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Original Article

Self-Reported Musculoskeletal Problem during Stop-Go Driving: The Combined Variables Contribution towards Knee Pain among Car Drivers

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Abstract

Background: Musculoskeletal problems among drivers sourced from severe traffic congestion have become a substantial public health issue. Prominent driving risk exposures were deemed to inflict symptoms such as discomfort and ache among drivers that subsequently contribute to fatigue. This study aimed to investigate the relationship between frequency and period of getting stuck during driving through stop-go motion towards the prevalence of musculoskeletal problems. Moreover, several combined effects of parameters were investigated towards the experience of knee pain among drivers.

Methods: This study adopted a cross-sectional questionnaire survey method. The survey conducted in 2021 was randomly sampled among 18-year-old and above Malaysian drivers with valid driving license and the survey conducted through social media via an online Google form. To analyse the association and outcomes of the survey, Chi-Square and Binary Logistic Regression tests were used respectively.

Results: Overall, 320 drivers were recruited in this study. Data of 180 drivers who frequently stuck during peak hours in congestion was analysed with chi-square test that showed no significant relationship for both the driving exposure variables with the prevalence of knee pain during stop-go motion. Nevertheless, 92 (51.11%) drivers reported commonly experiencing knee pain symptoms from prolonged repetitive driving motion. The total sample of this study tested using regression analysis for combined effects of the parameters showed a significant ($P<0.05$) correlation of the drivers' experience of knee pain while driving in heavy traffic.

Conclusion: Generally, there are combined variables that contributed towards the occurrence of knee pain during stop-go driving in this study.

Keywords: Musculoskeletal pain; Fatigue; Knee pain; Driving

Introduction

Increase in life expectancy and quality of life means a growth in older adults driving around urban areas (1). This also means higher number of vehicles on roads and traffic congestion. Study by Sarker (2) observed that traffic congestion, rising at an alarming rate, is a national predicament in cities. This situation has imposed various adverse

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health effects in drivers, including musculoskeletal problems.

The World Bank, 2015 reported that Kuala Lumpur dwellers tend to travel at slower pace (29km/h) during the day peak time and spend on average of 250 million hours annually in the road congestion (3). The duration spent commuting amidst traffic congestion was considered long, in which longer period will result in repetitive motion of the lower limb.

Long durations of traffic jams require lower extremities to carry out motion that has been associated with varieties of musculoskeletal conditions including back and knee deformities. A study by Punnett discussed the prevalence of musculoskeletal inflammation and degeneration as results of frequent repetitive behavior (4). Similar activities may even cause ligament damages if carried out in an active manner as observed in past studies (5-7). In addition, the occurrence of knee pain is associated with the duration of driving. A secondary analysis study (8) stated that a driving duration of approximately 6 h is vastly linked to the occurrence of patellar pain. A study among taxi drivers for musculoskeletal disorders (9) reported a driving duration of more than 10 h for the same prevalence. Thus, an exact driving duration associated with musculoskeletal problems among drivers cannot be deduced owing to the different demographic and other independent variables.

Previous studies mainly researched the downside of driving activity related to traffic jams. Research by Khamis studied the drivers' engagement with the cars' pedals under a virtual traffic jam condition using a simulator (10). In a cross-sectional survey (11), the impairment of knee osteoarthritic drivers' performance during traffic congestion was emphasized. Several other cross-sectional studies (12-14) highlighted the relationship for drivers' fatigue condition with their safety of driving, by taking drivers' time of exposure into account. In this study, we aimed to bridge the gap by emphasizing the physiological effects in regard to knee pain symptoms. This study aimed to investigate the role of frequency and period of getting stuck during driving through stop-go motion that were expected to have most weightage and contribution towards the prevalence of musculoskeletal problems.

Materials and Methods

Questionnaire Development and Distribution

This cross-sectional study used questionnaire survey investigated the various driving exposure parameters, conditions towards the prevalence of musculoskeletal problems and the impact of optimum driving posture among drivers. The questionnaire prepared by adapting some relevant insights from Nordic Musculoskeletal Questionnaire such as identification of lower limb associated with musculoskeletal problems, the period of engagement and body's postural when carrying out activities as observed in Crawford's study (15). The questionnaire comprised of 28 questions in 5 different sections.

In the first section, the respondents' information form included a brief introduction, objectives, and the participants' eligibility criteria. Second section covered the participation consent ensuring they understood the scope of the research survey and voluntarily agreed to participate. Third section was the demographic particulars such as age, gender, weight, height, and type of car driven.

Next was the driving exposure, such as tendency of driving during peak hours, frequency stuck in congestion, car driven speed, phase of the day stuck in congestion and the location of musculoskeletal pain symptoms. In the final section, on respondents' health overview, the survey focused on the diagnosis of knee osteoarthritis and the effects experienced from driving in traffic congestions. This questionnaire structured with simple binomial or categorical responses.

A random sampling method utilized to distribute the questionnaire survey through social media (Emails, WhatsApp, and Telegram), via an online Google form. The inclusion criteria were Malaysian driver aged 18 yr and above with valid driving license. The study developed using a preliminary survey that was carried out to comprehend the level of understanding and time taken by the respondents to successfully answer all the questions. The respondents did not take more than 15 min to

complete the questionnaire. None of the respondents are truck or lorry drivers, most of the respondents are driving sedan cars, multi-purpose vehicles or sports utility vehicle cars.

Population Sample Size and Statistical Design

This study attained 320 responses. Incomplete or double responses were excluded. The amount of raw data obtained was sufficient based on Sudman's study (16) that highlighted responses for surveys to have at least 100 components from every prime group classification. This study has 14 predictors fulfilling Pallant's criteria for sample size with a minimum of 15 responses for every predictor intended for logistic regression analysis (17). The sample size calculation performed using G*Power 3.1.9.7 software considering the F-test statistical analysis with a power density of 95%, effect size of 0.15, 5% alpha error and 14 predictors, that suggested a minimum sample size of 194 participants for this study. The scale of data used were nominal and ordinal.

The data obtained analyzed statistically using SPSS ver. 5 (Chicago, IL, USA). The analyses divided into two groups: the targeted drivers' group and the total sample size. Drivers who regularly drive through traffic congestion during peak hours were regarded as the targeted drivers' group. Pearson's Chi Square test was used to evaluate the association ($P<0.05$) of the categorical parameters (frequency and period stuck in traffic congestion) towards the onset of knee pain for targeted drivers' group. Phi and Cramer's V values with the degree of freedom of 3 were used to study the effect size of the tested categorical variables.

For the total sample size group, 14 predictors were used in binomial logistic regression to find the collinearity of the various cumulative variables of interest with the prevalence of knee pain among drivers during stop-go motion. The dependent variable was the knee pain while the independent variables being the age, height, body mass, body mass index(BMI), tendency of driving during peak hours, frequency of getting stuck in traffic congestion, experiencing traffic congestion during weekend, experiencing traffic congestion during festive seasons, experiencing foot pain while/after driving through traffic congestion, experiencing calf pain while/after driving through traffic congestion, experiencing thigh pain while/after driving through traffic congestion, diagnosed with knee osteoarthritis (kOA), type of diagnosis and stages of kOA.

Participants' Demographic

The total sample size of the questionnaire was 320 (Male=140; Female=180). The respondents' mean height was 1.63 ± 0.09m, mean weight 64.14 ± 14.30kg, and mean BMI 24.13 ± 5.20kg/m^2. Out of 320, 180 (56.25%) respondents answered as "usually drives through traffic congestion during peak hour", and they were regarded as targeted drivers' group for this study. Table 1 showed the demographics.

Table 1: The age categories for the total sample size and targeted drivers' groups

Age Categories (years old)	Total Sample Size, n (%)	Targeted Drivers' Group, n (%)
20 – 24	189 (59.1)	97 (53.9)
25 – 29	50 (15.6)	29 (16.1)
30 – 39	35 (10.9)	23 (12.8)
40 – 44	4 (1.3)	2 (1.1)
45 – 49	7 (2.2)	6 (3.3)
50 – 54	23 (7.2)	15 (8.3)
55 - 59	12 (3.8)	8 (4.4)
Total, n	320 (100)	180 (100)

The demographics for the targeted drivers' group of 180 respondents (Male=76; Female=104) were: mean height=1.63 ± 0.10m, mean weight=64.23 ± 14.98kg, and mean BMI=24.15 ± 5.57kg/m^2.

Responses for kOA with clinical diagnosis reported 55 respondents to be normal (kOA stage 0), 14 stage 1, 8 stage 2, and 1 stage 4.

Ethics Approval and Consent to Participate

The study has acquired research ethics approval from University of Malaya Research Ethics Committee (UMREC) (UM.TNC2/UMREC – 208). The participation was voluntary, and all the participants read, confirmed, and provided their written informed consent in the questionnaire prior to answering questions. All particulars obtained from participants were held in strict confidentiality.

Results

Frequency Stuck

The frequency of getting stuck in traffic congestion was categorised into everyday (n=7), a few times per week (1≤ n ≤ 5), a few times per month (n > 1) and a few times per year (seldom getting stuck). From the targeted drivers' group, the frequency stuck in traffic congestion a few times per week showed the highest (48.3%) percentage of respondents, followed by getting stuck everyday with 45 (25%) respondents, a few times per month with 35 (19.4%) respondents and lastly, a few times per year with 13 (7.2%) respondents (Fig.1).

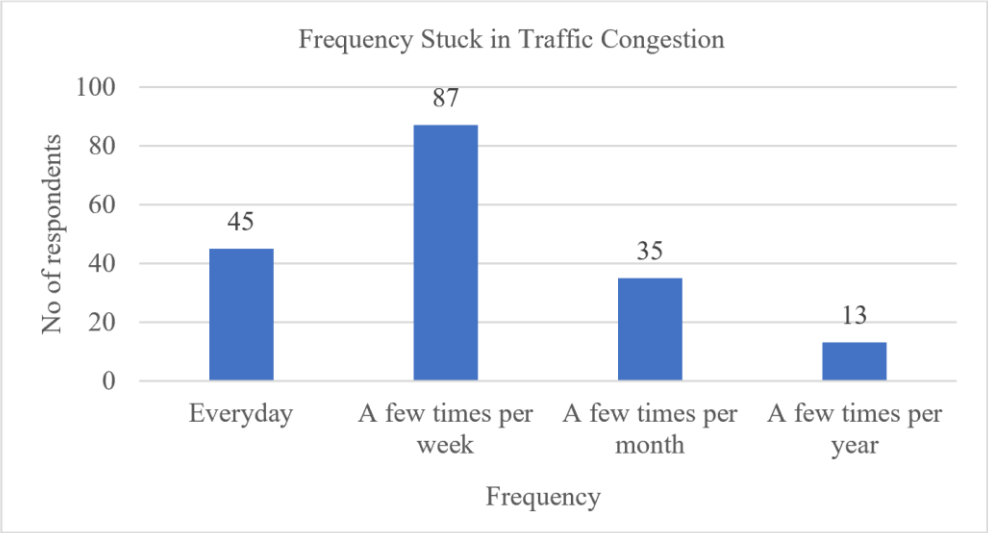

Fig. 1: The number of times targeted drivers' group stuck in traffic congestion

Period Stuck

The targeted drivers' group were asked about the average duration they get stuck in traffic congestion. The period stuck variable was calculated as: a person usually leaves their place at 8.00 am and reaches their destination at 8:30 am. If due to traffic congestion, the person reaches at 9.00am, the extra 30 min is considered as 'period stuck'.

From Fig. 2, 56.7% of the targeted respondents answered to have been stuck in traffic congestion for less than 1 hour. Only 39.4% respondents answered to be stuck for 1-2 h, 3.3% respondents answered to be stuck for 2-3 h and 0.6% respondent answered to be stuck for more than 3 h.

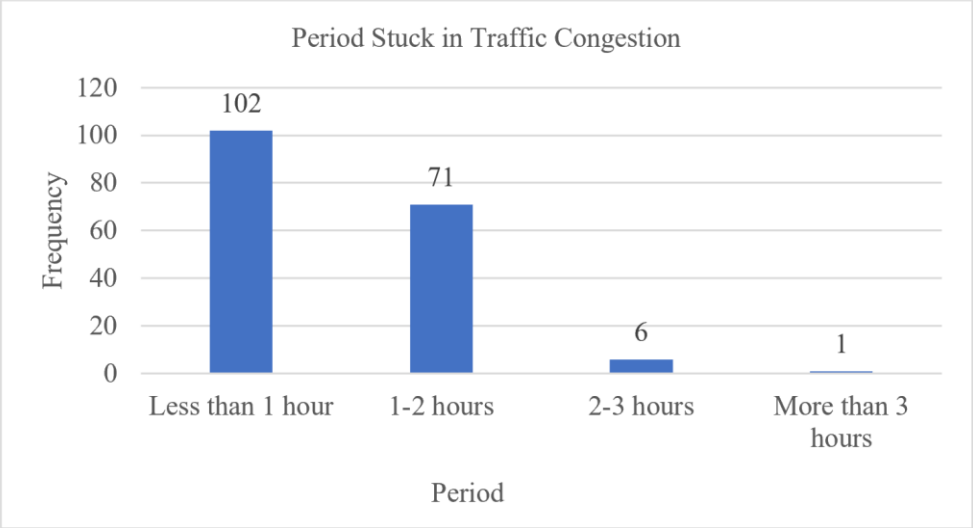

Fig. 2: The different period of targeted drivers' groups stuck in traffic congestion

Statistical Analysis of Driving Exposure Categorical Parameters

The driving exposure categorical parameters such as frequency stuck, and period stuck in traffic congestion were statistically tested using chi-square test to evaluate the significance of association for the targeted drivers' group experiencing knee pain symptoms while/after driving through traffic congestion. The significance determined was α=0.05. The test's null hypothesis (H_0) would indicate the absence of significant relationship between the categorical parameters and drivers experiencing knee pain symptoms. While, the test's alternative hypothesis (H_a) would indicate presence of significant relationship between the variables. The Phi and Cramer's V values from 2×4 table were used to indicate the strength of the association.

Relationship of frequency stuck and knee pain

Table 2 showed cross tab outcome for the targeted drivers' group when tested to evaluate their frequency stuck in traffic congestion with knee pain symptoms.

Table 2: The frequency stuck in traffic congestion and drivers experience of knee pain

Frequency stuck in traffic vs experience of knee pain symptoms Cross tabulation				
Count				
		Experience of knee pain symptoms		Total
		No	Yes	
Frequency stuck in traffic	A few times per year	9	4	13
	A few times per month	16	19	35
	A few times per week	43	44	87
	Everyday	20	25	45
Total		88	92	180

Pearson chi-square test revealed that the asymptotic significance (2-sided) value was 0.447 (P>0.05), whereas the symmetric measures for Cramer's V significance was 0.122 (showed below medium effect size) as medium effect size for df =3 is 0.17. Hence, analysis showed frequency stuck in traffic congestion has no statistical significance with experiencing knee pain symptoms among drivers.

However, a statement question 'driving in prolonged repetitive stop-go motion in heavy traffic can enhance the occurrence of knee pain' was asked and the majority of the respondents agreed to the statement. Overall, 128 (92.1%) respondents answered that prolonged repetitive motion can contribute to knee pain symptoms while 11 (7.9%) answered otherwise.

Relationship of period stuck and knee pain

Table 3 showed the crosstab outcome for the targeted drivers' group when tested to evaluate their period stuck in traffic congestion leading to knee pain symptoms.

Table 3: The period stuck in traffic congestion and drivers experience of knee pain

Period stuck in traffic vs experience of knee pain symptoms Cross tabulation				
Count				
		Experience of knee pain symptoms		Total
		No	Yes	
Period stuck in traffic	Less than 1 hour	51	51	102
	1 - 2 h	32	39	71
	2 - 3 h	5	1	6
	More than 3 h	0	1	1
Total		88	92	180

Table 3 showed the crosstab outcome for the targeted drivers' group when tested to evaluate their period stuck in traffic congestion leading to knee pain symptoms.

Pearson chi-square test revealed that the asymptotic significance (2-sided) value was 0.234 (P>0.05), whereas the symmetric measures for Cramer's V significance was 0.154 (showed below medium effect size) as medium effect size for df=3 is 0.17. Hence, analysis showed the period stuck in traffic congestion has no statistical significance with the experience of knee pain symptoms among drivers.

However, a statement question 'long duration drive in traffic congestion can enhance/increase the occurrence of knee pain' was asked and majority respondents agreed to the statement. Totally, 176 (97.8%) respondents who usually drive in traffic congestion agreed on the prevalence of knee pain due to prolonged driving based on their own experience of knee pain symptoms during the prolonged driving.

Variables of Interest

Since the targeted drivers' group who usually drive through traffic congestion during peak hours showed statistically non-significant correlation for the two categorical parameters, an overall total sample size of 320 was selected to interpret the possible contribution of independent variables towards the experience of knee pain symptoms

while/after driving through traffic congestion. A binary logistics regression was carried out for this purpose.

The overall observed data against predicted data classification accuracy was 78.1%. Hosmer-Lemeshow statistics showed 0.6 (P>0.05), non-significant value that indicated good fit of the model. There were many parameters included in the model to test the independent variables. The variables that showed statistical significance (P<0.05) were the tendency of driving during peak hours (P=0.030), experiencing thigh pain while/after driving through traffic congestion (P=0.008), type of diagnosis (P=0.040), and stages of kOA (P=0.047). The remaining 8 variables showed statistical insignificance (P>0.05).

Musculoskeletal Pain and Driving in Traffic Congestion

Driving through traffic congestion with repetitive stop-go motion can contribute to various pain symptoms. In Fig. 3, the 180 respondents who usually drive through traffic congestion have reported experiencing foot pain (64.44%) as the most common pain symptom, followed by knee pain (51.11%).

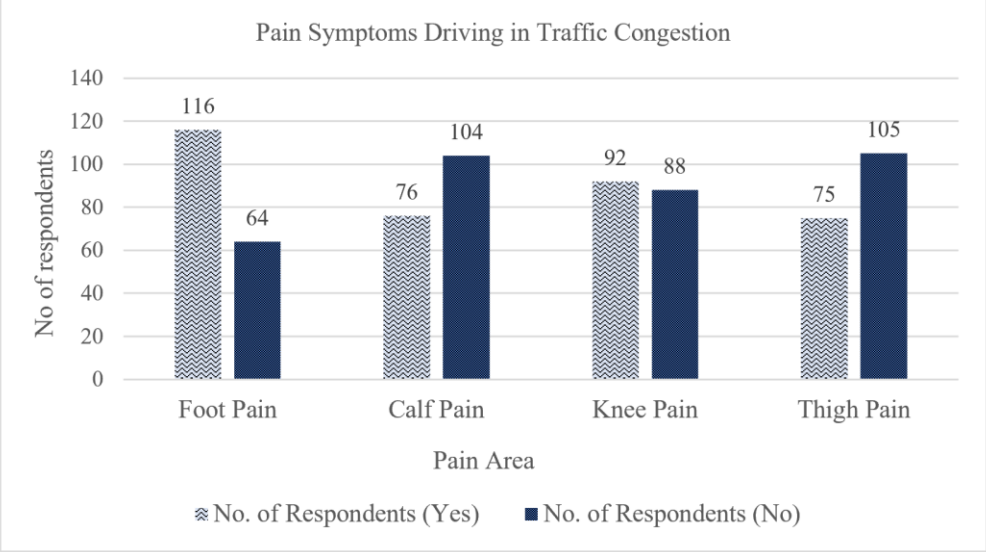

Fig. 3: The different types of pain symptoms during/after driving in traffic

Discussion

The purpose of this study was to evaluate the driving exposure parameters' association with the prevalence of musculoskeletal problems while driving through traffic congestion. The driving exposure parameters tested in this study comprised of mainly the frequency and period of getting stuck in traffic congestion.

The study carried out using an online questionnaire survey, as these studies (18, 19) suggested the usage of web-based questionnaires raise data quality. This study garnered a total sample size of 320 respondents and a targeted drivers' group of 180 respondents, where both the respondents' BMI groups classified into normal BMI (18.5–24.9 kg/m^2) in corroboration with Shafer's validity study (20).

48.3% of targeted drivers were stuck a few times per week, while 25% of the targeted drivers were stuck in traffic congestion on a daily basis. Laflamme (21) reported that despite the congestion surges from a.m. to p.m. rush hours, the period of traffic still relied on the day of the week as well, in which heavier congestion was observed from Monday to Thursday. Meanwhile, 56.7% of targeted drivers reported getting stuck in traffic congestion for less than 1 hour besides 39.4%

drivers experienced getting stuck for at least 1-2 h. Drivers get stuck during peak morning and evening, in agreement with previous studies (21, 22).

An occupational driving study among police officers has (23) reported that driving exposures such as the period and distance travelled had contributed to significant repercussion on the musculoskeletal pain. Fatigue-inducing driving conditions due to frequent and prolonged traffic congestion, likewise, can result in harmful effects to the musculoskeletal (8, 9, 18, 23, 24-28). Thus, the driving exposures in this study were statistically investigated with the prevalence of knee pain symptoms as the primary musculoskeletal pain. The knee pain symptoms comprised of numbness or ache when the knee was kept in prolonged active state. Contrary to the prediction, the frequency of targeted drivers stuck in traffic congestion showed no statistical significance in their experience of knee pain symptoms. Nevertheless, Szeto (29) discussed that the drivers' frequent motion can be associated to the knee/thigh pain based on the loading forces. From this study, 92.1% respondents agreed that prolonged repetitive motion can contribute to knee pain symptoms.

Binomial logistic regression of the total sample to compute combined contribution of the independent variables towards knee pain yielded 78.1% Hosmer-Lemeshow accuracy with significant association ($P<0.05$) for the tendency of driving during peak hours, experiencing thigh pain while/after driving through traffic congestion, type of diagnosis for kOA and stages of kOA. The tendency of drivers driving during peak hours constituted both the discussed driving exposures. This closely correlated with the prevalence of knee pain according to the previous studies. Prolonged and frequent driving exposures may lead to fatigue condition (24), and this was often experienced by the actively participated quadriceps or thigh muscles. Active repetitive joint motion may cause muscle acidosis that is linked with muscle fatigue and deterioration of proprioception (5). Thigh muscle fatigue and reduction of strength near patella may subsequently result in knee stiffness and debilitation/weakness (30). This later translates into knee pain. Additional determinants such as the diagnosis and stages of kOA made the drivers more susceptible to experiencing knee pain according to this study's finding. However, there are no past studies that researched the contribution of kOA towards the prevalence of knee pain among drivers through stop-go motion. Incidentally, a study on the prevalence of knee osteoarthritis (31) reported that the duration variable and kOA crepitus symptom during motion were associated with knee pain. Thus, combined variables contributed towards the prevalence of knee pain among drivers during stop-go motion.

The proportion of musculoskeletal pain experienced by drivers through stop-go motion was also studied in this cross-sectional survey. Majority of the targeted respondents reported foot pain (64.44%) as the most common pain, followed by knee pain (51.11%) due to prolonged driving. Several similar knee pain/discomfort prevalences due to driving were found in past studies (18, 26, 29, 32, 33). The reported knee pain in this study varied slightly from the past investigations. This could be due to the decision of selectively choosing only drivers who usually drive in prolonged stop-go condition. Such selective decision deemed important as to precisely address the consequences of prolonged frequent stop-go driving towards the prevalence of knee pain.

Although this study has garnered considerably large amount of data for analysis, some possible biases could present with the nature of the survey, such as the potential deviation in the self-reported responses, adopted drivers' knee posture and angle which could not be further explored. Despite the data reported anonymously, the scientific values provided were guaranteed, and scales of measures were recommended to use in order to limit the potential biases especially for the self-reported responses (12).

Conclusion

The period and frequency of repetitive driving exposures among 180 targeted drivers who usually drive during peak hours in traffic congestion

showed no statistically significant effects on experiencing knee pain. However, when an overall of 320 drivers were tested with logistic regression for a combined model of 14 variables, 4 variables showed significant contribution towards the occurrence of knee pain. This study is fundamental to evaluate the contribution of various parameters towards the prevalence of musculoskeletal problems among drivers.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Availability of Data and Materials

Datasets cannot be shared publicly because of University of Malaya Research Ethics Committee guidelines. Datasets are available from the University of Malaya (author) for researchers who meet the criteria for accessing confidential datasets.

Conflict of interest

The authors declare that there is no conflict of interests.

References

1. Cohen JE (2003). Human population: the next half century. *Science*, 302 (5648): 1172-1175.
2. Sarker VK, Gia TN, Ben Dhaou I, et al (2020). Smart parking system with dynamic pricing, edge-cloud computing and lora. *Sensors*, 20 (17): 4669.
3. Zachau, Ulrich, Shetty, et al (2015). Malaysia Economic Monitor June 2015 Transforming Urban Transport. The World Bank. Available from: https://www.worldbank.org/content/dam/Worldbank/document/EAP/malaysia/Malaysia_Economic_Monitor_June_2015.pdf
4. Punnett L, Wegman DH (2004). Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *J Electromyogr Kinesiol*, 14 (1): 13-23.
5. Ju YY, Wang CW, Cheng HY (2010). Effects of active fatiguing movement versus passive repetitive movement on knee proprioception. *Clin Biomech*, 25 (7): 708-712.
6. Kennedy JC, Alexander IJ, Hayes KC (1982). Nerve supply of the human knee and its functional importance. *Am J Sports Med*, 10 (6): 329-335.
7. Rozzi SL, Lephart SM, Gear WS, et al (1999). Knee joint laxity and neuromuscular characteristics of male and female soccer and basketball players. *Am J Sports Med*, 27 (3): 312-319.
8. Chen JC, Dennerlein JT, Shih TS, et al (2004). Knee pain and driving duration: a secondary analysis of the Taxi Drivers' Health Study. *Am J Sports Med*, 94 (4): 575-581.
9. Abledu JK, Offei EB, Abledu GK (2014). Occupational and personal determinants of musculoskeletal disorders among urban taxi drivers in Ghana. *Int Sch Res Notices*, 2014 (1): 517259.
10. Khamis NK, Md Deros B, Nuawi MZ, et al (2018). Pattern of muscle contraction in car pedal control. *J Kejuruteraan*, 30 (1): 23-29.
11. Hofmann UK, Jordan M, Rondak I, et al (2014). Osteoarthritis of the knee or hip significantly impairs driving ability (cross-sectional survey). *BMC Musculoskelet Disord*, 15: 1-9.
12. Useche SA, Alonso F, Cendales B, et al (2021). More than just "stressful"? Testing the mediating role of fatigue on the relationship between job stress and occupational crashes of long-haul truck drivers. *Psychol Res Behav Manag*, 1211-1221.
13. Alonso F, Esteban C, Useche SA, et al (2016). Prevalence of physical and mental fatigue symptoms on Spanish drivers and its incidence

on driving safety. *Adv Psychol Neurosci*, 1 (2): 10-18.
14. Useche S, Serge A, Alonso F (2015). Risky behaviors and stress indicators between novice and experienced drivers. *Am J Appl Psychol*, 3 (1): 11-14.
15. Crawford JO (2007). The Nordic musculoskeletal questionnaire. *Occup Med*, 57 (4): 300-301.
16. Sudman S (1976). *Applied sampling*. 1st ed. Academic Press Inc, New York.
17. Pallant J (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*. 7th ed. Routledge, London, pp.: 378.
18. Robb MJ, Mansfield NJ (2007). Self-reported musculoskeletal problems amongst professional truck drivers. *Ergonomics*, 50 (6): 814-827.
19. Van Gelder MM, Bretveld RW, Roeleveld N (2010). Web-based questionnaires: the future in epidemiology?. *Am J Epidemiol*, 172 (11): 1292-1298.
20. Shafer KJ, Siders WA, Johnson LK, et al (2009). Validity of segmental multiple-frequency bioelectrical impedance analysis to estimate body composition of adults across a range of body mass indexes. *Nutrition*, 25 (1): 25-32.
21. Laflamme EM, Ossenbruggen PJ (2017). Effect of time-of-day and day-of-the-week on congestion duration and breakdown: A case study at a bottleneck in Salem, NH. *J Traffic Transp Eng*, 4 (1): 31-40.
22. Marion T, Hugh (2017). Stuck in traffic: we need a smarter approach to congestion than building more roads. Grattan Institute, Australia. Available from: https://theconversation.com/stuck-in-traffic-we-need-a-smarter-approach-to-congestion-than-building-more-roads-84774
23. Gyi DE, Porter JM (1998). Musculoskeletal problems and driving in police officers. *Occup Med*, 48 (3): 153-160.
24. Zhang G, Yau KK, Zhang X, et al (2016). Traffic accidents involving fatigue driving and their extent of casualties. *Accid Anal Prev*, 87: 34-42.
25. Novak RD, Auvil-Novak SE (1996). Focus group evaluation of night nurse shiftwork difficulties and coping strategies. *Chronobiol Int*, 13 (6): 457-463.
26. Mozafari A, Vahedian M, Mohebi S, et al (2015). Work-related musculoskeletal disorders in truck drivers and official workers. *Acta Med Iran*, 432-438.
27. Kuijer PP, Van Der Beek AJ, Van Dieën JH, et al (2005). Effect of job rotation on need for recovery, musculoskeletal complaints, and sick leave due to musculoskeletal complaints: a prospective study among refuse collectors. *Am J Ind Med*, 47 (5): 394-402.
28. Torén A, Öberg K, Lembke B, et al (2002). Tractor-driving hours and their relation to self-reported low-back and hip symptoms. *Appl Ergon*, 33 (2): 139-146.
29. Szeto GP, Lam P (2007). Work-related musculoskeletal disorders in urban bus drivers of Hong Kong. *J Occup Rehabil*, 17: 181-198.
30. Peeler J, Christian M, Cooper J, et al (2015). Managing knee osteoarthritis: the effects of body weight supported physical activity on joint pain, function, and thigh muscle strength. *Clin J Sport Med*, 25 (6): 518-523.
31. Kaur R, Sharma VL, Singh A (2015). Prevalence of knee osteoarthritis and its correlation in women of rural and urban parts of Hoshiarpur (Punjab). *J Postgrad Med Educ Res*, 49 (1): 32-36.
32. Akinpelu AO, Oyewole OO, Odole AC, et al (2011). Prevalence of musculoskeletal pain and health seeking behaviour among occupational drivers in Ibadan, Nigeria. *Afr J Biomed Res*, 14(2): 89-94.
33. Karali S, Gyi DE, Mansfield NJ (2017). Driving a better driving experience: a questionnaire survey of older compared with younger drivers. *Ergonomics*, 60 (4): 533-540.