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Research article

Quantitative indicators of street lighting with mood, fatigue, mental workload and sleepiness in car drivers: Using generalized structural equation modeling

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ABSTRACT

Inadequate lighting will be associated with some degree of perceptual error such as sleepiness. The main purpose of this study was to investigate the interactions between mood, fatigue, mental workload, and sleepiness and their relationship with quantitative indicators of street lighting in passenger car drivers. The present study was a cross-sectional study that was performed on 270 drivers of passenger cars. The quantitative indices of lighting studied were illuminance, luminance, uniformity, and disability glare which were calculated using the Hagner device (EC1-L) and according to EN 13201 standard. Alertness and mood indices, fatigue scale (SAMN-PERELLI), mental workload (NASA-TLX), positive and negative affect schedule (PANAS) were used. Generalized structural equation modeling (GSEM) was used to investigate the relationship between mood, fatigue, mental workload, and drivers' sleepiness. Data analysis was performed in version 26 of SPSS software and version 14 of Stata software There is a significant relationship between illuminance and mood ($P < 0.001$). There is a significant relationship between the degree of disability glare on the streets and the mood ($P = 0.006$). There is a significant relationship between fatigue score and mood ($P < 0.001$) so that with increasing one unit in fatigue scale, mood score decreases by 0.669 units ($P < 0.001$). Finally, it can be assured that lighting interventions can be done as an effective way to increase alertness and reduce fatigue and the mental workload of drivers with the aim of reducing night traffic accidents.

1. Introduction

Road transport has an important impact on the implementation of the sustainable development plan of countries, and therefore much attention should be paid to road safety [1]. Traffic accident injuries are a major global public health concern [2]. According to the World Health Organization (2022), about 1.3 million people die each year due to road accidents [3]. More than half of the deaths

Abbreviations: GSEM, Generalized Structural Equation Modeling; PANAS, Positive and Negative Affect Schedule; VAMS, Visual Analogue Mood Scales; NASA-TLX, National Aeronautics and Space Administration Task Load Index; KSS, Karolinska Sleepiness Scale; TI, Threshold Increment.

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from road accidents are among pedestrians, cyclists and motorcyclists [3]. According to the legal medical statistics of Iran, accidents related to pedestrians in the city are 31.5% [4]. Traffic accidents have various factors such as human errors such as inattention and distraction, decision errors such as speeding, road and environmental infrastructure factors such as road type, geometric design, traffic control, lighting, and weather [5,6]. Although the traffic of vehicles, bicycles, and pedestrians is significantly lower during the night, more accidents than expected occur during this time. A very influential factor is the lack of night vision [7]. Driving is a complex task that involves three main factors: human (i.e. driver), vehicle, and environment [8]. Street lighting is effective in road traffic accidents, which needs to be investigated more carefully [9].

Sources of street lighting are car headlights and streetlights. The amount of light in the streets is divided into three specific areas based on the lighting by the headlights of the cars and the illuminance of the street lamps: 1. nearby area (10–40 m from the car), 2. middle area (40–60 m from the car), and 3. far area (more than 60 m from the car) [10]. Headlights are predominant in the nearby area. The role of car headlights and street lighting is almost equal in the middle area, however, the combination of these lights may not be effective in detecting all objects in this area. In the far areas, street lighting is predominant. Street lighting at distances beyond the range of car headlights allows drivers to predict the geometry of the road at long distances by increasing the detection of objects in the far areas [10].

Reduced visibility at night is one of the most important causes of driving accidents at night [1]. Also, psycho-physiological conditions that are influenced by various factors are important [11].

The study of the relationship between street lighting and road safety at night has begun several decades ago [12]. Inadequate lighting not only reduces vision, but is also associated with higher degrees of perceptual errors such as distraction, inattention, and sleepness [13]. Studies show that drowsiness causes 25-30% of driving accidents [14]. Visual and mental tasks are closely related [15]. Assessing the mental workload can be effective in road safety, as it can be useful in improving driving tasks to reduce the number of accidents that are more often attributed to drivers [15]. It is well documented that improper light stimulation can lead to sleep problems that can lead to mood disorders [16]. Studies have shown that exposure to light greatly affects performance, alertness, and mood [17]. Numerous studies have confirmed the hypothesis that with increasing street lighting, the ratio of night to day accidents decreases [18].

Therefore, as mentioned, due to the effect of quantitative lighting indicators on the modes of car drivers, is better, a study the effect of illuminance, luminance, uniformity and disability glare on the modes of car drivers. So the study was designed investigate to the relationship between mood, mental load, fatigue and sleepiness using generalized structural equation modeling (GSEM) and its relationship with quantitative indicators of street lighting to examine the extent to which each of the lighting indicators affects the drivers of passenger cars.

2. Method

The present study is an cross-sectional study in which a field method was performed to examine the indicators of street lighting on mood, fatigue, mental workload, and sleepiness.

2.1. Participants

In this study, the target population was passenger car drivers. The required sample size in this study was 270 which selected formula 1. Where $\alpha = 0.05$, $\beta = 0.2$ and $r = 0.16$.

Fig. 1. Zoning map of Kerman city.

$$n = \left(\frac{Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}}{0.5 \ln\left(\frac{1+r}{1-r}\right)} \right)^2 + 3 \tag{1}$$

Sampling in this study, the available sampling method has been used. The samples were selected from 5 streets with different intensities of illuminance, luminance, overall uniformity and disability glare. Then, a house was randomly selected from each street and the surrounding houses (from the right or left) were examined to reach the desired sample size. Before being selected to enter the study, quality of sleep, lifestyle, and mental health were interviewed and individuals were selected and entered into the study with the following conditions: voluntary participation in the study, having a driver's license, not consuming alcohol, and drugs [19], not taking sleeping pills and having a car, no history of stroke, no physical disability, no neurological problems such as epilepsy and having sleep disorders [20]. In addition, all participants participated in the research with informed consent. The questionnaire was completed with a full description of the study objectives and the participants were informed. Study protocol through the code of ethics IR.SSU.SPH.REC.1400.155 approved by the University Ethics Committee.

2.2. Lighting measurement

In order to sample, first, the city was zoned (Fig. 1), then five districts were randomly selected from among the districts and one street was selected from each district and then the units were selected using convenience sampling.

Method EN13201:2015 standard has been used to measure quantitative indicators of lighting [21]. The studied indices are illuminance, luminance, disability glare, and uniformity of light. The Hagner luxmeter (EC1-L) and luminance meter (Hagner-S4) were was used to measure the lighting indicators. The device calibration was checked by darkening the surface of the receiving cell.

The measurement method according to this standard is as follows:

The calculation of illuminance should be in the longitudinal direction between two light sources in a row and the observer should be 60 m away from the first light source.

In the longitudinal direction:

The points selected to measure the illuminance should be obtained according to Formula 2:

$$D = \frac{s}{N} \tag{2}$$

In this formula, D is the distance of points in the longitudinal direction in meters, S is the distance of light sources in a row in meters, and N is the value of points calculated in the longitudinal direction.

In the transverse direction:

The distance d in the transverse direction is obtained from formula 3:

$$d = \frac{w}{r} \tag{3}$$

In this formula, d means the distance between points in the transverse direction (meters) and W is the width of the driving path in meters.

The luminance of the passages at night was measured by a Hanger-S4 Luminance Meter at the grid points in the field, and the average luminance was obtained by the arithmetic mean averaging of the luminosities.

To increase the disability glare parameter of the street light, the threshold increment (TI) parameter was used.

Threshold increment (TI) is obtained using formulas 4 and 5:

$$\mathrm{TI} = \frac{65}{(average\ road\ luminance)^{0.8}} \times \%L_v \tag{4}$$

$$L_v = \sum_{k=1}^{n} \frac{E_k}{\theta_{k^2}} = \frac{E_1}{\theta_{1^2}} + \frac{E_2}{\theta_{2^2}} + \frac{E_3}{\theta_{3^2}} \ldots. + \frac{E_n}{\theta_{n^2}} \tag{5}$$

In this formula, L_v is equivalent to the equivalent lighting (cd/m2), E_k is the light produced by K's new mode light source, perpendicular to the line of sight, and at the height of the observer's eye, θ_k is the angle (in degrees) of the arc between the line of sight and The line between the observer and the center K is the source of light.

Light overall uniformity is defined as the uniform distribution of light in an environment or space. Formula 6 has been used to calculate the uniformity:

$$U_{o=} \frac{E_{min}}{E_{ave}} \tag{6}$$

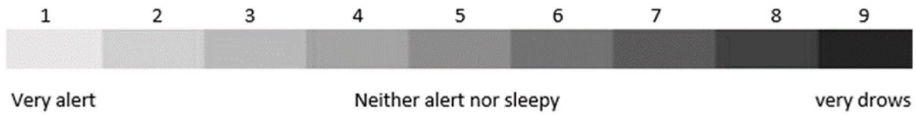

Fig. 2. Sleepiness index ranking (Mental consciousness) Karolinska.

In this formula, E_{min} is the lowest illuminance anywhere in the network in the calculation field and E_{ave} is the average ambient illuminance.

2.3. Questionnaires

The questionnaire used in the research is 42 questions, which include Positive and Negative Affect Schedule (PANAS)[22], Fatigue Scale (SAMN-PERELLI) [23], Mood Index (Visual Analogue Scale for Mood: VAMS) [24], Mental workload (The National Aeronautics and Space Administration Task Load Index: NASA-TLX) [25], Sleepiness Index (Karolinska Sleepiness Scale: KSS) [26]. The samples were asked about demographic information such as age, gender, degree of education, accident history, driving experience, vision status. The questionnaire was completed with a full description of the study objectives and the participants were informed. The PANAS measures two subscales of positive emotion and negative emotion on a five-point likert scale from one (by no means) to five (very high). Cronbach's alpha obtained is above 70% [27]. The SAMN-PERELLI has 17 questions and each question is based on a 5-point likert scale (1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high) [28]. An eleven-point VAMS index was used to assess mood. In this index, a score of zero is used for a very bad mood and a score of 100 is used for a very good mood [24]. The NASA-TLX questionnaire was used to assess mental workload. NASA-TLX is a multifaceted tool for assessing individual mental workload. Numerical values are not used in this scale, but the scale from 1 to 100 is assumed [30]. The KSS was used to measure the level of sleepiness [29]. The KSS scale is a self-reported method for measuring sleepiness (Fig. 2) This method includes a 9-point likert scale (1 = very alert, 3 = alert, 5 = neither alert nor sleepy, 7 = sleepy, and 9 = very sleepy and trying to stay awake) [31]. The Cronbach's alphas in the current study are 0.89 and 0.74 for SAMN-PERELLI and PANAS, respectively.

2.4. Data analysis

In this study, the data were described using frequency, median, and interquartile range, and a correlation coefficient was used to examine the relationship between variables. Also, the GSEM model was used to investigate the relation between sleepiness, mood, positive and negative emotions, fatigue, and mental workload. Data analysis was performed in version 26 of SPSS software and version 14 of Stata software and the value of 0.05 was considered as a significant level. Maximum likelihood method was used to fit the model.

3. Results

As shown in Table 1, 41.9% of participants were in the age range of 36–50 years. The majority of participants in this study were male (61.5%). 71.9% of the participants in this study were married. 46.7% of them had an Associate degree and below, 75.5% of them had good eyesight. Participants often had a driving experience of 1–10 years (38.9%). 76.7% of them had a history of accidents

Table 1
Frequency distribution of the studied samples in terms of demographic variables (n = 270).

Variable	Level	Frequency	Percentage
Age (year)	19–35	96	35.6
	36–50	113	41.9
	51–65	61	22.5
Gender	Male	166	61.5
	Female	104	38.5
Marital Status	Single	211	78.1
	Married	59	21.9
Degree of Education	Associate degree and below	126	46.7
	Bachelor's degree	91	33.7
	Master's degree and above	53	19.6
Vision Status	Good	204	75.5
	Medium and bad	66	24.5
Driving Experience (year)	0–10	105	38.9
	11–20	104	38.6
	21–30	46	17
	31–40	15	5.6
Accident History	0–4	207	76.7
	5–8	50	18.5
	9–12	10	3.7
	13–16	3	1.1

Table 2
Relationship between mood, positive emotion, mental workload, fatigue and sleepiness with demographic variables.

Variable	Demographic variables																						
	Vision status					Degree of education							Gender					Marital status					
	Good		Medium and Bad		P-value*	Associate degree and below		Bachelor's degree		Master's degree and above		P-value*	Male		Female		P-value*	Married		Single		P-value*
	Median	Interquartile range	Median	Interquartile range		Median	Interquartile range	Median	Interquartile range	Median	Interquartile range		Median	Interquartile range	Median	Interquartile range		Median	Interquartile range	Median	Interquartile range	
Mood	70	20	70	30	0.148	70	30	80	20	80	15	P < 0.001	70	22.5	70	20	0.244	70	30	80	20	P < 0.001
Positive emotion	45	7	45	6	0.646	45	7	44	5	45	8	P < 0.001	45	6	44	7	0.078	45	7	45	6	0.28
Mental Workload	39.42	21.16	51.46	24.6	P < 0.001	43.99	24.04	38.74	22.46	39.62	20.15	0.105	42.33	25.04	36.76	19.63	0.08	42.61	24.82	38.25	17.11	0.43
Fatigue	25	10	31	13.25	P < 0.001	29	10.25	24	11	24	8.5	P < 0.001	27	12	25	10.75	0.39	28	12	22	7	P < 0.001
Sleepiness	3	0	3	0	0.605	3	0	3	0	3	1	0.109	3	0	3	0	0.207	3	0	3	2	0.01

* A value of 0.05 was considered as a significant level.

Table 3
Relationship between mood, negative-positive emotion, mental workload, fatigue, and sleepiness with demographic variables.

Variable	Driving experience		Accident history		Age	
	Correlation coefficient	P- value*	Correlation coefficient	P-value*	Correlation coefficient	P- value*
Mood	−0.327	P < 0.001	−0.163	0.007	−0.285	P < 0.001
Positive emotion	−0.13	0.032	0.17	0.005	−0.217	P < 0.001
Mental Workload	0.157	0.01	0.035	0.565	0.134	0.028
Fatigue	0.382	P < 0.001	0.0223	P < 0.001	0.422	P < 0.001
Sleepiness	0.254	P < 0.001	0.203	0.01	0.265	P < 0.001

* A value of 0.05 was considered as a significant level.

Table 4
Investigation of the relationship between quantitative indicators of lighting with sleepiness, fatigue, positive-negative emotion, mood, and mental workload in car drivers.

Quantitative indicators of lighting.	Variable	Correlation coefficient	P-value
Illuminance	Sleepiness	−0.232	P < 0.001
	Fatigue	−0.301	P < 0.001
	Positive emotion	−0.032	0.606
	Mood	0.0344	P < 0.001
	Mental Workload	−0.22	P < 0.001
Luminance	Sleepiness	−0.232	P < 0.001
	Fatigue	−0.301	P < 0.001
	Positive emotion	−0.032	0.606
	Mood	0.344	P < 0.001
	Mental Workload	−0.22	P < 0.001
Overall uniformity	Sleepiness	−0.225	P < 0.001
	Fatigue	−0.254	P < 0.001
	Positive emotion	−0.021	0.725
	Mood	0.32	P < 0.001
	Mental workload	−0.172	0.004
Disability glare	Sleepiness	0.173	0.004
	Fatigue	0.017	0.783
	Positive emotion	0.116	0.056
	Mood	−0.165	0.006
	Mental workload	0.007	0.915

between 1 and 4 accidents.

The results of Tables 2 and 3 show that there is a relation between positive emotion and the variables age ($P < 0.001$), driving experience ($P = 0.032$), history of accidents ($P = 0.005$), and degree of education ($P < 0.001$). Based on the results, no significant relation was observed between gender ($P = 0.078$), marital status ($P = 0.28$), visual status ($p = 0.646$), and positive-negative emotion. There is a significant relation between mental workload and age ($P = 0.028$), driving experience ($P = 0.01$), and visual status ($P < 0.001$). Also, according to the results, there was not a meaningful relationship between the variables of a degree of education ($P = 0.055$), gender ($P = 0.08$), marital status ($P = 0.43$), and history of accidents ($P = 0.565$) and mental workload. There is a significant between fatigue and age ($P < 0.001$), driving experience ($P < 0.001$), accidents history ($P < 0.001$), degree of education ($P < 0.001$), marital status ($P < 0.001$) and visual status ($P < 0.001$). Also, no significant relation was observed between gender and fatigue ($P = 0.39$). There is a significant relation between sleepiness and age ($P < 0.001$), marital status ($P = 0.01$), driving experience ($P < 0.001$) and accident history ($P = 0.01$). But among the variables, degree of Education ($P = 0.109$), gender ($P = 0.207$) and visual status ($P = 0.605$) were not significantly related with sleepiness.

Findings of the effects of quantitative indicators of light on sleepiness, fatigue, negative-positive emotion, mood, and mental workload are reported in Table 4. There is a significant correlation between the illuminance of streets and sleepiness index (KSS), fatigue, mood, and mental workload ($P < 0.001$). There is a significant correlation between different levels of luminance and fatigue, mood, and mental workload ($P < 0.001$). There is a significant correlation between light uniformity and sleepiness ($P < 0.001$), fatigue ($P < 0.001$), mood ($P < 0.001$) and mental workload ($P = 0.004$). There is a significant correlation between disability glare and sleepness ($P = 0.004$). There is a significant correlation between the degree of disability glare on the streets and the mood of car drivers ($P = 0.006$).

To investigate the relation between the variables of sleepness, fatigue, positive-negative emotion, mood, and mental workload in-car drivers in Kerman, a GSEM has been fitted, the results of which are presented in Table 5. Based on the results, there is a significant relationship between mental workload and mood ($P < 0.001$) so that with each unit increase in mental workload score, mood score decreases 0.259 units. Mental workload also has a significant effect on fatigue ($p < 0.001$) so that with each unit increase in mental workload score, fatigue score also increases by 0.353 units. Also, with increasing the fatigue scale , the mood score decreases 0.669 units ($p < 0.001$). Based on the results, fatigue also has a significant effect on the sleepiness score, so that odds of awareness multiply by 0.87 for each unit increase in fatigue score ($p < 0.001$). The results show that with each degree of decrease in consciousness, the mood score decreases by 3.469 units ($p < 0.001$). Path coefficients are also given in the concept model in Fig. 3, and significant relations are

Table 5
Results of the GSEM in investigating the relationship between the variables of sleepness, fatigue, positive-negative emotion, mood, and mental workload in passenger car drivers.

Structure	Coefficient	Standard Error	z	P
Moods < - Fatigue	−0.669	0.098	−6.78	p < 0.001
Moods < - Mental workload	−0.259	0.056	−4.57	p < 0.001
Moods < - Sleepness	−3.469	0.624	−5.56	p < 0.001
Fatigue < -Mental workload	0.353	0.0315	11.20	p < 0.001
Emotional positive - negative < - Moods	−0.005	0.032	−0.17	0.866
Emotional positive - negative < - Mental workload	0.029	0.031	0.94	0.347
Emotional positive - negative < - Sleepness	−0.251	0.362	−0.69	0.489
Sleepness < - Mental workload	−0.003	0.011	−0.31	0.759
Sleepness < - Fatigue	0.128	0.019	6.49	p < 0.001

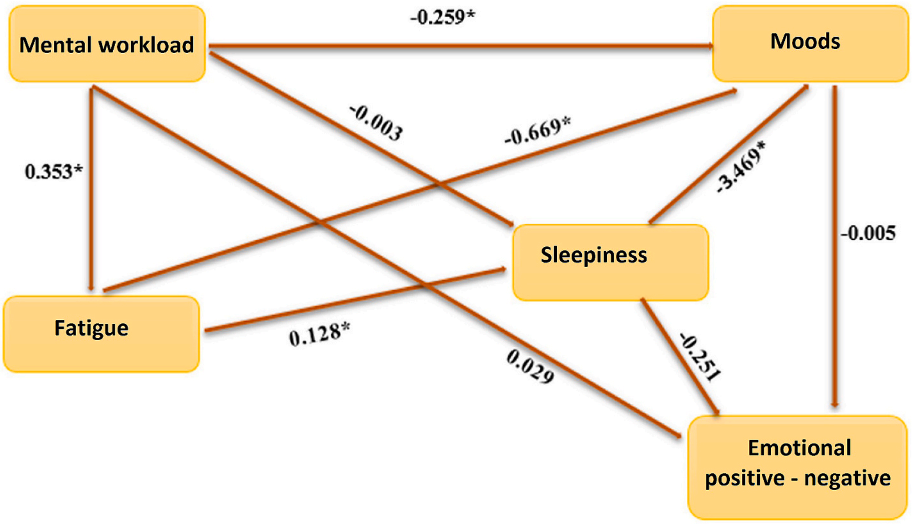

Fig. 3. Conceptual model with an estimation of path coefficients isGSEM.

indicated by the * sign.

4. Discussion

This study aimed to investigate the relationship between mood, mental workload, fatigue, and sleepiness in car drivers and their relationship with quantitative light indicators. According to the findings of other countries, street lighting had a huge impact on the mood of car drivers. These findings reflected the positive consequences of using appropriate lighting on the roads to control the mental and emotional states of drivers, as well as the interaction of different drivers' moods while driving at night. These findings show the importance of using proper street lighting in drivers' situations and reducing the risk of accidents and suggest that to control the number of accidents, the amount of street lighting and drivers' mental and emotional states should also be considered.

In the present study, the results showed that at different levels of illuminance, with increasing illuminance, sleepiness in car drivers decreases. The present study was consistent with the study of Ahlstrom et al in 2018 on the factors affecting sleepiness concluded that with increasing illuminance, sleepiness in people decreases [32].

According to the results of this study, at different levels of the illuminance of streets, in streets where the illuminance is higher, fatigue is reduced. The present study is consistent with the study of Mohebian et al. Mohebian et al. conducted a study in 2017 to examine the quality of sleep and mental fatigue at different levels of light. They concluded that in environments with insufficient lighting, sleep quality decreases, and the rate of mental fatigue and error increases [33].

According to the results of the present study, the illuminance of the street has a significant effect on the mood of car drivers. This effect is direct, as the illuminance of the street increases, the mood among the subjects is significantly improved. Veronica et al. conducted a study in 2015 to examine the effect of bright light on mood. They concluded that exposure to bright light can improve mood levels [34].

According to the findings of this study, the illuminance of the street has a significant relation with the mental workload of passenger car drivers. As the illuminance increases, the mental workload of passenger car drivers decreases. In 2021, Bao et al. conducted a study to investigate the effects of illuminance and colour temperature on mental workload. They reported that the effect of color temperature and illuminance on participants' mental workload was not clear [35].

According to the results of this study, the state of luminance is associated with fatigue and sleepiness. By changing the state of luminance and increasing it, fatigue and sleepiness in people can be reduced. The present study is consistent with the study of Brown et al. Brown et al. Reported in 2015 reported that increased luminance reduced cognitive fatigue and alertness in employees [36].

According to the results, there is a significant relationship between the luminance of the street and mental workload. In other words, with the increase of the level of luminance of the streets, the mental workload of the drivers of passenger cars decreases. Oner et al., reported in 2020 that no significant relation was found between luminance and mental workload [37].

Based on the results, it can be seen that luminance has a significant relation with mood. This effect is direct, by increasing the luminance, the mood among the people improves. Li et al. reported that mood, cognitive performance and alertness of the participants are related to luminance and color temperature [38].

Based on the findings of the present study, it can be concluded that there is a significant relationship between the uniformity of street lighting and the sleepiness of car drivers. As the uniformity of the lighting of the passages increases, the sleepiness of the drivers of the passenger cars decreases, and the level of consciousness in them increases. Oner et al. according to the KSS, it is reported that participants are more alert when the light distribution is more uniform [37].

Based on the results, it was found that there is a significant relationship between the uniformity of lighting and fatigue, which is an inverse relation. This means that in return for increasing the uniformity of lighting, fatigue among the samples decreased. The present study is consistent with the study of Farokhzad et al. Farokhzad et al. conducted a study in 2015 to investigate the effects of light uniformity on fatigue. They reported that experiments and analyzes would reduce visual fatigue and mental states in individuals by increasing the light uniformity [39].

According to the findings, there is no significant relation between disability glare and mental workload and fatigue, i.e. with a change in the level of the disability glare of street lighting; there is no change in the amount of fatigue and mental workload of car drivers. On the other hand, Glimne et al. reported results in 2019 that were contrary to the results of the present study [40].

Based on the results, there is a significant difference between the levels of light uniformity and mood. In other words, by increasing the uniformity of lighting, the mood of the drivers of passenger cars improves. Light can affect brain activity, physiological responses and cognitive performance.[41].

According to the results of this study, there is a significant relation between disability glare and sleepiness. The light may cause glare to drivers and pedestrians, which is a serious issue for traffic safety [42].

According to the results of this study, the glare of street lights has a significant relationship with the mood of passenger car drivers. By reducing the glare of the passages, the mood in people improves. Randi et al. glare has been reported to cause visual discomfort and stress in people. The result of this effect can be a decrease in mood [43].

Based on the results of GSEM, the mental workload has a significant relationship with fatigue. As the volume of mental work increases, so does the fatigue of car drivers. Studies have shown that people with high mental workload due to fatigue cause memory dysfunction and disruption in their thinking process [44].

According to the findings of the GSEM, with increasing fatigue, the mood in the drivers of passenger cars decreases and goes towards a bad mood. The present study has a significant relationship with the study of Matcham et al. In 2015, they conducted a study that reported that in a bad mood, fatigue increases in people [45].

This study, like other studies, has some limitations. Participants in this study were relatively young and middle-aged, due to the potential changes in the retina and the neural structure of the eye due to aging, caution should be exercised in direct generalization of the results of the present study to older groups [31]. We tried to use the people who have the most traffic on the selected street. In addition, streets were selected in which the lighting was significantly different from each other. This approach, while increasing the accuracy of the results as a positive point, is likely that the generalization of the results to people's daily lives, has reduced.

Following the results of previous studies, the present study, based on the evidence of the effect of quantitative indicators of light on the mood, fatigue, mental workload, and sleepiness, suggests that by changing the lighting levels and optimizing the lighting of passages, and performing interventions from this Such as an effective solution to reduce mental workload and fatigue and improve mood. It should be noted that more studies are needed to decide on the appropriate amount of lighting for coping strategies.

5. Conclusion

Under natural conditions, indicators such as illuminance, luminance, and uniformity of light have a significant relationship with mood, fatigue, mental workload, and sleepiness, and there is a way to deal with them. In the glare of light, it was concluded that they were inversely related to mood. With the increase of glare in the passages, the mood in people decreases, in a sense, glare is also related to sleepiness. It was observed that in the streets where there is a lot of glare, sleepiness among the drivers of the cars on that street has significantly increased and the level of consciousness of the drivers has decreased. According to the GSEM, the mental workload is related to mood in passenger car drivers. By reducing mental workload, the level of consciousness and mood in drivers of passenger cars improves. Mental workload is also significantly associated with fatigue. In a way, with the increase of mental workload in the drivers of passenger cars, fatigue also increased in them. Finally, according to the GSEM, sleepiness and fatigue have a significant relationship that with increased fatigue in passenger car drivers causes the sleepness.

Author contribution statement

Rohollah FallahMadvari: Conceived and designed the experiments; Wrote the paper.

Reyhane Sefidkar: Analyzed and interpreted the data.

Golam Hossein Halvani: Contributed reagents, materials, analysis tools or data.
Hesam Mohammad Alizadeh: Performed the experiments; Wrote the paper.

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Data availability statement

Declaration of interest's statement:
The authors declare no conflict of interest.

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