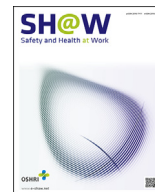




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Original Article

## The Complex Interrelationship of Work-Related Factors Underlying Risky Driving Behavior of Food Delivery Riders in Athens, Greece

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### ABSTRACT

**Background:** In this study, the association of work and demographic characteristics with different traffic offenses committed by food delivery riders in Greece was examined. Previous research has identified various factors related to risky driving however, there is a need for exploring the complex interrelationship of work-related factors underlying risky driving behavior.

**Materials and Methods:** A 2-items questionnaire was used exploring delivery riders demographic characteristics, terms of employment, issues of concern during work and type of traffic offenses committed. In total, questionnaires were analyzed using logistic regression in order to identify characteristics independently associated with serious traffic offenses, namely, red-light running and helmet non-use.

**Results:** The analysis showed that: (i) typical health and safety measures had no effect on serious traffic offenses, (ii) young age was related to both offenses however (iii) different sets of work conditions were associated with reports of red-light running (i.e. low work experience, use of personal vehicle for work, and payment by hour) and helmet non-use respectively (i.e. intense work pace, high tip income per day and low concern about vehicle condition).

**Conclusion:** The above findings provide evidence that serious traffic offenses are manifestations of underlying conflict experienced by the riders between safety and various performance criteria. Each one of the two offenses is related to different rider profiles aiming to satisfy different goals, namely, those mainly trying to maximize profit non-helmet users and those, mostly inexperienced ones, trying to cope with work pressure red light runners. Potential regulatory measures to alleviate risky practices are discussed.

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## 1. Introduction

Delivery riders are reported to accept high risk-taking, typically more than the general rider population [1,2]. Among other reasons, such behavior is probably linked with the often informal character of the employment. In fact, high risk-taking is a well-recognized phenomenon in various types of informal work, characterized by short contract duration, less job security, irregular working hours, various forms of dependent self-employment, and also bogus/informal work arrangements [3]. In the case of delivery riders, in particular, speeding and negligence of self-protection means (i.e., not wearing helmet at work or using helmet without jaw protection) are two typical traffic offenses that are associated with increased risk of riders' involvement in accidents [4]. Two possible

reasons typically reported in the literature are (i) personal traits related to low education and socioeconomic status of the particular population and (ii) work-related factors linked to pressure for fast deliveries and/or income increase.

For instance, a cross-sectional assessment of 101 delivery riders in Brazil showed a higher prevalence of mental disorders (i.e. attention deficit/hyperactivity and antisocial personality disorder) than in the general population, which were associated with negative traffic outcomes [5]. Other studies, especially in African countries, highlight the fact that this occupation is a way out of poverty and/or unemployment for people with low educational and socioeconomic level [6–8], who are also impregnated with poor safety culture, such as drug/alcohol use before riding to enhance their performance while working [9–13] or even reliance on

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charms against road traffic injuries, the so-called “road traffic injury immune delusion syndrome” [14]. In addition, delivery riders tend to be young or novice road users with no formal training in riding, suggesting a low level of awareness of the risks associated with reckless driving and/or to nonuse of personal protection equipment (PPE) [15–20]. In this context, recommended regulatory measures for improving delivery riders' safety at work typically include riders' training before licensing for commercial purposes, or even age restrictions, combined with strict enforcement for compliance with road safety highway codes [21–25].

Other studies focus on work-related factors, particularly those related to the often informal character of the occupation, allowing companies to account for fluctuation demands [2,26,27]. Reportedly, delivery riders are temporary employed, poorly paid, and often paid ‘by the job’, e.g., paid by the hour or the amount of delivery goods [28,29]. This tends to induce intense work pace for long hours, without breaks but also higher work stress, work fatigue, and unsafe driving behaviors, e.g., running a red light or a stop sign [4,28–31]. In addition, delivery riders frequently drive without wearing a helmet for time saving and convenience [30,32] or make use of uncertified helmets just for compliance purposes [33]. The aforementioned findings suggest that more than mere ignorance, the combined pressure exerted both by employers for fast deliveries and by employees for higher profits possibly pushes delivery riders to risky behavior [4]. At the same time, it is extremely difficult to specify hard regulatory measures for alleviating such combined pressure (e.g., speed limit, maximum number of deliveries per hour, etc.). This is both impractical because of high variation in travel distances and demand peaks among the stores and unsounded because such hard constraints do not address the complex interrelationship underlying the aforementioned risk-taking practices.

In Greece, in particular, although reliable data on employment forms are not available, informal employment is prevalent among delivery riders. According to the Hellenic Labor Inspectorate, it is estimated that about 55% of delivery riders are undeclared [34]. Sporadic studies in the last 20 years indicate that (i) many employers do not provide delivery riders with company motorcycle and/or PPE e.g., helmet [35], (ii) delivery riders are poorly paid and rely heavily on tips to increase their incomes [36], and (iii) they work under time pressure for fast delivery [37]. For instance, testimony of an employee who worked in a company that rated its delivery riders' efficiency on a weekly basis, disclosed that four deliveries per hour was the minimum goal; whereas those who were low rated were in the fear of dismissal [38].

The present study examines the association of terms of employment, working conditions, and personal characteristics with different types of unsafe behaviors of food delivery riders in Athens, Greece, in an attempt to shed light on the complex interrelationship of work-related factors underlying risk-taking practices. The aim is to inform regulatory measures and policies for improving delivery riders' safety at work, at local, and possibly at international level.

## 2. Materials and method

### 2.1. Sample selection

The survey was conducted in the seven municipal departments of the central Athens regional area, with a population of approximately 665,000 inhabitants (Greek Statistical Authority census of 2011). As stated in the introduction, because of high prevalence of informal employment, demographics and the total number of delivery riders population are unknown; thus, a consecutive, non-probability sampling approach was used. The number of

participants was proportionally allocated in accordance with each municipal department's population (i.e., 53, 71, 32, 59, 68, 90, and 86 in the seven departments, respectively) resulting in a final sample of 460 that corresponds to one participant per 1440 inhabitants. Participants' selection was done as follows: one researcher visited food and beverage take-away shops and administered printed questionnaires face-to-face to the delivery riders being present at the shops, until the required number of participants per municipal department was met. The data gathering took place from September to November 2016.

### 2.2. Material

A self-administered anonymous questionnaire was used, consisting of both closed and open questions. The questionnaire was developed through several stages of improvement. Initial selection of the questionnaire's topics was based on a literature review. The main issues identified in the review were (i) pressure for timely delivery [4,27,31,37,39,40], (ii) work/safety equipment [16,18,20,22,23,25,27,33,34,39], (iii) the type of the contract/payment method [4,27,31,32,39,41], (iv) prolonged work hours/night-shift [4,27,42], (v) regulatory enforcement issues [32,34], (vi) malicious acts [43], and (vii) alcohol/drug consumption [6,10–13,19,20,42]. These topics were checked for relevance for the specific delivery community in Greece through semistructured interviews with six experienced food delivery riders (all men, with more than 10 years of work experience in food and beverage delivery), who were not included in the sample. Through these interviews, the topics were further specified into question items and attributes. For example, payment methods were specified by hour, day or month, excluding payment per delivery or per mile. Regulatory enforcement issues were specified in accordance with their severity as red-light running and helmet nonuse followed by more common or less severe such as unsafe lane splitting and driving on pedestrian zones. Note that, speed limit and alcohol/drug consumption were not judged as relevant for this specific traffic environment and community; thus, they were not included in the questionnaire (i.e., speed limits in the selected urban areas are less than 50 km/h and are generally not respected by the driver population; alcohol/drug consumption was mentioned not to be an issue in this population during the semi-structured interviews). Through the aforementioned process an initial questionnaire was developed. Then, to verify the appropriateness of question wording and the question ordering, a pilot study was conducted by self-administering the questionnaire to 10 other delivery riders (all men) who were also not included in the sample. After fine-tuning in terms of wording and comprehensibility, the final questionnaire consisted of 24 items corresponding to the following topics: (i) demographic characteristics (5 items), i.e. rider's age, rider's gender, riding experience, work experience, and involvement in serious accident, (ii) terms of employment (8 items), i.e., use of personal vehicles for work, PPE provision, accident insurance, employer's control over helmet use, mileage per week, payment methods, and tip income, (iii) rider's concerns during work (5 items), i.e., concern about wayfinding, client behavior, road condition, weather condition, and vehicle condition, and (iv) traffic offenses (six items), i.e., unsafe lane splitting, driving the wrong way on one-way streets, driving with one hand, driving on pedestrian zones, driving without wearing helmet and running a red light.

### 2.3. Procedure

The food delivery riders were approached at the place of their work and were informed by the researcher about the purpose of the study. Typically, the riders were willing to participate in the study

at nonpeak hours. For this reason, the researcher might have visited the same shop up to three times. The riders were asked to fill in the questionnaire in a quiet place and place it in a sealed envelope to ensure their anonymity. Typically, the time needed to complete the questionnaire ranged from 5 to 8 minutes.

#### 2.4. Data process and analysis

Logistic regression analysis was used to examine the association of work and demographic characteristics of food delivery riders with their reported traffic offenses. Because of the relatively small sample size, a binary approach was used by single coding all responses to questions.

The dependent variables in this study were related to reports of two specific traffic offenses, namely: (i) red-light running (yes: frequently; or no: rarely) and (ii) nonuse of helmet (yes: frequently; no: rarely); these two offenses being the most serious ones (see section 3.2).

The independent variables were coded in the following manner: gender of the rider (male; female); age of the rider (18–24 years; or  $\geq 25$  years); riding experience, i.e., years of holding a motorcycle or moped license ( $< 5$  years; or  $\geq 5$  years); work experience, i.e., years of working as a food delivery rider ( $< 2$  years; or  $\geq 2$  years); involvement in serious accident(s), i.e., resulting in rider's hospitalization for more than two days (yes or no); use of personal vehicle for work (yes or no); PPE provided to the rider (yes or no); accident insurance provided to the rider (yes or no); employer control over helmet use (yes or no); typical mileage per week ( $< 250$  km; or  $\geq 250$  km); work pace, i.e., calculated by dividing the reported number of deliveries per day to the number of working hours ( $< 3.5$  deliveries per hour; or  $\geq 3.5$  deliveries per hour); the payment method (by the hour; or set salary by month or week); average tip income per day ( $< 8$  euros;  $\geq 8$  euros); concern about wayfinding, i.e., difficulty in finding the clients' address (yes: frequently; no: rarely); concern about client behavior (yes: frequently; no: rarely); concern about the road condition (yes: frequently; no: rarely); concern about the weather condition (yes: frequently; no: rarely); concern about the vehicle condition (yes: frequently; no: rarely).

The bivariate analysis was carried out using the Chi-square test with a level of significance set at .05, and the odds ratios along with their respective 95% confidence intervals. The binary logistic regression was carried out by selecting variables through the stepwise method, to investigate factors independently associated with reports of red-light running or nonuse of helmet. The criterion for including variables in the logistic regression was a  $p < .10$  in the bivariate analysis, and these were kept in the model when  $p < .05$ . The SPSS software version 26 was used for the statistical analyses.

#### 2.5. Ethical aspects

Participants were informed about the purpose of the study. All participants signed an informed consent and were informed that anonymity will be kept and the obtained data would be used only for statistical purposes, as per the operational guide of the National Technical University in Athens, Ethics Committee for Research.

### 3. Results

In total, 460 filled-in questionnaires were collected. Response quality was good with only 26 questionnaires being excluded due to missing information, i.e., more than three unanswered questions (loss of 5.6%), resulting in a sample of 434 riders.

#### 3.1. Respondents' work and demographic characteristics

Descriptive statistics of food delivery riders' characteristics participating in the study is presented in Table 1, using descriptive measures, i.e. mean (M) and standard deviation (SD). Regarding their demographic characteristics, all 434 respondents were male. This is rather expected because it is quite rare in Athens, a delivery rider to be female. The majority of riders (63%) were over 25 years old (M = 28.45, SD = 7.58), and 79% of them held a moped or motorcycle license for more than five years (M = 11.34, SD = 7.23). In addition, more than half of riders (56%) had more than two years of work experience (M = 3.93, SD = 3.11), whereas 25% of them reported being a victim of an accident with serious injury (i.e., requiring hospitalization for more than two days).

Regarding respondents' work characteristics, the vast majority (83%) reported having an intensive work pace, i.e., more than 3.5 deliveries per hour (M = 5.14, SD = 3.28), whereas only half of them (54%) reported traveling more than 250 km per week (M = 290.09, SD = 128.49) or paid by the hour (52%). This suggests that work demand for fast deliveries is invariant to local differences in terms of mileage at work or payment methods. At the same time, there seems to be a prevalence of informal work with the majority of the respondents reporting use of personal vehicles for work (67%), not being provided with accident insurance (64%) or PPE (63%), or being controlled by their employers for wearing helmet at work (74%). It is also worth to mention that two thirds of respondents (66%) reported earning more than 8 euros per day through tips [note that the average daily salary is 35 euros]. Finally, the main sources of riders' concern during work were related to vehicle condition (61%), road conditions (57%), and weather conditions (44%).

#### 3.2. Traffic offenses

All respondents reported frequently committing at least one of the six traffic offenses mentioned in the questionnaire, namely: unsafe lane splitting (91%), driving the wrong way on one-way streets (75%), driving with one hand (70%), driving on pedestrian zones (69%), driving without wearing a helmet (41%), and running a red light (30%). It turns out that apart from red-light running and helmet nonuse all the other four traffic offenses were committed on daily basis by at least 70% of delivery riders. The high frequency

**Table 1**

Work and demographic characteristics of the food delivery riders participated in this study (N = 434)

Variables	Values	%
<b>Demographic characteristics</b>		
Rider's gender	Men	100.0
Rider's age	>25 years	63.1
Riding experience	>5 years	78.8
Work experience	>2 years	56.2
Involvement in serious accident	Hospitalization	25.3
<b>Terms of employment</b>		
Using personal vehicle for work	No	67.3
PPE provision (by company)	No	63.1
Accident insurance provision	No	63.8
Employer control over helmet use	No	73.8
Mileage at work	>250 km/w	53.5
Work pace	>3.5 deliveries/h	82.8
Payment method	By hour	52.1
Tip income	>8 EUR/day	65.9
<b>Riders' concerns during work</b>		
Concern about wayfinding	Yes	19.4
Concern about client behavior	Yes	27.2
Concern about road condition	Yes	56.7
Concern about weather condition	Yes	43.8
Concern about vehicle condition	Yes	60.7

PPE, personal protection equipment.

**Table 2**  
Association between work and demographic characteristics of the food delivery riders and reports of serious traffic offenses (i.e., red-light running and nonuse of helmet)

Variables	Red-light running			Nonuse of helmet		
	Sig.	OR	95% CI	Sig.	OR	95% CI
Rider's age (18–24 years)	*	2.66	[1.47 – 3.26]	*	2.19	[1.47 – 3.26]
Riding experience (<5 years)	*	2.09	[1.30 – 3.37]	*	2.88	[1.79 – 4.62]
Work experience (<2 years)	**	1.71	[1.13 – 2.59]	ns	1.04	[0.71 – 1.53]
Involvement in serious accident (yes)	*	2.21	[1.41 – 3.47]	ns	0.97	[0.62 – 1.51]
Use of personal vehicle for work (yes)	*	2.89	[1.75 – 4.75]	ns	1.40	[0.92 – 2.11]
PPE provision (yes)	ns	0.80	[0.52 – 1.23]	ns	0.89	[0.60 – 1.53]
Accident insurance provision (yes)	ns	0.78	[0.51 – 1.21]	ns	1.02	[0.68 – 1.53]
Employer control over helmet use (yes)	ns	0.68	[0.42 – 1.11]	ns	0.77	[0.50 – 1.21]
Work pace (>3.5 deliveries/h)	ns	0.70	[0.41 – 1.19]	*	2.65	[1.46 – 4.80]
Mileage for work (>250 km/week)	*	2.41	[1.57 – 3.71]	ns	1.00	[0.68 – 1.46]
Payment method (by hour)	*	2.59	[1.68 – 4.00]	ns	1.04	[0.71 – 1.53]
Tip income (>8 EUR/day)	ns	1.36	[0.87 – 2.10]	**	1.80	[1.19 – 2.73]
Concern about wayfinding (low)	**	1.98	[1.21 – 3.24]	ns	1.13	[0.69 – 1.82]
Concern about client behavior (low)	ns	1.03	[0.65 – 1.64]	ns	0.81	[0.52 – 1.25]
Concern about the weather condition (low)	ns	0.85	[0.56 – 1.28]	ns	0.76	[0.51 – 1.12]
Concern about the road condition (low)	ns	1.04	[0.69 – 1.57]	*	2.17	[1.46 – 3.20]
Concern about the vehicle condition (low)	ns	0.66	[0.42 – 1.04]	*	2.40	[1.59 – 3.63]

\* $p < 0.001$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.05$ , ns: non-significant.

PPE, personal protection equipment.

Note: Sig. = significance; OR = odds ratio; CI = confidence interval.

of the latter offenses seems to be more indicative of delivery riders' norms about "acceptable" practices rather than of individual or specific work characteristics. This was also evidenced by the six experienced delivery riders' interviews that unanimously referred to these offenses as an inevitable part of the job whereas red-light running and helmet nonuse were considered as critical for their safety (This is also reflected in the Greek Highway Code [44], where these two offenses are classified as serious ones whereas the rest as minor). For reasons of parsimony, only red-light running and helmet nonuse were included for further analysis as the two most critical in terms of safety and, therefore, the most indicative in terms of unsafe riding behavior in this particular context.

### 3.3. Univariate analysis

To examine the association of all 17 work and demographic characteristics with the two most serious traffic offenses, a bivariate analysis was used.

This analysis showed that red-light running was significantly associated with eight work and demographic characteristics, namely: (i) young age (18–24 years),  $\chi^2(1, N = 434) = 21.29$ ,  $p < 0.001$ , (ii) low riding experience (<5 years),  $\chi^2(1, N = 434) = 9.41$ ,  $p = 0.002$ , (iii) low work experience (<2 years),  $\chi^2(1, N = 434) = 6.60$ ,  $p = 0.010$ , (iv) involvement in serious accidents,  $\chi^2(1, N = 434) = 12.17$ ,  $p < 0.001$ , (v) use of personal vehicle for work,  $\chi^2(1, N = 434) = 18.21$ ,  $p < 0.001$ , (vi) payment by the hour,  $\chi^2(1, N = 434) = 19.01$ ,  $p < 0.001$ , (vii) high mileage for work (>250km per week),  $\chi^2(1, N = 434) = 16.53$ ,  $p < 0.001$ , and (viii) low concern about wayfinding,  $\chi^2(1, N = 434) = 7.62$ ,  $p = 0.006$ .

Accordingly, nonuse of helmet was significantly associated with six work and demographic characteristics, namely: (i) young age (18–24 years),  $\chi^2(1, N = 434) = 15.01$ ,  $p < 0.001$ , (ii) low riding experience (<5 years),  $\chi^2(1, N = 434) = 19.90$ ,  $p < 0.001$ , (iii) intense work pace (>3.5 deliveries per hour),  $\chi^2(1, N = 434) = 10.84$ ,  $p = 0.001$ , (iv) high tip income (>8 euros per day),  $\chi^2(1, N = 434) = 7.82$ ,  $p = 0.005$ , (v) low concern about the vehicle condition,  $\chi^2(1, N = 434) = 17.69$ ,  $p < 0.001$ , and (vi) low concern

about the road condition,  $\chi^2(1, N = 434) = 15.20$ ,  $p < 0.001$ . Table 2 summarizes the univariate analysis results.

### 3.4. Multivariate analysis

Two binary logistic regressions were conducted on the eight and the six characteristics associated with reports of red-light running and nonuse of the helmet, respectively, that met the inclusion criteria of  $p \leq 10$ .

Results of the first logistic regression indicated that young age, low work experience, use of personal vehicles for work, and payment by the hour were associated with reports of red-light running. The logistic regression model was statistically significant,  $\chi^2(4) = 52.603$ ,  $p < 0.001$ . The model explained 29.1% (Nagelkerke  $R^2$ ) of the variance in red-light running and correctly classified 73.3% of cases.

Accordingly, results of the second logistic regression indicated that young age (18 to 24 years), intense work pace (>3.5 deliveries per hour), high tip income per day (>8 euros), and low concern about the vehicle condition were associated with reports of nonuse of the helmet. The logistic regression model was statistically significant,  $\chi^2(4) = 48.495$ ,  $p < 0.001$ . The model explained 14.9% (Nagelkerke  $R^2$ ) of the variance in nonuse of the helmet and correctly classified 64.1% of cases. Table 3 summarizes these results.

**Table 3**

Multivariate analysis for food delivery riders' reports of red-light running and nonuse of helmet

Traffic offense	Characteristics	Sig.	OR	95% CI
Red-light running	Rider's age (18–24 years)	*	2.90	[1.76 – 4.79]
	Work experience (<2 years)	**	2.22	[1.32 – 3.75]
	Use of personal vehicle for work (yes)	*	3.13	[1.80 – 5.45]
	Payment method (by hour)	**	2.06	[1.27 – 3.33]
Nonuse of helmet	Rider's age (18–24 years)	*	3.03	[1.85 – 4.96]
	Work pace (>3.5 deliveries/h)	***	2.07	[1.11 – 3.86]
	Tip income (>8 EUR/day)	***	1.69	[1.09 – 2.62]
	Concern about vehicle condition (low)	**	0.50	[0.32 – 0.77]

\* $p < 0.001$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.05$ .

Note: Sig. = significance; OR = odds ratio; CI = confidence interval.

#### 4. Discussion

This is the first study conducted in Greece attempting to examine the association of terms of employment, working conditions, and personal characteristics with different traffic offenses committed by food delivery riders. In total, 434 self-administrated questionnaires were analyzed aiming to shed light on the complex interrelationship of work-related factors underlying risk-taking practices. The main findings of this research can be summarized as follows: (i) typical health and safety measures (e.g., provision of PPE, employers' control over the use of the helmet) seem to have no effect on the reported traffic offenses and (ii) a marked difference was observed in the type of reported traffic offenses. On the one hand, there is a set of offenses that are understood as serious or "unacceptable" (i.e., red-light running or nonuse of the helmet) and, on the other hand, a larger group of offenses that are pervasive or "acceptable" and as such constitute a norm in the delivery riders community (i.e., unsafe lane splitting, driving the wrong way on one-way streets, driving with one hand or driving on pedestrian zones); and (iii) each of the two serious traffic offenses (i.e., red-light running and nonuse of helmet) seem to be related to differing sets of work conditions.

Regarding the first finding, namely no effect of typical health and safety measures on traffic offenses, it should be noted that two thirds of the respondents (about 65%) reported a lack of health and safety policy in their work. This is in line with previous reports in Greece about the estimated compliance of food delivery companies to safety and health rules [34,35] suggesting that—at least in this particular sociocultural context—delivery industry lacks safety culture thus making risk-taking acceptable for a delivery rider. This is supported by the vast majority of respondents (83%) reporting an intensive work pace (more than 3.5 deliveries per hour) suggesting that employers vastly promote fast delivery over self-protection. With this background, it is difficult to draw conclusions about the potential impact of typical health and safety measures in reducing risk behaviors of delivery riders. It seems more reasonable to say that in a working environment with a poor safety culture, provision of PPE, or other safety measures alone are not sufficient for ensuring responsible driving behavior because safety and work performance are evaluated on unequal terms both by the employers and the delivery riders alike. In fact, the triple pressure exerted, for different reasons, by employers, clients, and the riders themselves to disregard traffic rules to satisfy (i) the demand for fast delivery [32,37,40] and (ii) the need to make a living [1,6] results in a self-reinforcing loop that regenerates even more stressful working conditions and negative attitudes toward safety [45,46]. Although the questionnaire used in this study was not explicitly focused on the riders' attitudes toward safety, some insight is provided by the riders' responses ( $N = 190$ ) concerning the reason(s) for helmet nonuse. To describe the thematic content of the riders' responses, a coding frame was designed [47]. According to this, the majority of helmet nonusers reported that its use hindered work by (i) causing time delays while taking off and putting on the helmet several times per trip (71%), (ii) restricting their field of view while searching customers' address (18%), and (iii) thermal discomfort (5%). Some sporadic responses that could not be attributed in a category were named as "other" (6%). To inform measures for behavioral changes, further research is needed particularly in exploring delivery riders' and employers' attitudes towards safety. It is expected that increased motivation (e.g., through social marketing campaigns [48]) may have more impact on delivery riders' practices rather than compliance to typical, but only normative, health, and safety measures.

The aforementioned comments on the poor safety culture of delivery industry are also relevant to the second finding of this

study, i.e., delivery riders' norms about "acceptable" traffic offenses, as an inevitable part of this job. Evidently, the fact that at least 70% of respondents reported frequently committing particular traffic offenses (including driving the wrong way on one-way streets, driving on pedestrian zones, driving with one hand or unsafe lane splitting) is alarming. Provided that these offenses do involve significant risk, the aforementioned stance probably indicates either a compromise of delivery rider's safety under conditions of high job stress and job insecurity or a trade-off between the expected benefit of such traffic offenses (e.g., saving time) and the costs associated with them (e.g., fine imposed), as if neglecting the high personal cost of an eventual accident. Note that such compromises resulting in aberrant driving behaviors have also been reported in the literature for other professional drivers, such as public transport drivers [49,50] and bike messengers [51]. In this respect, it is worth noting that the riders' subjective differentiation between "acceptable" and "unacceptable" traffic offenses in a way reflects the classification of fines in the Greek Highway Code [44]. According to this, the so-called minor traffic offenses (including driving the wrong way on one-way streets, driving on pedestrian zones, driving with one hand or unsafe lane splitting) can be liable to a fine of up to 100 euros, whereas the so-called serious offenses (including helmet nonuse and running a red light) incur a three-month and permanent suspension of license, respectively. In future studies, particular attention should be paid on formally assessing the risk of the "acceptable" traffic offenses and communicating the consequences of such practices to the traffic system and to the riders' safety. It is also suggested to exploit experienced delivery riders knowledge both in raising public awareness of unsafe-driving behaviors and in shaping subjective norms. As previous studies show, peer opinions have a powerful influence on the adoption of a given behavior or not [52–54].

Finally, regarding the factors independently associated with serious traffic offenses (i.e., running a red light or helmet nonuse), results of the binary logistic regression showed a combined effect of personal and work-related characteristics. In both cases, traffic offenders tend to be young (18–24 years) which is a common finding in many previous studies [4,17,19,24]. However, each of the two offenses was found to be associated with a different set of work conditions, possibly outlining two different profiles of high-risk delivery riders. In particular, the "red-light runners" were more likely than other riders to be inexperienced at work, to use their personal vehicle for work, and to be paid by the hour. Instead, the "helmet nonusers" were more likely to be top median tip earners, to exert high rates of deliveries per hour, and to be less concerned about their vehicle condition. That is to say, the red-light runners appear to have a more informal type of employment (and type of incentives) and less work experience than the helmet nonusers. The aforementioned characteristics possibly make them more vulnerable to pressure from the employers and thus more willing to drive in a risky manner. On the contrary, the helmet nonusers appear to be self-motivated. They tend to be committed to their personal goal of increasing their profits through tips which is linked to their recognized need for a friendlier, face-to-face contact with customers. Indeed, this is supported by a number of studies showing that service employees' displaying positive emotions (e.g., providing a smile) enhance customers' satisfaction and their desire for leaving higher tips [55–59]. Provided that taking off and putting on the helmet several times per trip is a source of annoyance, they (delivery riders) end up driving without wearing one [32].

To address the issue of time pressure, as exemplified by the red-light runners' profile, a viable measure could be the establishment of legal coresponsibility of the employers for the traffic offenses committed by the delivery riders. Such a measure could act both as an inhibiting factor from employer's pressure and as an indirect

means of controlling the self-pressure of rider's themselves. This could also be applicable for the emerging gig-delivery platforms in which delivery riders are paid by the piece and are ranked solely in terms of delivery expedience [60,61]. Such a measure could thus help loosen the vicious link between pressure for expedience and job security or income.

To address the issue of the helmet use as a barrier to face-to-face contact with customers and thus tipping, as exemplified by helmet nonusers, a viable way could be to influence customers' awareness on safety issues and accordingly their evaluation criteria of delivery riders' services. In this way, wearing (or holding) a helmet while facing a customer along with protective clothing could be established as a symbol of socially responsible delivery service. Thus, linking customer tips with responsible service (along with friendliness) can act as an incentive for delivery riders to adopt safe practices.

Finally, young age being the common denominator of both high-risk delivery riders' profiles, in line with previous research findings, indicates that age is a critical risk factor. To address this issue, a number of complementary measures are necessary. In addition to compulsory initial training, harder measures should be considered such as a demerit point system for young delivery riders or even establishing an age threshold. Practically, the introduction of a demerit point system for young delivery riders (e.g. suspension of driving license if the number of points accumulated over a period of time exceeds a threshold) might be a viable measure.

#### 4.1. Limitations

A few limitations of this study are worth noting. Firstly, because of the lack of official records for the number of delivery riders per municipal department, sample selection in this study was based on the distribution of inhabitants in the corresponding seven municipal departments of the central Athens regional area. This involves the risk of a nonrepresentative sample which was partially addressed by using (i) a relative large number of participants and (ii) systematic sampling focused on a specific geographical area (i.e., central Athens) with homogeneous characteristics (e.g., distances traveled, density of routes, payment methods). Thus, systematic sampling allowed, at least, drawing conclusions for this particular population that may however differ in provincial or suburban areas in Greece. Secondly, self-reported information might include biases in the reporting of traffic offenses. To avoid response bias, the phrasing used for sensitive questions related to traffic offenses was carefully worded, i.e., “how often are you forced to commit (a particular traffic offense)”. The fact that all respondents reported at least one traffic offense and at least 70% reported frequently committing four of the six offenses mentioned in the questionnaire suggests that the respondents were at least not refraining from declaring their traffic offending [45]. However, the actual frequency of committed traffic offenses by delivery riders may be underreported. Therefore, the percentage frequency of each offense found in this study should be read with caution. Field observation studies are needed to be conducted in the future, to estimate the level of risk exposure of food delivery riders in Athens, Greece. Finally, the 24-item questionnaire used in this study did not include specific questions related to work stress, work overload, and work overtime which are frequently associated with road crashes of professional drivers [4,49]. Taking into account the multifaceted dimensions of work stress and work overload, a compromise was sought between the number of items on the questionnaire and the reliability of answers to sensitive emotive issues. To this end, objective indices such as deliveries per hour and working hours per day were used as an indirect measure of work pace and stress.

## 5. Conclusions

Working conditions of food delivery riders in Athens, Greece, show a lack of adequate safety culture. Within this working environment, the following conclusions can be drawn along with suggestions for further research:

1. A weak association between serious traffic offenses (i.e., red-light running and helmet nonuse) and employers' compliance with health and safety measures was found. This suggests that regulatory measures for enforcing normative compliance will only have a limited effect if not coupled with measures for delivery riders' and employers' attitudes toward safety. It is expected that increased motivation (e.g., through social marketing campaigns) may positively affect both employers' attitudes toward safety and delivery riders' driving behaviors.
2. Subjective norms of delivery riders about acceptable risk-taking are reflected through high rates of minor traffic offenses. Further research is needed on assessing the risk of the “acceptable” traffic offenses. Exploiting experienced delivery riders' knowledge is suggested as a means to positively affect the subjective norms of this community.
3. “Red-light running” and “helmet nonuse” seem to be associated with different pressures and/or motivations for delivery riders. To address the issue of employers' pressures, it is recommended to establish legal coresponsibility of the employers for the traffic offenses committed by delivery riders. To address the issue of delivery riders' tip-chasing, it is recommended to promote linking of customer tipping with responsible delivery services.
4. Finally, young age (18–24 years) was strongly associated with risky driving behavior. Therefore, the introduction of a demerit point system for young delivery riders or even the establishment of an age threshold should be considered.

## Conflicts of interest

All authors have no conflicts of interest to declare.

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