0.36,0.97	0.038	0.91	0.57,1.47	0.709
Apprenticeship	0.96	0.64,1.45	0.858	0.92	0.60,1.43	0.721	0.85	0.56,1.28	0.432
Full-time	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Part-time	1.31	0.77,2.23	0.317	2.44	1.30,4.58	0.005	1.30	0.76,2.20	0.337

CH=Switzerland; statistically significant results are in bold

Table 3
Association of SARS-CoV-2 crisis with bus drivers' work conditions and impact on health.

	Extra hours			Replacement on short-term notice			Increased workload			Shortening of rest phases			Negative impact on health		
	OR	95% C.I.	p-value	OR	95% C.I.	p-value	OR	95% C.I.	p-value	OR	95% C.I.	p-value	OR	95% C.I.	p-value
Sex: female	0.75	0.47,1.18	0.212	0.79	0.50,1.25	0.320	0.74	0.46,1.19	0.212	0.60	0.36,0.98	0.043	0.94	0.58,1.51	0.788
Age (per year)	0.98	0.96,1.00	0.023	0.99	0.97,1.01	0.354	0.99	0.97,1.00	0.118	0.99	0.97,1.01	0.398	0.99	0.97,1.01	0.440
Seniority (per year)	1.01	0.99,1.02	0.545	1.02	1.00,1.04	0.022	1.01	0.99,1.03	0.178	1.02	1.00,1.04	0.104	1.01	0.99,1.03	0.300
Espace Mitteland	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Northwestern CH	0.89	0.47,1.68	0.036	1.45	0.76,2.74	<0.001	0.85	0.44,1.64	<0.001	0.56	0.29,1.11	<0.001	0.53	0.27,1.05	0.028
Eastern CH	1.81	0.95,3.47		5.15	2.22,11.95		2.50	1.29,4.84		2.80	1.43,5.50		1.59	0.83,3.04	
Lake Geneva R.	0.87	0.58,1.31		0.59	0.39,0.89		0.73	0.48,1.10		0.57	0.38,0.87		1.06	0.70,1.61	
Ticino	0.87	0.51,1.48		1.91	1.05,3.47		0.48	0.27,0.84		0.45	0.25,0.79		0.51	0.29,0.90	
Central CH	2.15	1.22,3.80		3.08	1.63,5.81		1.97	1.11,3.51		1.14	0.64,2.03		0.92	0.51,1.65	
Zurich	0.80	0.40,1.62		0.69	0.35,1.37		0.81	0.40,1.64		0.71	0.35,1.43		1.17	0.59,2.33	
Union 1	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Union 2	1.35	0.91,2.02	0.136	1.17	0.76,1.78	0.475	1.56	1.04,2.35	0.032	1.31	0.87,1.98	0.196	1.49	0.99,2.25	0.055
Union 3	0.72	0.45,1.16	0.174	0.61	0.37,1.00	0.050	0.67	0.41,1.08	0.101	0.78	0.48,1.26	0.303	0.85	0.52,1.37	0.496
Mandatory school	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Secondary school	1.24	0.88,1.76	0.219	1.45	1.02,2.08	0.040	1.62	1.14,2.31	0.008	1.27	0.89,1.82	0.185	1.83	1.28,2.61	0.001
Superior school	1.35	0.89,2.05	0.162	1.93	1.24,2.99	0.004	1.53	0.99,2.36	0.056	1.45	0.93,2.24	0.099	1.77	1.15,2.73	0.009
Apprenticeship	1.26	0.87,1.82	0.221	1.31	0.90,1.91	0.151	1.04	0.71,1.51	0.843	1.25	0.85,1.84	0.255	1.41	0.97,2.06	0.074
Full-time	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Part-time	0.67	0.42,1.05	0.079	0.67	0.42,1.06	0.085	0.51	0.32,0.82	0.006	0.44	0.27,0.72	0.001	0.33	0.20,0.54	<0.001

CH=Switzerland; O.R. = Odd ratio, C.I.:Confidence interval. Statistically significant results are in bold

confidence interval (95% CI).

The quick response, the feeling of being sufficiently protected, and the application of protective concepts were all three significantly associated with the geographic region of BDs' residence. Compared to the Espace Mitteland, satisfaction with the speed of response and with the implementation of protective concepts were more than twice as low in Eastern Switzerland, Lake Geneva region, and Zurich. Satisfaction with feeling sufficiently protected was twice as low in Zurich as in Espace Mitteland.

BDs affiliated with Union 2 were significantly less satisfied with the quickness of the company's response to the crisis, the feeling of being sufficiently protected, and the application of a protective concept than those affiliated with Union 1. Furthermore, quick response was significantly associated with age and with seniority.

Moreover, participants with superior education were also twice less satisfied regarding the feeling of being sufficiently protected than those with only mandatory education. However, participants working part-time had a higher satisfaction rate.

3.4. Associations between SARS-CoV-2 crisis consequences and socio-professional and demographic characteristics of bus drivers

Table 3 presents the results of multivariate logistic regression analyses.

The five analyzed variables (i.e., extra hours, replacement on short-term notice, increased workload, shortening of rest phases, and negative impact on health) were significantly associated with the geographic region of BDs' residence. Extra hours were twice as common in Central Switzerland as in the Espace Mitteland. Short-term replacements were less frequent in the Lake Geneva region, while it was twice as high in Ticino, three times as high in Central Switzerland, and six times as high in Eastern Switzerland compared to the Espace Mitteland. In addition, the increase in workload was half as experienced in Ticino, while it was more than twice as frequent in Eastern and Central Switzerland. Shortened rest phases were less frequent in the Lake Geneva and Ticino regions, while they were more than twice as frequent in Eastern Switzerland compared to the Espace Mitteland. Moreover, the number of BDs whose health has been negatively affected by deteriorating working conditions was half as high in Ticino as in the Espace Mitteland.

Increase in workload, shortening of breaks and rest time, and impacts on physical and mental health were half as frequent among BDs working part-time. In addition, short-term replacement, increased workload, and impact on physical and mental health were almost twice more frequent among BDs with secondary or superior education. Replacements on short notice were less frequent among BDs affiliated with Union 3 than those affiliated with Union 1. Furthermore, the increased workload was more frequent among BDs affiliated with Union 2 than those affiliated with Union 1. Finally, the shortening of the rest time was less frequent in female BDs.

3.5. Associations between grades attributed to bus companies for their management of the SARS-CoV-2 crisis and crisis consequences and demographic characteristics of bus drivers

Table 4 presents the results of multivariate linear regression analyses, summarized as β coefficient, and associated 95% C.I.

In the multivariate linear model of Table 4, the company's quick response to the pandemic (i.e., rapid implementation of protective measures) was strongly associated with the attributed grade. The association was positive and strong ($\beta = 0.87$), meaning that BD had a 2.39-time (calculated as $e^{0.87}$) higher chance to attribute a high grade to the company which acted fast by implementing protective measures. A positive association was also observed with the BDs' feeling of being sufficiently protected ($\beta = 0.46$). When the company

Table 4

Linear regression analysis of the association between the grade attributed to bus companies for their management of the SARS-CoV-2 crisis and its impacts and demographic characteristics.

	β coefficient	95% C.I.	p-value
Quick response	0.87	0.71, 1.04	<0.001
Sufficiently protected	0.46	0.27, 0.65	<0.001
Application of protective concept	0.42	0.23, 0.61	<0.001
Extra hours	-0.09	-0.25, 0.07	0.281
Replacement on short notice	0.05	-0.09, 0.20	0.456
Increased workload	-0.12	-0.29, 0.05	0.174
Shortening of the rest phase	-0.24	-0.42, -0.07	0.006
Repercussion on health	-0.32	-0.48, -0.16	<0.001
Sex: female	-0.11	-0.30, 0.07	0.221
Age (per year)	0.01	-0.002, 0.01	0.154
Seniority (per year)	-0.01	-0.02, -0.001	0.027
Espace Mitteland	Ref.	Ref.	Ref.
Nordwestern Switzerland	0.01	-0.25, 0.27	0.217
Eastern Switzerland	-0.38	-0.66, -0.10	
Lake Geneva Region	-0.05	-0.22, 0.13	
Ticino	0.02	-0.20, 0.24	
Central Switzerland	-0.07	-0.31, 0.17	
Zurich	-0.02	-0.31, 0.27	
Union 1	Ref.	Ref.	Ref.
Union 2	0.01	-0.15, 0.18	0.863
Union 3	-0.14	-0.33, 0.06	0.166

The adjusted R^2 was 0.47. Statistically significant results are in bold

was considered as compliant with the application of protective concepts the likelihood of giving a high grade was 1.52 times higher. The shortening of the rest phase, and repercussions on health were negatively associated with the grading ($\beta = -0.24$ and $\beta = -32$, respectively). Finally, being in the region of Eastern Switzerland was negatively associated with BD's grading of their companies compared with being in Espace Mitteland (reference).

4. Discussion

4.1. Interpretation of study results

In Switzerland, the first positive case of SARS-CoV-2 was discovered on February 25, 2020. On March 13, 2020, schools were closed. On March 16, 2020, the Federal Council declared a State of Emergency under the Federal Epidemic Law. The next day, bars, restaurants, recreation areas, theaters, sports facilities, and stores were closed. However, pharmacies, food stores, postal services, and public transport remained open. Since the end of April 2020, the closed facilities slowly started opening in the next three months. Mask-wearing became mandatory in public transport in July 2020. In December 2020, the first vaccines against SARS-CoV-2 were administered. Since April 1, 2022, all restrictions have been lifted (Foph).

At the beginning of the pandemic in Switzerland, a partial lockdown was in place, which reduced the number of passengers on public transport. Moreover, to protect BDs, bus companies put in place several protective measures: personal protective equipment including hydro alcoholic gel, regular disinfection of buses, and requiring passengers to enter and exit through the doors in the middle and rear of the bus. Then, there was the isolation of the BD either by adding a Plexiglas panel to create an enclosed cabin or by the "Covid-chain" blocking access to the front of the bus. All those actions led to three-quarters of BDs feeling sufficiently protected during the various waves of the pandemic. Similar results were found in a study in the British public transport sector (Gartland et al., 2022). However, in another study, essential workers did not feel well protected and reported late and improper protective equipment at the beginning of the crisis (May et al., 2021). This underlines the importance of rapid action to make the driver feel sufficiently protected and reassured.

Despite a relatively high satisfaction rate of the SARS-CoV-2 crisis management among Swiss BDs, the average grade attributed to their companies was 4.1 corresponding to a sufficient performance. To understand what this grade means, it is important to know that the scale chosen is based on the Swiss school system's grading scale, which operates on a scale of 1 (no performance) to 6 (excellent). The minimum grade to pass the exams in Switzerland is 4, any grade below this indicates a failure. This means that an average of 4.1 is a relatively low grade and that there is room for improvement. The company grading was associated with the impact of the crisis on BDs' working conditions and health. Bus drivers satisfied with the crisis management in their companies rated them better. Conversely, bus drivers having noticed the negative impacts of the crisis management on their working conditions and health attributed lower grades to their companies.

A regional difference was observed in all analyses. This confirms our hypothesis on a potential heterogeneity in crisis management across Swiss cantons and consequently, across public transport companies. Indeed, it was expected as most BDs work in the same or close to the region of their residence. It should be noted that being a federal state, Switzerland allows the cantonal governments to manage public health issues independently. Consequently, before the introduction of the federal law on pandemic management on March 16, 2020, each canton applied its regulation. In addition, each company had different internal rules, which could be stricter than the national restrictions. This can lead to a wide range of protective actions, varying from one company to another. However, most companies used the same approach: distribution of hydroalcoholic gel and isolation of the bus driver, although with a different rapidity. Such inter-cantonal variations help explain the regional variations in the appraisal of the SARS-CoV-2 crisis management and its consequences. The case of Eastern Switzerland and Zurich, which tended to have a lower satisfaction rate than Espace Mitteland and a higher rate of experiencing negative consequences of the SARS-CoV-2 crisis perfectly illustrates this. Indeed, the pandemic was first reported in Ticino (the region closest to Italy, from where the first cases came) and the western part of Switzerland (Fig. 1). These regions took measures to limit the spread of SARS-CoV-2 more rapidly and more restrictively than Eastern Switzerland and Zurich, which waited for the federal order to act. In Western Switzerland, the restrictions were often dictated as mandatory constraints, whereas in Eastern Switzerland, they were recommendations (Bradley, 2020; Roten, 2020a, 2020b). As discussed with the unions, BDs from the Western region tend to be more satisfied with how their company managed the crisis than the BDs from Eastern Switzerland, where the actions were taken later and less strictly. Furthermore, BDs in Eastern Switzerland graded their companies lower than those in the Espace Mitteland. However, this grading might also reflect the BDs' dissatisfaction with their companies prior to the crisis, a parameter that we could not assess in this cross-sectional study. The unions notified preexisting tensions in Eastern Switzerland due to the shortage of BDs and its repercussion on the working conditions, which could explain the lower satisfaction rates among BDs from this region.

Union was another original variable associated with several impact variables. It is noteworthy that unions are not always representative of regions. For instance, Union 2 represents the workers of one large, historical public transport company, while the two other unions represent the workers of dozens of bus companies. Union 1 is preferentially established in French-speaking Switzerland (west part of Switzerland) and regional companies in German-speaking Switzerland, while Union 3 is mainly established in German-speaking Switzerland (east part of Switzerland), particularly in the cities (Fig. 1). This distribution explains at least partially the variation in SARS-CoV-2 crisis management satisfaction rate as it is related to the geographical distribution of the BDs. For example, a large transport company represented by Union 2 experienced delays in the distribution of protective equipment at the beginning of the crisis due to the size of the company. The decisions and measures taken to fight the spread of SARS-CoV-2 and protect its employees were based on the views of the managers of the regional centers covering the whole of Switzerland, with western Switzerland pushing for

stricter measures and German-speaking Switzerland questioning such strict measures. Consensus was needed to ensure that these measures were accepted and respected by BDs and other employees.

Another factor influencing the pandemic management appraisal and its impacts was the work rate. Bus drivers working part-time tended to have a lower risk of experiencing the negative impacts of the crisis and a higher satisfaction rate than full-time working BDs. A gender difference was observed only in the shortening of rest phases, less frequent in female than in male BDs.

4.2. External coherence of the results

In other countries, such as the United States and the United Kingdom, increased workload and the number of extra work hours were the most reported changes in work conditions among essential workers, mainly healthcare workers (May et al., 2021; Vindrola-Padros et al., 2020). In this study, we found similar results. Another finding was the high proportion of BDs having to replace their sick colleagues on short notice, which was a predictor of the increased workload and extra hours. Furthermore, due to a shortage of bus drivers in general, companies have fewer BDs available for organizing replacements. In case of a high absence rate, companies must make BDs work during their days off to guarantee the public transport service. This also contributed to an increase in extra hours (Le, 2020; Sancey, 2019; Tribune de, 2020).

Due to the SARS-CoV-2 crisis consequences on work conditions, 41.2% of the BDs reported negative consequences on their physical or mental health. Studies that analyzed the mental burden of the SARS-CoV-2 crisis on essential workers reported an increase in stress and anxiety, either due to the fear of contracting SARS-CoV-2 or to the increased workload (Gartland et al.; Gold, 2020; Lan et al., 2021; May et al., 2021). Therefore, our results are consistent with the external evidence.

4.3. Methodological aspects and result generalization

The questionnaire used in this study was limited to nine questions. A larger number of questions would have allowed for assessing the effects on BDs' health more precisely, but from previous surveys, we know that this population is reluctant to answer long questionnaires and participate in medical screening, even the compulsory ones. In addition, as it was a self-administered questionnaire, participants may have over- or under-estimated their exposures and health outcomes. Therefore, an information bias might be present, as in all studies of this kind (Schubauer-Berigan et al., 2023). Without objective data from medical records and occupational exposure registers, which do not exist in Switzerland besides ionizing radiation exposure (Guseva Canu et al., 2020), it is difficult to predict the amount and direction of this bias on the study results.

As the survey was not mandatory and mostly distributed to the unionized BDs, a potential selection bias cannot be excluded. Yet, we are confident that its impact on study results, if any, would be limited, and that the study has captured the Swiss BDs' opinions in quite a representative way. The overall BDs' unionization rate in Switzerland is 40.3%. The unionization rate varies from one company to another; in some companies, it reaches 80%. Even if the unions sent the links to their members, the study was promoted broadly in all bus companies, so we could also include 7.3% of BDs not affiliated with any union. When comparing the characteristics of the target (Swiss BDs) and study populations, we found that the regional distribution of BDs in the study sample does not perfectly reflect the distribution in the target population. However, it is a rather typical situation in the national-wide surveys conducted in Switzerland (Plys et al., 2022; Remy and Guseva Canu, 2023). The selection might operate through many factors including health literacy, culture, or religion. Switzerland has four linguistic regions, with a distinguished culture and its own traditions. In the German-speaking part of Switzerland, the culture of Protestant Christianity is more strongly imprinted than in the predominantly Catholic French-speaking or Latin part of Switzerland. This Protestant ethic being associated with a capitalist work culture, might partially explain the differences in participation observed in this and other studies targeting work conditions (Guseva Canu et al., 2021; Weber, 1978).

For all these aspects, owing to the study design and data (un)availability this study should be considered as exploratory and descriptive.

5. Conclusion

Our study showed that the SARS-CoV-2 pandemic negatively impacted the working conditions and the physical and mental health of BDs. Furthermore, it showed that the SARS-CoV-2 crisis management in public transport companies differed across geographic regions, leading to a variation in the BDs' satisfaction rate and an average grade corresponding to sufficient performance. Moreover, the rates of experiencing the negative impact of the SARS-CoV-2 crisis on BDs' work conditions and health were not uniform in Switzerland and depended on the union. Age, driving seniority, education level, and work time were identified as determinants associated with varying rates of BDs' satisfaction regarding crisis management in their companies. Since this study is descriptive, a more comprehensive assessment of the BDs' work conditions and the changes associated with the pandemic is necessary to ensure better crisis management in the future, especially in regions and unions with low BDs satisfaction rates.

Author contributions

VR collected, cleaned and analyzed the data and drafted the manuscript. IGC conceived the study protocol, obtained the funding and access to the data, critically reviewed and completed the manuscript and coordinated the study. Both authors read the final version of the manuscript.

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Ethical authorization

The study protocol was submitted to the competent ethics committee, which waived the need for a participants’ informed written consent (CER-VD decision number 2021-01089).

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

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