Review Article

Bull Emerg Trauma 2023;11(1):1-12.

Bulletin of Emergency And Trauma

Driving Hazard Perception Components: A Systematic Review and Meta-Analysis

***Yasaman Habibzadeh*[1], *Mohammad Hossein Yarmohammadian*[1*], *Homayoun Sadeghi-Bazargani*[2]**

[1]*Department of Health Services Management, School of Management and Medical Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran*
[2]*Road Traffic Injury Research Center, Tabriz University of Medical Sciences, Tabriz, Iran*

***Corresponding author:** *Mohammad Hossein Yarmohammadian*
Address: Department of Health Services Management, School of Management and Medical Information Sciences, Isfahan University of Medical Sciences, Isfahan, Iran. **Tel:** +98-9117423813
e-mail: y_habibzadeh@yahoo.com

Received: May 10, 2022
Revised: December 12, 2022
Accepted: December 25, 2022

ABSTRACT

Objective: To estimate the rate of driving hazard perception (HP), explicate the content of HP and determine its components.
Methods: The present study is a systematic review and a meta-analysis which is carried out to gather data, to search Science Direct, PubMed, Scopus, PROQUEST, web of knowledge databases, Google scholar search engine and also to search manually from January 2000 to September 2021 with using related keywords. EndNote X20 software was used to manage and screening studies. Stata16 was used for meta-analysis. Thematic content analysis was used to analyze the findings. The entire review process was conducted by two authors, and disputes were referred to a third person.
Results: Out of the 1167 founded articles, 50 were finally included in the study. According to 10 imported papers for meta-analysis includes 2770 sample size, general HP of drivers is estimated 3.33 [4.04-2.62 with CI 95, I2=89.72]. Also, HP for experienced and beginner drivers is estimated 3.26 [2.23-4.26 with CI 95, I2=89.47] and 3.42 [2.41-4.43 with CI 95, I2=89.68], respectively. Also, in the data meta-synthesis, 28 definitions of HP and 6 main components are identified to evaluate HP using thematic content analysis.
Conclusion: In this study, obtained results show that all people need constant and gradual training at all levels. A factor that can be effective to improve drivers' HP is to make drivers to take training courses and to pass standard tests at the time of obtaining driving license.

Keywords: Hazard; Perception; Traffic accident; Automobile drivers; Component.

Please cite this paper as:
Habibzadeh Y, Yarmohammadian MH, Sadeghi-Bazargani H. Driving Hazard Perception Components: A Systematic Review and Meta-Analysis. *Bull Emerg Trauma*. 2023;11(1):1-12. doi: 10.30476/BEAT.2023.95410.1356.

Introduction

Nowadays in the world particularly in Low-Middle income countries (LMIC), traffic accidents and its consequent injuries are the most important and the main factors of disability and death [1, 2]. That, death casualty because of traffic accidents is over 1.36 million annually worldwide and around 50 million are also injured each year [3]. Traffic incident is the main reason for casualty among

5-20-year-old people around the world [4], as well. Although, corrective activities were implemented in all countries especially LMIC in 2013 to reduce the traffic accidents and to safe the roads, there isn't still any significant reduction in the number of traffic accidents and its complications[5]. Therefore, World Health Organization (WHO) predicts that traffic accidents will be one of the biggest future problems of the world [6, 7].

Findings of studies show that traffic accidents are preventable [8-14] and discriminating the nature of cause and effect has a significant effect on preventing RTIs [10, 15]. Researches performed on traffic accidents mentioned three factors of human, road and vehicle as elements cause the accidents. Among mentioned factors, human factor is identified as the most important factor causes these incidents [16]. Human errors are the reason of 95% of traffic accidents [17]. Based on international reports, passengers of vehicles have the highest mortality rate among road users in 2020. About one third (32%) of mortality rate caused by accident is related to the ages of 15 to 17 [18]; this rate decreases substantially after getting driving license and by maturing and gaining experience in driving [19]. Higher rate of accidents among fresh young drivers is related to their failure to recogne driving dangers and their reaction towards them [20, 21]. Several studies consider the traffic incidents occurrence rate directly relevant to the level of driver's skills in recognizing and reacting of driving hazards [21-23].

Hazard is defined as "the probability of a vehicle collision with a moving or stationary object or its deviation of road because of changing its speed or direction" [24]. In other words, hazard is defined as a dangerous, unsafe and unusual driving event [25]. Factors such as pedestrian, motorist or cyclist, unusual object on the road, pedestrian sidewalk on highway, the car that is parking, road construction sites, traffic control equipment, road side entrance to main road, front car breakdown or warning and other thereof factors are included as driving hazards [26, 27].

HP have been investigated by researches for decades (the first paper was presented by Spicer in 1964 cited by Plez and Krupat, 1974) [28]. Lots of studies have examined HP, measurement methods and factors affecting it, in which different definitions are given. In these studies, expressions related to hazard are often used interchangeably; such as hazard recognition [29], HP [20, 29, 30], hazard prediction[31], and awareness of hazard [32, 33]. Not only are these expressions independent [34], but sometimes studies that use these terms also offer adverse meanings. As an example, HP is defined as ability to recognize situations of the road danger [35], to predict the hazard signs [36], to identify and respond the dangers [30], to have the early detection of hazards [37] or the process of risk awareness [38]. In addition, several studies have also failed to identify correct and measurable terms for HP [29, 39].

Regrading to the importance of HP and its key role in declining accident occurrence, having an accurate and clear definition of the term can be helpful for authorities in setting transparent policies to prevent accidents and also for researches of this field. Therefore, by the purpose of conducting a systematic review in this field, current study tries to gather driving HP and its available definitions in different studies and to explicate HP concept and determine its dimensions.

Materials and Methods

Design

Present study is a systematic review and meta-analysis which was conducted to explain the concept of HP and to assess its dimensions in 2021 according to the book of "systematic reviews to support evidence-based medicine" [40].

Data Sources and Searching Strategy

Searching the information is done in databases: Science Direct, PubMed, Scopus, PROQUES, Web of knowledge and Google scholar search engine from January 2000 to September 2021. The related key words derived from Mesh were used in studies search. Also, after searching the databases, in order to identify and cover more published papers, some specialized Journals related to the topic were searched and the reference list of finalized papers to enter the study were investigated, manually (Table 1). Also search strategy was developed for other data bases according to the data bases conditions.

Inclusion Criteria

- All observational studies (descriptive-analytical, cross-sectional) entered the study.
- Studies investigating the motorist's perspectives of HP were discarded.
- Studies were conducted from 2000 to 2021.

Exclusion Criteria

- Studies that investigated the HP from cyclists' point of view were not included.
- Studies that were written in language other than English were excluded from the study.
- Papers presented in conferences and congresses were excluded from the study.

Review Process

After removing duplicate cases, the titles of all papers were investigated and the papers that seemed not to be consistent with study objectives were excluded. In the next stages, the abstract and full context of the articles were studied respectively and the studies that didn't have the entry criteria and had weak relationships with the objectives were identified and discarded. All systematic review processes were done by two authors and the cases of dispute between them were referred to a third party. Endnote X9 was used to manage the organization of the resources.

Table 1. Complete search strategy for **PubMed** databases

Num	Search Strategy	Result
#1	(((((((“Hazard Perception”[Title/Abstract]) OR (“Hazard Detection”[Title/Abstract])) OR (“Hazard Response Time”[Title/Abstract])) OR (“Potential Hazards”[Title/Abstract])) OR (“Risk Estimation”[Title/Abstract])) OR (“Hazard Prediction”[Title/Abstract])) OR (“Hazard Perception Assessment”[Title/Abstract])) OR (“Road Risk Perception”[Title/Abstract])) OR (“Risk Perception”[Title/Abstract])	11839
#2	((((((((((“Road Traffic”[Title/Abstract]) OR (“Road Safety”[Title/Abstract])) OR (“Traffic Injury”[Title/Abstract])) OR (“Traffic Violations”[Title/Abstract])) OR (“Traffic Accident”[Title/Abstract])) OR (“Accident Prevention”[Title/Abstract])) OR (“Traffic Behavior”[Title/Abstract])) OR (“Traffic Education”[Title/Abstract])) OR (“Traffic Safety”[Title/Abstract])) OR (“Road Traffic Injury”[Title/Abstract])) OR (“Road Traffic Accident”[Title/Abstract])) OR (“Road Traffic Crash”[Title/Abstract])) OR (“Road Traffic Collision”[Title/Abstract])) OR (Crashes[Title/Abstract])	25097
#3	(((((((Driving[Title/Abstract]) OR (Driver[Title/Abstract])) OR (“Car Driving”[Title/Abstract])) OR (“Car Driver”[Title/Abstract])) OR (“Automobile Driving”[Title/Abstract])) OR (“Automobile Driver”[Title/Abstract])) OR (“Driver Behavior”[Title/Abstract])) OR (“Novice Drivers”[Title/Abstract])) OR (“Experienced Drivers”[Title/Abstract])	140667
#4	#1 AND #2 AND #3	129

Data Extraction

According to the objectives and based on preliminary evaluation of extracting data, the extraction form was designed by Microsoft Word 2016. At the first, data from 5 papers were experimentally extracted using this form and the shortcomings and problems of the initial form were eliminated. Data were extracted according to the author, year, country, methodology, sample size, participants, age, hazard perception, and definition variables.

Quality Appraisal

Critical Appraisal was done for 50 included articles in systematic review and meta-analysis. The studies reporting quality was independently assessed by two investigators (Y.H & H.S) according to 22-items STROBE checklist for the cross-sectional studies [41, 42] and JBI experimental checklist for experimental studies [43]. This checklist contains 22 questions. The checklist items score was 0, 1 and 2, according to matching the checklist question criteria with the contents of the articles. The minimum score for checklists is 0 and maximum score is 44. Studies were classified as good [the score in the range 30-44], medium [15-29] and poor [0-14] quality studies. The JBI checklist for experimental studies items score was 0 and 1. The minimum score for checklists is 0 and maximum score is 9.

Articles were assessed by two of authors and they categorized studies into three groups of high, moderate and low quality based on their overall score. Any disagreements between investigators were resolved by discussion and in consultation with research team.

Data Analysis

Qualitative Data Analysis

The Thematic Content-Analysis was applied which is a common method for identifying, analyzing, and reporting the patterns within the texts [44-47]. Coding was done by two researchers independently. Steps of the analysis included: reading the text several times, getting familiarized with data, identifying and extracting the primary codes, identifying the themes by placing similar codes together, revising the themes, naming and defining the themes, and ensuring the reliability of identified codes and themes by obtaining agreement between the two coders and resolving the disputes by discussion.

Data Analysis for Meta-analysis

At first, weighted average was estimated for studies that reported HP. In order to estimate the variable of the overall HP drivers in both groups of experienced and novice drivers, meta-analytical statistical methods were used. First, the data of selected studies was entered in Excel sheet. Stata 16 was used to perform the meta-analysis. Forest plot diagrams were used to report the results, where the size of each square represents the sample size and the lines on each side of the square represent 95% confidence interval for each study. Q and I^2 were used to evaluate the heterogeneity of the studies' result. To interpret the I^2, thresholds recommended by Higgins *et al.* [48], were used (25% for low heterogeneity, 50% for medium, 75% for high heterogeneity). Due to the high heterogeneity of the studies random model was used. Funnel plot diagram and Egger's regression test were used to measure publication bias.

This study was part of a Ph.D. Thesis supported by Isfahan University of Medical Sciences (ethical code: IR.MUI.RESEARCH.REC.1399.719).

Results

In the first stage of searching in different databases, 1167 articles resulted from studies were found. Subsequently, 225 articles were removed because of duplication and 942 articles were entered into the investigation process of title and abstract. After reviewing their titles and abstracts, 267 related articles were selected out of total number of papers. Finally, after screening complete context of the articles with entry criteria, 50 articles were entered the study as related qualified articles and among them, only 10 articles were used for meta-analysis that based on quality evaluation checklist as well as entry and exit criteria, they had the retention condition in study (Figure 1) [21, 22, 26, 27, 35, 36, 49-92].

A summary of extracted data for meta-analysis is also indicated in Table 2. To conduct meta-analysis, some studies that did not report the needed data were excluded from the study. The appendix shows a summary of the extracted data for meta-synthesis (Supplementary 1- characteristics of included studies and summarized in the study).

Articles about drivers HP of traffic accidents used in the study were mostly conducted in high-income countries in continent of Europe. The results demonstrated that Canada and Australia had the most studies in this issue. Also, South America had the fewest studies; there wasn't any noticeable attention about this case in Africa so that there wasn't any study about it in this continent. By investigating the time of article publication, it was shown that most of the papers were published between the years of 2009 till 2021 (Figure 2).

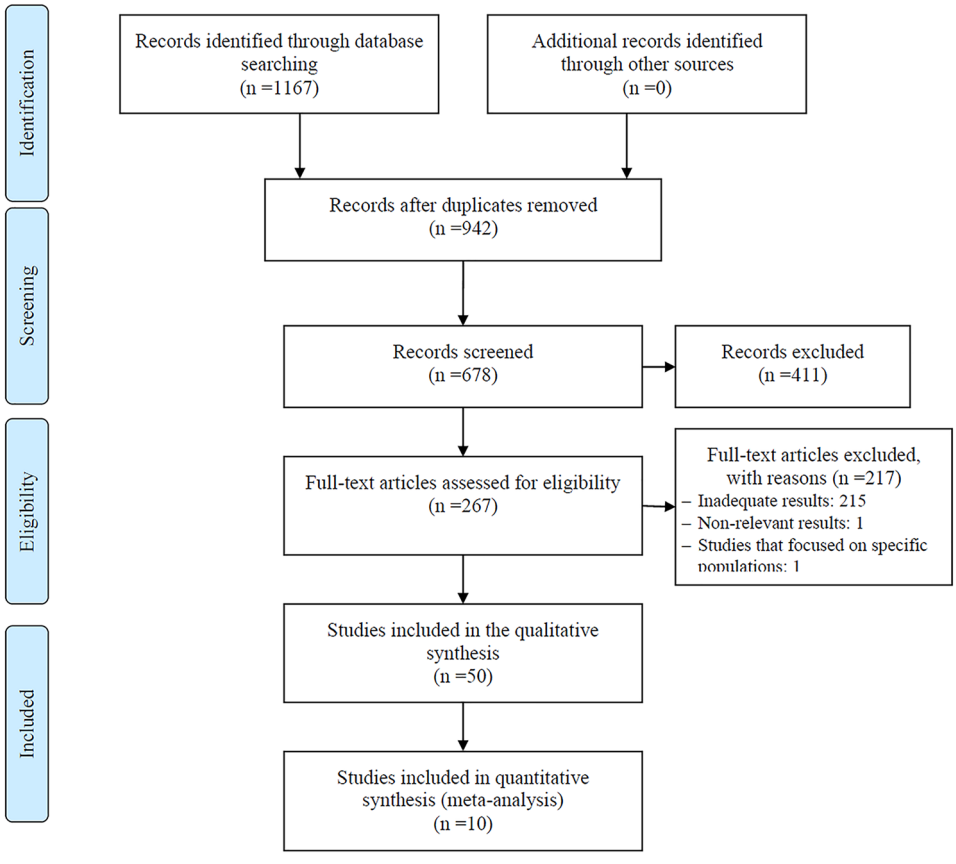

Fig. 1. Flow diagram of the searches and Inclusion process.

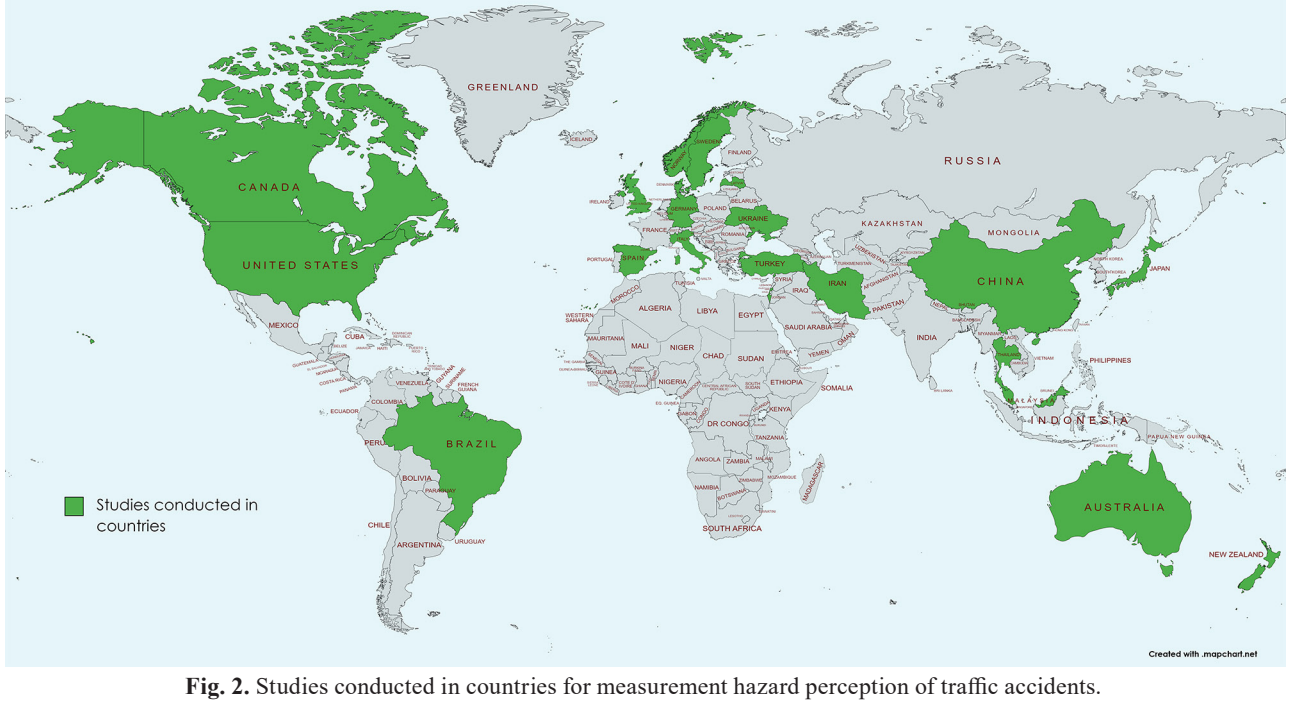

Fig. 2. Studies conducted in countries for measurement hazard perception of traffic accidents.

Table 2. Characteristics of the included studies for meta-analysis

Num	Author & Year	Country	Methodology	Sample Size	Participant	Age		Hazard perception (s)		Quality Appraisal
						Mean	SD	Mean	SD	
1	Harry Manley, et al, 2020 [53] (1)	Thailand Australia	Cross sectional	48	Novice	21.12	1.25	3.94	0.71	40
2	Harry Manley, et al, 2020 [53] (2)	Thailand Australia	Cross sectional	87	Experienced	36.08	14.49	3.34	0.81	40
3	John Lyon, et al, 2011[96] (1)	Canada	Cross sectional	25	Novice	19.9	1.6	2.06	0.26	38
4	John Lyon, et al,2011[96] (2)	Canada	Cross sectional	26	Experienced	20.4	2.2	1.75	0.35	38
5	Charles T.Scialfa, et al, 2014, [86](1)	Canada	Cross sectional	62	Novice	21.9	3.75	2.40	0.49	36
6	Charles T.Scialfa, et al, 2014, [86] (2)	Canada	Cross sectional	62	Experienced	20.54	1.39	2.25	0.52	36
7	M.A. Wetton, et al, 2010, [93](1)	Australia	Cross sectional	24	Novice	21.25	4.17	5.98	1.14	39
8	M.A. Wetton, et al, 2010 [93] (2)	Australia	Cross sectional	24	Experienced	40.58	9.34	5.14	0.76	39
9	Long Sun, et al, 2019 [89] (1)	CHINA	Experimental	25	Novice	23.24	2.05	2.85	0.35	7 JBI
10	Long Sun, et al, 2019 [89] (2)	CHINA	Experimental	24	Experienced	23.96	2.31	2.53	0.45	7 JBI
11	Long Sun, et al, 2019 [89] (3)	CHINA	Cross sectional	25	Experienced	39.6	6.66	1.99	0.48	38
12	Charles T. Scialfa, et al, 2011[85] (1)	Canada Australia	Cross sectional	29	Novice	20.15	2.45	3.16	0.86	36
13	Charles T. Scialfa, et al, 2011 [85] (2)	Canada Australia	Cross sectional	146	Experienced	21.31	1.86	2.76	0.66	36
14	Charles T. Scialfa, et al, 2012 [84] (1)	Canada Australia	Experimental	25	Novice	19.9	2.2	2.06	.26	7 JBI
15	Charles T. Scialfa, et al, 2012 [84] (2)	Canada Australia	Experimental	26	Experienced	20.4	1.6	1.75	.35	7 JBI
16	Yisrael Parmet, et ai,2014 [81] (1)	Israel	Cross sectional	39	Novice	---	---	4.15	1.86	39
17	Yisrael Parmet, et ai,2014 [81] (2)	Israel	Cross sectional	33	Experienced	---	---	2.82	1.42	39
18	Robert B. Isler, et al, 2009 [78] (1)	Australia New Zealand	Cross sectional	24	Novice	---	---	6.01	0.67	37
19	Robert B. Isler, et al, 2009 [78] (2)	Australia New Zealand	Cross sectional	9	Experienced	---	---	6.83	0.67	37
20	Mark S. Horswill, et al, 2011[73]	Australia	Cross sectional	2007	65 years and over	74.76	6.92	5.55	0.96	66

According to obtained results, the average score of drivers' HP in investigated studies were estimated 3.33 [4.04-2.62 with CI 95, I^2=89.72]. The results also demonstrated that there is a high level of heterogeny among studies results (Figure 3).

Before investigated the heterogeneity of the studies, the score was 3.91 [2.81-5-01 with CI 95, I^2=99.92]. After the heterogenic of studies was investigated through analyzing the sensitivity and one study was deleted from analysis because it reported a high average score that had excessive effect on average score and caused its deviation (Figure 4).

Reviewing the obtained results show that the beginners with average score of 3.42 [2.41-4.43 with CI 95, I^2=89.68] in compare with experienced drivers with average score of 3.26 [2.23-4.26 with CI 95, I^2=89.47] received lower score (Figure 5).

Quality Appraisal Results

The average overall quality of reporting the articles with cross sectional methodology was 37.75 (rang=0-44) and the average overall quality of reporting the articles with experimental methodology was 7. Generally, the reporting quality of articles was estimated as a good category (Table 2).

Defining Hazard Perception and Its Components

The results obtained through reviewing the studies showed that there are several definitions about HP which are categorized in Table 3 to make its concept

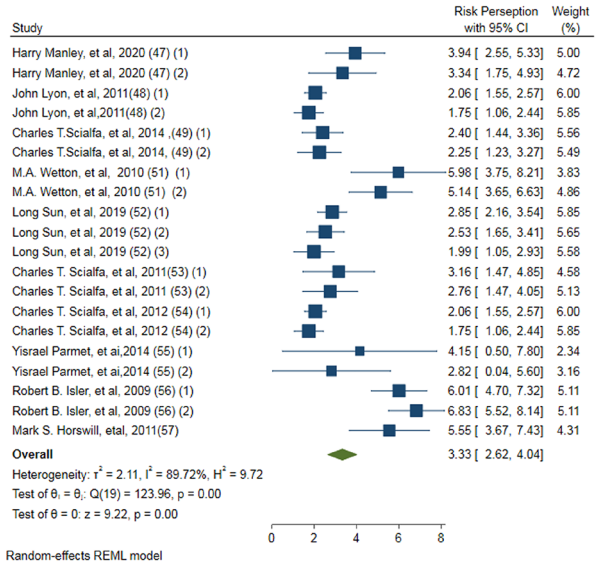

Fig. 3. The overall score of hazard perception in the included study.

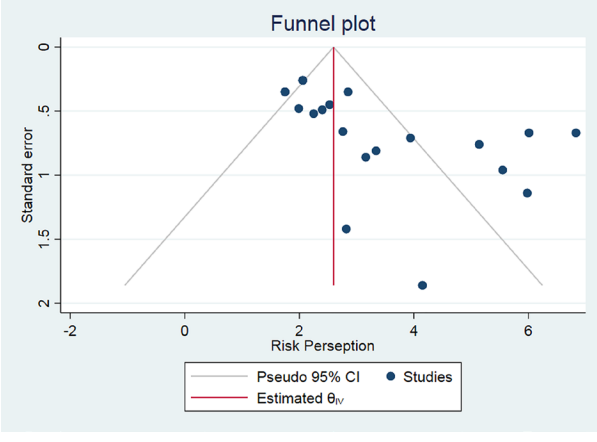

Fig. 4. Publication bias of the studies on hazard perception.

more understandable. The most definition is related to the concept presented in Horswill and McKenna article in 2004 (32) which refers to "the ability to predict the potential hazards of the road and traffic situations" [49-51, 54, 57, 65, 67-69, 75, 78, 79, 81, 87, 93]. Also, another study by Horswill conducted in 2016 redefined the HP in drivers as "the driver's ability to predict and identify the road potential hazards" [21] (Table 3).

Identifying and determining the effective component in HP is one of the most important points needed in measuring the drivers' HP that through investigations of current study, 7 effective components were identified (Figure 6).

Discussion

The current research was conducted to explain the concept of HP and to determine its effective components. In this study, 6 effective components and 28 definitions of drivers' HP in traffic accidents were identified in these studies. Also, reviewing of obtained results from meta-analysis demonstrated that average score of drivers' HP is 3.33 [4.04-2.62

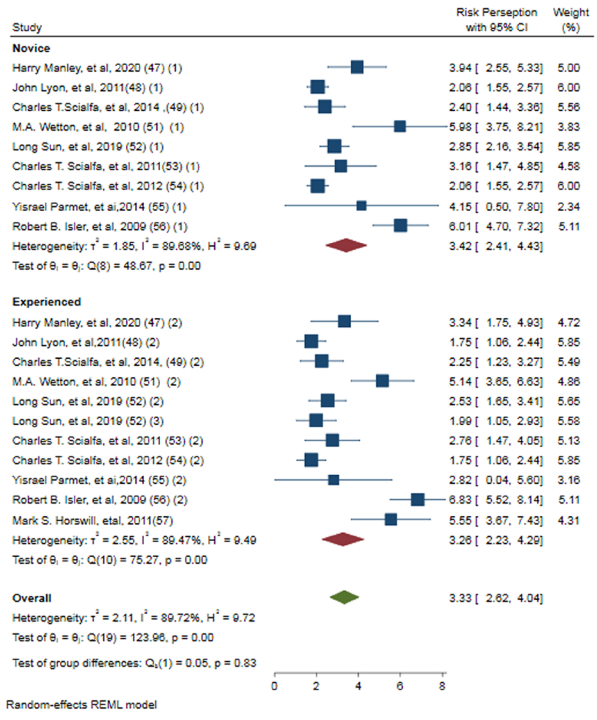

Fig. 5. Average scores of Hazard Perception based on participant skill.

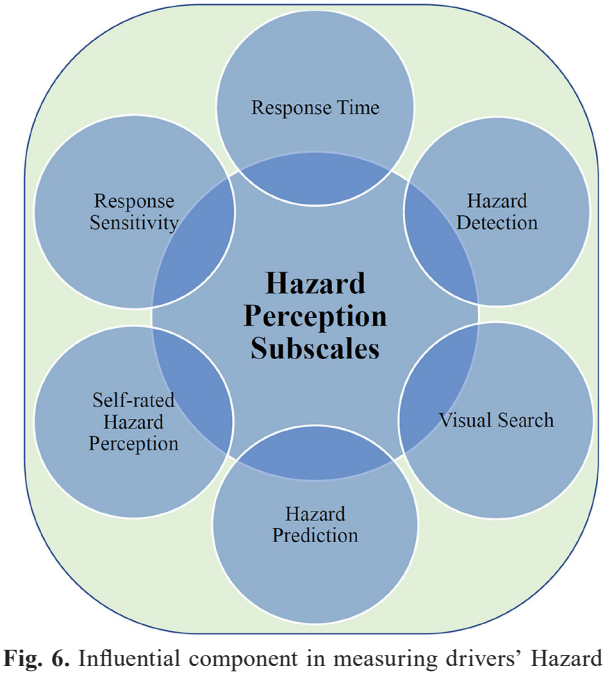

Fig. 6. Influential component in measuring drivers' Hazard perception.

with CI 95, I^2=89.72].

The results obtained from meta-analysis indicated that average score of drivers' HP is low and regarding to the importance of the issue, it's not acceptable and more attention of countries needs to improve drivers' HP of traffic accidents. Several factors can be effective in reducing drivers' recognition of danger related to the condition of each country. The level of experience in driving is one of the factors that have a direct effect on increasing the HP of traffic accidents and can have a high influence to reduce the incidence of traffic accidents [36, 94, 95].

Table 3. Identified definitions for hazard perception of traffic accidents from included studies

Num	Author & Year	Definition	References
1	Horswill & McKenna, 2004	Ability to anticipate potentially dangerous road and traffic situations	[49-51, 54, 57, 65, 67-69, 75, 78, 79, 81, 87, 93]
2	Horswill, 2016	Driver's skill in anticipating and detecting potential road hazards	[53, 92]
3	Crundall, D. and V. Kroll (2018).	Ability to perceive, anticipate and respond to situations in traffic that have a high probability to lead to a crash	[26]
4	Ehsani et al., 2020	Ability to perceive, anticipate, and respond to traffic situations that have a high probability to lead to a crash	[52]
5	Lyon, J., et al (2011)	Identify an individual's ability to both detect and respond to common roadway hazards.	[96]
6	Palamara, P., Adams, C., 2005	The ability to identify dangerous situations on the road ahead	[56]
7	Crundall et al. 2012	The skill of detecting, evaluating, and reacting to events on the road that have a high probability of producing a collision	[58]
8	(Crundall et al., 2003)	Driver's ability to detect and respond in time and appropriately to potentially dangerous events on the road	[59]
9	McDonald et al., 2015	Refers to a group of behaviors that allow the driver to be aware of, anticipate and detect potential, emerging, or latent hazards and thus avoid or minimize unsafe situations	[60]
10	Egea-Caparrós, et al, 2016	Detecting hazards	[63]
11	Borowsky, A. et al, 2010	Detecting hazard anticipation cues	[63]
12	Mackenzie, A.K.; Harris, J.M., 2015	Detecting and responding to hazards	[63]
13	Chapman, P.R.; Underwood, G., 1998	The latency in detecting and responding to hazards	[63]
14	Ventsislavova, P, et al, 2016	The process which involves situation awareness	[63]
15	Deery, H.A. 1999	"Elements of both driving skills (e.g., hazard perception latency) and subjective experience (e.g., quantifying the dangerous potential of hazards"	[63]
16	Borowsky, A., D. Shinar and T, 2010	The ability to identify hazardous situations while driving Situation awareness for hazardous situations	[36]
17	G. Li, et al., 2017	Situation awareness of a driver for potentially dangerous incidents in the traffic environment	[71]
18	Wetton et al., 2011	Anticipating potential traffic conflicts that may require to take evasive action further down the road	[72]
19	Horswill et al., 2008	Anticipating potential traffic conflicts that may require to take evasive action further down the road	[73, 85]
20	McKenna & Horswill, 1999	The ability to anticipate potentially dangerous situations on the road ahead.	[74, 76]
21	Jackson et al., 2009	Ability to anticipate potentially dangerous situations on the road ahead	[77]
22	Crundall et al., 2012	Detection, evaluation and response to road hazards	[22, 80]
23	Benda and Hoyos., 1983	The ability to anticipate traffic situations has been suggested to be an important aspect of driving competence, possibly explaining part of the difference in crash risk between novice and experienced drivers.	[83]
24	Charles T. Scialfa, et al, 2012	To identify and respond to road hazards	[84]
25	Scialfa, C. T., et al., 2014	Ability to perceive hazards in the driving environment	[86]
26	Mayhew and Simpson, 1995	Hazard perception requires scanning of the road environment, fixation on appropriate stimuli	[88]
27	Deery, 1999	Hazard perception is therefore a multi-component cognitive skill that can improve with experience	[88]
28	Li, Y., et al, 2018	Driver's ability of detecting potential collision risk. The ability of hazard perception is usually related with the braking response when facing a potential collisions risk.	[22]

One of the interesting points that can be observed in current study is the high average score of HP among beginner drivers with the score of 3.42 [2.41-4.43 with CI 95, $I^{2=}$89.68] compared to the experienced drivers with average score of 3.26 [2.23-4.26 with CI 95, I^2=89.47] [53, 89, 96]. A review of recent decade studies shows that experienced drivers get higher HP score than beginner drivers and even perform better to respond the dangers and also to identify concealed or hidden dangers that contradicts the findings of current study [33, 36, 91, 97-101]. According to obtained results, the present study shows that currently, the beginner drivers also offer close or even better performance than experienced drivers which can be related to many strictness during basic driving trainings that improves drivers' abilities. In addition, taking strict and graded tests regarded to vehicle at the time of issuing driver license can also be effective in this matter. Nowadays, compulsory and professional driving education in countries, taking HP tests from driving license applicants and necessary training appropriate to beginner drivers' needs reduces driving accidents as well as increases the HP of drivers [102-106]. Another probable reason which causes higher average score of HP in beginner drivers can be the fear of an accident; this fear makes the fresh drivers to investigate the road with great sensitivity and accuracy to reduce probable accident. A study in Turkey shows that fear of traffic accidents danger is one of the most important factors effective on increasing demands for professional driving trainings; these training can have a very positive effect on increasing the individuals' HP [102].

The results of study investigation show that many components can be effective on drivers' HP. Hazard recognition and response time to traffic accidents are two identified effective components that are closely related. HP and response time are considered more than other components in measuring HP due to their repetitive frequency and their importance in articles. Both components are placed together in such a way that HP is a major principle in responding to the danger and takes precedence over it and the response time for identified danger can only be measured during this process [80]. It is also thought that early HP is performed better in drivers having good skill to recognize the danger [53]. In a study by using signal recognition theory of Wallis and Horsville, different criteria of making decision between experienced and beginner drivers causes them to be different in HP [107]. In other studies, it is also demonstrated that drivers with freer decision-making criteria can respond faster to the dangers [20, 94].

Visual search of road by driver is another component that can reduce or increase drivers' HP especially in beginners. when beginner drivers are in dangerous traffic situation, their road visual search is less, while for experienced drivers, it is more [36]. In this regard, other studies also indicate that experienced drivers have more horizontal eye movement than beginner drivers [108, 109]. Different studies showed that the more experienced a driver is, the better they use their visual search on the road to prevent different traffic situations and hazards [110]. A study designed by Fisher and Pollatsek in 2006 demonstrated that beginner drivers see and distinguish high risk situations on the road less than experienced drivers and in this regard, they believed that necessary trainings can be used in order to enable the fresh drivers to recognize high risk situations on the road [111].

One of the most important identified components mentioned in drivers' HP is the prediction of danger. In this component, researchers investigate the ability of drivers to predict what the potential hazard situations are and how likely they are to occur. This component can be said to be a completed and enhanced component of HP. This component taken from Situation Awareness Global Assessment technique (SAGAT) is the danger prediction test in which they try to show drivers some videos related to probability of traffic accidents occurrence then suddenly and at the time when the danger arises the video is blocked to allow the drivers to predict that situation, answer the questions and make decision [38, 58, 68, 112]. Therefore, Jackson *et al*., study argued that accident prediction is perhaps the most important aspect of HP as it clarifies the place of future dangers and the ability of their processing, as well [112]. Given that limited studies have conducted using HP but one of the advantages mentioned for that is the accurate record of hazards predicted by drivers that can be a powerful test to distinguish between beginner and experienced drivers [38, 58, 68, 112].

Drivers' response sensitivity to situations of danger is another component that was identified during measurement of drivers' HP. In response sensitivity, level of drivers' sensitivity in reacting to hazards is measured to show that whether they consider the situation as a danger or not. One of the importance of this component is clarified when the hazard potential situations which seem to be unimportant in drivers' point of view are not excluded from response sensitivity test and are analyzed for response sensitivity [81]. In this regard, the results of studies conducted by Ventsislava *et al*., in 2016 demonstrated that the more sensitive a driver is to traffic hazards, the better he can recognize the hazards and ultimately has a better perception of danger [35].

Limitations and Strengths

One of the limitations of the current study was using a language (English) to search the studies and documents. While it is possible that studies and documents about drivers' HP are conducted in different countries and published in the language of those countries but they are not found and examined in the present study. Many different and influential factors can be effective in drivers' HP but in current studies, it is tried to find and select components related to human factors and use

them to evaluate the drivers' HP. One of the strengths of the study is that it has tried to focus on the human factors influencing the occurrence of traffic accidents because identifying and defining these factors and training in these fields can increase the accuracy of drivers and reduce road traffic accidents.

Conclusion

Despite the general perception and belief about direct relationship between driving history and experience with increasing HP, current study results showed that increasing driving years has reverse relationship with driving HP and experienced drivers have much lower HP than beginners. The results also showed that although lots of attentions are focused on traffic accidents and its prevention in countries, drivers' HP is still less. In this regard, due to the importance of HP discussion and its important role in traffic accidents, more focus and more accurate studies about identified components are needed. Therefore, it is suggested that the researchers should evaluate different areas of HP such as psychology, traffic engineering and so on. Also, one of the things that can be effective in improving the drivers' HP is to make them to take training courses and to pass standard tests while they are getting the driving license.

Declarations

Ethics approval and consent to participate: The Institutional Review Board and the Ethics Committee of Isfahan University of Medical Sciences, Isfahan, Iran, approved this study (IR.MUI.RESEARCH.REC.1399.719).

Consent for publication: Not applicable.

Conflict of interest: Conflict of interest the authors state they have no conflicts of interest to declare.

Sources of funding: This study was financially supported by Isfahan University of Medical Sciences (Ethics and Grant number: IR.MUI.RESEARCH.REC.1399.719).

Authors' contributions: YHO & MY collected, reviewed papers, analyzed and prepared the figures. YHO & H.SB contributed in designing, analyzing and drafting the paper. YHO & MY & HSB contributed in categorizing the indicators, developing the tool and reviewing and YHO & MY & HSB Contributed in analyzing and editing the paper.

Acknowledgments: We are very grateful to Experts for contribution and time and invaluable comments. Also, we would like to thank the Research Administration of Isfahan University of Medical Sciences, Isfahan, who supported us in doing this study.

References

1. Hutton A., Savage C., Ranse J., Finnell D.;Kub J.; The use of Haddon's matrix to plan for injury and illness prevention at outdoor music festivals. *Prehospital and disaster medicine*. 2015;**30**(2):175-83.
2. Zimmerman K., Jinadasa D., Maegga B.;Guerrero A.; Road traffic injury on rural roads in Tanzania: measuring the effectiveness of a road safety program. *Traffic injury prevention*. 2015;**16**(5):456-60.
3. Short M.M., Mushquash C.J.;Bédard M.; Interventions for motor vehicle crashes among Indigenous communities: strategies to inform Canadian initiatives. *Canadian journal of public health*. 2014;**105**(4):e296-e305.
4. Organization W.H.; European regional status report on road safety 2019. 2020.
5. Staton C., Vissoci J., Gong E., Toomey N., Wafula R., Abdelgadir J., Zhou Y., Liu C., Pei F.;Zick B.; Road traffic injury prevention initiatives: a systematic review and metasummary of effectiveness in low and middle income countries. *PloS one*. 2016;**11**(1):e0144971.
6. Foreman K.J., Marquez N., Dolgert A., Fukutaki K., Fullman N., McGaughey M., Pletcher M.A., Smith A.E., Tang K.;Yuan C.-W.; Forecasting life expectancy, years of life lost, and all-cause and cause-specific mortality for 250 causes of death: reference and alternative scenarios for 2016–40 for 195 countries and territories. *The Lancet*. 2018;**392**(10159):2052-90.
7. Azami-Aghdash S., Sadeghi-Bazarghani H., Rezapour R., Heydari M.;Derakhshani N.; Comparative study of stewardship of road traffic injuries prevention with a focus on the role of health system; three Pioneer countries and three similar to Iran. *Bulletin of Emergency & Trauma*. 2019;**7**(3):212.
8. Manno M., Rook A., Yano-Litwin A., Maranda L., Burr A.;Hirsh M.; On the road with injury prevention—an analysis of the efficacy of a mobile injury prevention exhibit. *Journal of Trauma and Acute Care Surgery*. 2011;**71**(5):S505-S10.
9. Brewin M.;Coggan C.; Evaluation of a New Zealand indigenous community injury prevention project. *Injury control and safety promotion*. 2002;**9**(2):83-8.
10. Khan A.M.;Tehreem A.; Causes of road accidents in Pakistan. *Journal of Asian Development Studies*. 2012;**1**(1):22-9.
11. Dharmaratne S.D.;Ameratunga S.N.; Road traffic injuries in Sri Lanka: a call to action. *Journal of the College of Physicians and Surgeons--pakistan: JCPSP*. 2004;**14**(12):729-30.
12. Azami-Aghdash S., Sadeghi-Bazarghani H., Heydari M., Rezapour R.;Derakhshani N.; Effectiveness of interventions for prevention of road traffic injuries in Iran and some methodological issues: a systematic review. *Bulletin of Emergency & Trauma*. 2018;**6**(2):90.
13. Saadati M., Razzaghi A., Rezapour R.;PourEbrahim K.; Interventions for safety promotion of pedestrians; A scoping review. *Journal of Transport & Health*. 2021:101277.
14. Bazargani H.S., Saadati M., Rezapour R.;Abedi L.; Determinants and barriers of helmet use in Iranian motorcyclists: a systematic review.

Journal of injury and violence research. 2017;**9**(1):61.
15. Boniface R., Museru L., Kiloloma O.;Munthali V.; Factors associated with road traffic injuries in Tanzania. *Pan African medical journal*. 2016;**23**(1).
16. Yaacob N.F.F., Rusli N.;Bohari S.N., editors. A Review Analysis of Accident Factor on Road Accident Cases Using Haddon Matrix Approach. Proceedings of the Second International Conference on the Future of ASEAN (ICoFA) 2017–Volume 2; 2018: Springer.
17. O'Flaherty C.A. Transport planning and traffic engineering: CRC Press; 2018.
18. Organization W.H. Global launch: decade of action for road safety 2011-2020. World Health Organization; 2011.
19. Mayhew D.R., Simpson H.M.;Pak A.; Changes in collision rates among novice drivers during the first months of driving. *Accident analysis & prevention*. 2003;**35**(5):683-91.
20. Egea-Caparrós D.-A., García-Sevilla J., Pedraja M.-J., Romero-Medina A., Marco-Cramer M.;Pineda-Egea L.; Late detection of hazards in traffic: A matter of response bias? *Accident Analysis & Prevention*. 2016;**94**:188-97.
21. Horswill M.S.; Hazard Perception in Driving. *Current Directions in Psychological Science*. 2016;**25**(6):425-30.
22. Li Y., Zheng Y., Wang J., Kodaka K.;Li K.; Crash probability estimation via quantifying driver hazard perception. *Accident Analysis & Prevention*. 2018;**116**:116-25.
23. Rosenbloom T., Perlman A.;Pereg A.; Hazard perception of motorcyclists and car drivers. *Accident Analysis & Prevention*. 2011;**43**(3):601-4.
24. Benda H.v.;Hoyos C.G.; Estimating hazards in traffic situations. *Accident Analysis & Prevention*. 1983;**15**(1):1-9.
25. Barragan D.;Lee Y.-C.; Individual differences predict drivers hazard perception skills. *International Journal of Human Factors and Ergonomics*. 2021;**8**(2):195-213.
26. Tūskė V., Šeibokaitė L., Endriulaitienė A.;Lehtonen E.; Hazard perception test development for Lithuanian drivers. *IATSS research*. 2019;**43**(2):108-13.
27. Sümer N., Ünal A.B.;Birdal A., editors. Assessment of hazard perception latencies using real life and animated traffic hazards: comparison of novice and experienced drivers. Proceedings of the 4th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design; 2007.
28. Pelz D.C.;Krupat E.; Caution profile and driving record of undergraduate males. *Accident Analysis & Prevention*. 1974;**6**(1):45-58.
29. Underwood G., Phelps N., Wright C., Van Loon E.;Galpin A.; Eye fixation scanpaths of younger and older drivers in a hazard perception task. *Ophthalmic and Physiological Optics*. 2005;**25**(4):346-56.
30. Mackenzie A.K.;Harris J.M.; Eye movements and hazard perception in active and passive driving. *Visual cognition*. 2015;**23**(6):736-57.
31. McDonald C.C., Goodwin A.H., Pradhan A.K., Romoser M.R.;Williams A.F.; A review of hazard anticipation training programs for young drivers. *Journal of Adolescent Health*. 2015;**57**(1):S15-S23.
32. Parmet Y., Borowsky A., Yona O.;Oron-Gilad T.; Driving speed of young novice and experienced drivers in simulated hazard anticipation scenes. *Human factors*. 2015;**57**(2):311-28.
33. Borowsky A.;Oron-Gilad T.; Exploring the effects of driving experience on hazard awareness and risk perception via real-time hazard identification, hazard classification, and rating tasks. *Accident Analysis & Prevention*. 2013;**59**:548-65.
34. Evans T.;Macdonald W., editors. Novice driver situation awareness and hazard perception: an exploratory study. Proceedings of the Australasian road safety research, policing and education conference; 2002: Monash University.
35. Horswill M.S.;McKenna F.P.; Drivers' hazard perception ability: Situation awareness on the road. *A cognitive approach to situation awareness: Theory and application*. 2004:155-75.
36. Borowsky A., Shinar D.;Oron-Gilad T.; Age, skill, and hazard perception in driving. *Accident Analysis & Prevention*. 2010;**42**(4):1240-9.
37. Chapman P.R.;Underwood G.; Visual search of driving situations: Danger and experience. *Perception*. 1998;**27**(8):951-64.
38. Ventsislavova P., Gugliotta A., Peña-Suarez E., Garcia-Fernandez P., Eisman E., Crundall D.;Castro C.; What happens when drivers face hazards on the road? *Accident Analysis & Prevention*. 2016;**91**:43-54.
39. Huestegge L.;Böckler A.; Out of the corner of the driver's eye: Peripheral processing of hazards in static traffic scenes. *Journal of vision*. 2016;**16**(2):11-.
40. Khan K., Kunz R., Kleijnen J.;Antes G. Systematic reviews to support evidence-based medicine: Crc press; 2011.
41. Von Elm E., Altman D., Egger M.;Pocock S.; Gøtzsche PCVJSI. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *PLoS medicine*. 2007;**4**:e296.
42. Von Elm E., Altman D.G., Egger M., Pocock S.J., Gøtzsche P.C., Vandenbroucke J.P.;Initiative S.; The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. *International Journal of Surgery*. 2014;**12**(12):1495-9.
43. Aromataris E., Fernandez R., Godfrey C.M., Holly C., Khalil H.;Tungpunkom P.; Summarizing systematic reviews: methodological development, conduct and reporting of an umbrella review approach. *JBI Evidence Implementation*. 2015;**13**(3):132-40.
44. Speziale H.S., Streubert H.J.;Carpenter D.R. Qualitative research in nursing: Advancing the humanistic imperative: Lippincott Williams & Wilkins; 2011.
45. Grbich C. Qualitative data analysis: An introduction: Sage; 2012.
46. Pope C., Ziebland S.;Mays N.; Analysing qualitative data. *Bmj*. 2000;**320**(7227):114-6.
47. Hsieh H.-F.;Shannon S.E.; Three approaches to qualitative content analysis. *Qualitative health research*. 2005;**15**(9):1277-88.
48. Higgins J.P., Thompson S.G., Deeks J.J.;Altman D.G.; Measuring inconsistency in meta-analyses. *Bmj*. 2003;**327**(7414):557-60.
49. Du X., Ma J.;Chang R.; The interactive effect of vehicle signals and sensation-seeking on driver hazard perception. *Transportation research part F: traffic psychology and behaviour*. 2020;**73**:174-87.
50. Moran C., Bennett J.M.;Prabhakharan P.; The relationship between cognitive function and hazard perception in younger drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2020;**74**:104-19.
51. Scialfa C.T., Borkenhagen D., Lyon J.;Deschênes M.; A comparison of static and dynamic hazard perception tests. *Accident Analysis and Prevention*. 2013;**51**:268-73.
52. Di Stasi L.L., Diaz-Piedra C., Morales J.M., Kurapov A., Tagliabue M., Bjärtå A., Megias A., Bernhardsson J., Paschenko S., Romero S., Cándido A.;Catena A.; A cross-cultural

comparison of visual search strategies and response times in road hazard perception testing. *Accident Analysis and Prevention*. 2020;**148**.
53. Manley H., Paisarnsrisomsuk N., Hill A.;Horswill M.S.; The development and validation of a hazard perception test for Thai drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2020;**71**:229-37.
54. Caparelli-Daquer E., Santana T., Cordazzo S., Cordazzo H.;Scialfa C.T.; Hazard Perception Test (HPT): A Pilot Study in Brazil. 2017.
55. Lyon J., Borkenhagen D., Scialfa C., Deschênes M.;Horswill M.; Developing a North American static hazard perception test. 2011.
56. Wetton M.A., Hill A.;Horswill M.S.; The development and validation of a hazard perception test for use in driver licensing. *Accident Analysis & Prevention*. 2011;**43**(5):1759-70.
57. Castro C., Muela I., Doncel P.;Garcia-Fernandez P.; Hazard Perception and Prediction test for walking, riding a bike and driving a car:"Understanding of the global traffic situation". *PLoS one*. 2020;**15**(10):e0238605.
58. Castro C., Padilla J.L., Roca J., Benítez I., García-Fernández P., Estévez B., López-Ramón M.F.;Crundall D.; Development and validation of the Spanish hazard perception test. *Traffic injury prevention*. 2014;**15**(8):817-26.
59. Ābele L., Haustein S., Møller M.;Martinussen L.M.; Consistency between subjectively and objectively measured hazard perception skills among young male drivers. *Accident Analysis and Prevention*. 2018;**118**:214-20.
60. Alvarez L.;Colonna R.; Characteristics of a technology-based intervention for young drivers' hazard perception: A Delphi study. *Journal of Transport & Health*. 2020;**19**.
61. Arslanyilmaz A.; Hazard warning systems to improve young distracted drivers' hazard perception skills. *Safety*. 2020;**6**(1):12.
62. Asadamraji M., Saffarzadeh M., Ross V., Borujerdian A., Ferdosi T.;Sheikholeslami S.; A novel driver hazard perception sensitivity model based on drivers' characteristics: A simulator study. *Traffic injury prevention*. 2019;**20**(5):492-7.
63. Barragan D., Peterson M.S.;Lee Y.C.; Hazard perception–response: A theoretical framework to explain drivers' interactions with roadway hazards. *Safety*. 2021;**7**(2).
64. Borowsky A., Oron-Gilad T., Meir A.;Parmet Y.; Drivers' perception of vulnerable road users: A hazard perception approach. *Accident Analysis & Prevention*. 2012;**44**(1):160-6.
65. Botzer A., Musicant O.;Mama Y.; Relationship between hazard-perception-test scores and proportion of hard-braking events during on-road driving - An investigation using a range of thresholds for hard-braking. *Accident; analysis and prevention*. 2019;**132**:105267.
66. Burge R.;Chaparro A., editors. The effects of texting and driving on hazard perception. Proceedings of the human factors and ergonomics society annual meeting; 2012: SAGE Publications Sage CA: Los Angeles, CA.
67. Chen N., Mourant R.R.;Nie L., editors. Understanding novice drivers' hazard perception skills. ICTIS 2011: Multimodal Approach to Sustained Transportation System Development - Information, Technology, Implementation - Proceedings of the 1st Int Conf on Transportation Information and Safety; 2011.
68. Crundall D.; Hazard prediction discriminates between novice and experienced drivers. *Accident Analysis and Prevention*. 2016;**86**:47-58.
69. Crundall D.;Kroll V.; Prediction and perception of hazards in professional drivers: Does hazard perception skill differ between safe and less-safe fire-appliance drivers? *Accident Analysis and Prevention*. 2018;**121**:335-46.
70. Cohen-Lazry G.;Borowsky A.; Improving Drivers' Hazard Perception and Performance Using a Less Visually-Demanding Interface. *Frontiers in psychology*. 2020:2216.
71. Guo Z.Z., Pan Y.F., Zhao G.Z., Zhang J.;Dong N.; Recognizing Hazard Perception in a Visual Blind Area Based on EEG Features. *Ieee Access*. 2020;**8**:48917-28.
72. Hill A., Horswill M.S., Whiting J.;Watson M.O.; Computer-based hazard perception test scores are associated with the frequency of heavy braking in everyday driving. *Accident Analysis and Prevention*. 2019;**122**:207-14.
73. Horswill M.S., Anstey K.J., Hatherly C., Wood J.M.;Pachana N.A.; Older drivers' insight into their hazard perception ability. *Accident Analysis and Prevention*. 2011;**43**(6):2121-7.
74. Horswill M.S., Anstey K.J., Hatherly C.G.;Wood J.M.; The crash involvement of older drivers is associated with their hazard perception latencies. *Journal of the International Neuropsychological Society*. 2010;**16**(5):939-44.
75. Horswill M.S., Marrington S.A., McCullough C.M., Wood J., Pachana N.A., McWilliam J.;Raikos M.K.; The hazard perception ability of older drivers. *Journals of Gerontology Series B-Psychological Sciences and Social Sciences*. 2008;**63**(4):P212-P8.
76. Horswill M.S., Pachana N.A., Wood J., Marrington S.A., McWilliam J.;McCullough C.M.; A comparison of the hazard perception ability of matched groups of healthy drivers aged 35 to 55, 65 to 74, and 75 to 84 years. *Journal of the International Neuropsychological Society*. 2009;**15**(5):799-802.
77. Horswill M.S., Taylor K., Newnam S., Wetton M.;Hill A.; Even highly experienced drivers benefit from a brief hazard perception training intervention. *Accident Analysis and Prevention*. 2013;**52**:100-10.
78. Isler R.B., Starkey N.J.;Williamson A.R.; Video-based road commentary training improves hazard perception of young drivers in a dual task. *Accident Analysis and Prevention*. 2009;**41**(3):445-52.
79. Johnston K.A.;Scialfa C.T.; Hazard perception in emergency medical service responders. *Accident Analysis and Prevention*. 2016;**95**:91-6.
80. Malone S.;Brünken R.; The role of ecological validity in hazard perception assessment. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2016;**40**:91-103.
81. Parmet Y., Meir A.;Borowsky A.; Survival analysis: A fresh approach for analyzing response times in driving-related hazard perception paradigms. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2014;**25**(PART A):98-107.
82. Lacherez P., Au S.;Wood J.M.; Visual motion perception predicts driving hazard perception ability. *Acta ophthalmologica*. 2014;**92**(1):88-93.
83. Sagberg F.;Bjornskau T.; Hazard perception and driving experience among novice drivers. *Accident Analysis and Prevention*. 2006;**38**(2):407-14.
84. Scialfa C.T., Borkenhagen D., Lyon J., Deschênes M., Horswill M.;Wetton M.; The effects of driving experience on responses to a static hazard perception test. *Accident Analysis and Prevention*. 2012;**45**:547-53.
85. Scialfa C.T., Deschênes M.C., Ference J., Boone J., Horswill M.S.;Wetton M.; A hazard perception test for novice drivers. *Accident Analysis and Prevention*. 2011;**43**(1):204-8.
86. Scialfa C.T., Pereverseff R.S.;Borkenhagen D.; Short-term reliability of a brief hazard perception test. *Accident Analysis and Prevention*. 2014;**73**:41-6.

87. Shahar A., Alberti C.F., Clarke D.;Crundall D.; Hazard perception as a function of target location and the field of view. *Accident Analysis and Prevention*. 2010;**42**(6):1577-84.

88. Smith S.S., Horswill M.S., Chambers B.;Wetton M.; Hazard perception in novice and experienced drivers: The effects of sleepiness. *Accident Analysis and Prevention*. 2009;**41**(4):729-33.

89. Sun L.;Dou G.B.; Computer-based Hazard Perception Study in Chinese Drivers: Environmental Effects of Driving Experience and Age. *Ekoloji*. 2019;**28**(107):4311-7.

90. Syed Shazali S.T., Selvam A.;Bujang Z., editors. Study on Hazard Perception of Malaysian Drivers. Applied Mechanics and Materials; 2014: Trans Tech Publ.

91. Wetton M.A., Horswill M.S., Hatherly C., Wood J.M., Pachana N.A.;Anstey K.J.; The development and validation of two complementary measures of drivers' hazard perception ability. *Accident Analysis & Prevention*. 2010;**42**(4):1232-9.

92. Wood J.M., Black A.A., Anstey K.J.;Horswill M.S.; Hazard Perception in Older Drivers With Eye Disease. *Translational vision science & technology*. 2021;**10**(1):31.

93. Wetton M.A., Horswill M.S., Hatherly C., Wood J.M., Pachana N.A.;Anstey K.J.; The development and validation of two complementary measures of drivers' hazard perception ability. *Accident Analysis and Prevention*. 2010;**42**(4):1232-9.

94. Underwood G., Ngai A.;Underwood J.; Driving experience and situation awareness in hazard detection. *Safety science*. 2013;**56**:29-35.

95. Azami-Aghdash S., Gorji H.A., Derakhshani N.;Sadeghi-Bazargani H.; Barriers to and Facilitators of Road Traffic Injuries Prevention in Iran; A Qualitative Study. *Bulletin of Emergency & Trauma*. 2019;**7**(4):390.

96. Lyon J., Borkenhagen D., Scialfa C., Deschênes M.;Horswill M., editors. Developing a North American static hazard perception test. Proceedings of the Sixth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, University of Iowa; 2011.

97. Borowsky A., Oron-Gilad T.;Parmet Y.; Age and skill differences in classifying hazardous traffic scenes. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2009;**12**(4):277-87.

98. Scialfa C.T., Borkenhagen D., Lyon J., Deschênes M., Horswill M.;Wetton M.; The effects of driving experience on responses to a static hazard perception test. *Accident Analysis & Prevention*. 2012;**45**:547-53.

99. Scialfa C.T., Deschênes M.C., Ference J., Boone J., Horswill M.S.;Wetton M.; A hazard perception test for novice drivers. *Accident Analysis & Prevention*. 2011;**43**(1):204-8.

100. Pradhan A.K., Hammel K.R., DeRamus R., Pollatsek A., Noyce D.A.;Fisher D.L.; Using eye movements to evaluate effects of driver age on risk perception in a driving simulator. *Hum Factors*. 2005;**47**(4):840-52.

101. Pollatsek A., Narayanaan V., Pradhan A.;Fisher D.L.; Using eye movements to evaluate a PC-based risk awareness and perception training program on a driving simulator. *Human Factors*. 2006;**48**(3):447-64.

102. Yavuz A.A., Karacasu M.;Ergül B.; Identifying the Factors Affecting the Choice of Advanced Driving Education in the Context of Traffic Security. *Güvenlik Çalışmaları Dergisi*. 2021;**23**(1):91-105.

103. Shbeeb L.I.;Awad W.e.H.; Road traffic safety perception in Jordan. *Cogent engineering*. 2016;**3**(1):1127748.

104. Roberts I.G.;Kwan I.; School-based driver education for the prevention of traffic crashes. *Cochrane database of systematic reviews*. 2001(3).

105. Bakhtari Aghdam F., Sadeghi-Bazargani H., Azami-Aghdash S., Esmaeili A., Panahi H., Khazaee-Pool M.;Golestani M.; Developing a national road traffic safety education program in Iran. *BMC public health*. 2020;**20**(1):1-13.

106. Haghparast-Bidgoli H., Saadat S., Bogg L., Yarmohammadian M.H.;Hasselberg M.; Factors affecting hospital length of stay and hospital charges associated with road traffic-related injuries in Iran. *BMC health services research*. 2013;**13**(1):1-11.

107. Wallis T.S.;Horswill M.S.; Using fuzzy signal detection theory to determine why experienced and trained drivers respond faster than novices in a hazard perception test. *Accident Analysis & Prevention*. 2007;**39**(6):1177-85.

108. Hills P.J., Thompson C.;Pake J.M.; Detrimental effects of carryover of eye movement behaviour on hazard perception accuracy: Effects of driver experience, difficulty of task, and hazardousness of road. *Transportation research part F: traffic psychology and behaviour*. 2018;**58**:906-16.

109. Underwood G.; Visual attention and the transition from novice to advanced driver. *Ergonomics*. 2007;**50**(8):1235-49.

110. Underwood G., Chapman P., Brocklehurst N., Underwood J.;Crundall D.; Visual attention while driving: sequences of eye fixations made by experienced and novice drivers. *Ergonomics*. 2003;**46**(6):629-46.

111. Fisher D.L.;Pollatsek A.; Novice driver crashes: Failure to divide attention or failure to recognize risks. *Attention: From theory to practice*. 2007;**134**:134-56.

112. Jackson L., Chapman P.;Crundall D.; What happens next? Predicting other road users' behaviour as a function of driving experience and processing time. *Ergonomics*. 2009;**52**(2):154-64.