A review on impact of human factors on road safety with special focus on hazard perception and risk-taking among young drivers

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Abstract. Road traffic accidents represented as the third cause of “death and disease” also the major cause of death among young people aged 15-29 years. In recent decade consequential investigation has been conducted on road crash contributing factors. All these researches showed that the recurrence and severity of accidents depend on many causes, such as vehicle performance, roadway environment, and characteristics of road users. Despite many studies in this field, the function of human factors on road accidents, is still unclear, due to the complex human characteristics. The lack of comprehensive model or procedure for scrutiny and evaluating the human characteristics which contributed to road incidents, motivate us to review on previous studies in order to indicate the relationships between human factors and road safety. This paper focus on the natural driving behavior of drivers including hazard perception and risk-taking of drivers which is affected by age, perceptual/cognitive abilities and driving experience. The study clearly shows that the mentioned factors have a huge impact on road incidents. Therefore, this paper indicate and recommend a number of solutions in order to mitigate the severity and frequency of accidents caused by human errors. Also previous road safety studies will provide series of crucial information for improvement of driver licensing and their training procedure.

1. Introduction
Road incidents are one of the significant public health issues in the world [1]. According to collected data every year 50 million are injured and as many as 1.2 million people are killed in roadway accidents. Moreover, there are noticeable side costs associated with road crashes including economic costs of lost, human cost, medical cost and insurance expenses [2].Traffic experts are always looking for to identify the major causes of road crashes, these attempts are showing there are three main contributor factors: Human, road and vehicles. The human factor has a direct effect on 93% of crashes, which make human behavior as the main cause of incidents [3].

There has been a number of studies conducted in recent years in order to reveal the role of human in car crashes base on different aspect of human behavior and their influence on driving behavior of drivers. This paper indicates relationship and effect of risk taking in associated by age of drivers. Young drivers expose to higher risk of road traffic injuries than other road users, which is related to hazard prediction skill and tendency to accept more risk in driving [4].

Drivers with age of 15-29 are represented excessively in traffic fatalities [5]. Lack of practical experiences, immaturity and careless driving habits are factors which increase the risk of involving in fatal crashes among young people [6]. This study firstly discuss road safety theory and then present and
compare the human characteristics that have an effect on road accidents by special focus on hazard perception and risk taking which is correlated by age and perceptual and cognitive components.

2. Road safety theories

Different from other theoretically developed branches of knowledge, road safety is facing with the lack of comprehensive theory basis [7]. This deficiency is mainly because of incidents occurrence haphazardness. Road crashes are truly random and it’s difficult to predict them. On the other hand, some researchers maintain that crashes are predictable events and are not random phenomena [8]. After all, factors which are affecting accidents cannot be fully recognized through the analysis so the operations characterize incidents are random.

2.1. Risk homoeostasis theory

Researchers have been conducted a number of studies to explicate or introduce a model for road crashes occurrence and severity of injuries. For instance, Risk homoeostasis theory (risk compensation theory) tell that the features which is added to vehicles and road as safety measures increase drivers tendency to expose collision risk due to the fact that they feel more safety and protection by the safety facilities. Therefore, it’s a need to consider and use this theory in road safety strategies [9]. Always some activities include more danger in comparison with others, thus the challenge is to decrease or optimize the risk not totally eliminate, the more optimization the more overall benefits. Base on risk homoeostasis theory there is four target level of risk [10]:

- The anticipated benefits of risky behavior alternatives.
- The anticipated costs of comparatively cautious behavior alternatives.
- The anticipated benefits of comparatively cautious behavior alternatives.
- The anticipated costs of risky behavior alternatives.

Factors one and two increase the level of risk and other two factors mitigate the risk. Therefore, rational selection of a set of behavior alternatives will provide high amount of net benefit. The Swedish experiences on changing traffic from left hand to right hand traffic in 1967 can be a good example in order to clear the function of homeostatic mechanism on human behavior where statistics showed that the new rule made a big mitigation in road accidents and injuries because drivers found it dangerous and risky so they started to drive more cautious, but after a while when people by their experiences and media discovered that roads are safer than before they start to driving careless with high speed which is turn the situation to the place where they were before, thus the government decided to return to old system and accept the failure of new policy [11]. The Homeostatic mechanism shown in figure 1.

![Homeostatic mechanism](image)

**Figure 1.** Homeostatic mechanism

2.2. Theory of planned behavior

Another theory which used in road safety evaluation is Ajzen’s theory of planned behavior (TPB), Base on this theory, performing a specific behavior depends on social and individual causes. By considering the presence of these factors scientists can anticipate future behavior of people. Theory of planned
behavior is related to intentions, it means probability of doing a specific activity or showing a specific behavior by any person depends on their intention and motivation. The more intention and motivation the more possible to do it. TPB proposed three main factors in order to assess the intention of drivers [12].

a. Self-efficacy (perceived ability): self-efficacy is an ability to accomplish a specific behavior which is rated by the person depending on how much they are willing to do that behavior. It means how much they want to do something regardless to the fact that they are capable to do it or not.

b. Attitude: studies show that if people find out that doing a specific behavior have some positive outcomes for them, they have more tendency to perform that particular behavior. In counter, if they found that it has some negative outcome it leads them to have a negative attitude toward that behavior. For example, if a person knows by over speeding he can get to an appointment then he likely thinks in a positive way about over speeding but if he knows he will get a speeding fine, he is likely has a negative attitude toward over speeding.

c. Social norms: psychological studies prove that most of the behaviors are associated with social norms. Which described as feeling of pressure by society, family, friend and peers to comply or not comply with a particular behavior.

The relationship between TPB factors which lead a person to perform a specific behavior shown in figure 2.

![Figure 2. Flowchart of TPB factors](image)

The theory of planned behavior explains behavior as an outcome of intention which is failed to consider the fact that some of behavior are unplanned and sometimes irrational. Therefore, Gibbons and Gerrard come up with a new theory of willingness model which explains changes in behavior, especially among young people. Their study shows that young drivers behavior are less predictable in different situation, because of their lack of driving experiences and being more emotional which is make their base of judgment and lead them to take more risk compared to other drivers [13]. Behavioral willingness explains as, how likely a person commit a specific behavior in different circumstances. This theory discuss that behavior may relate to the situation a person find themselves in, for instance may not decide to drink and drive but under pressure of friends and the need to go back home, they may decide to drive. On the other hand, young people’s behavior is influenced by the social image because most of their activities happen in social space (with friends, colleagues, peers). Thus if a behavior has a bad social image then youth will not willing to do it and avoid of being seen when performing that specific behavior. Also, they tend to perform behaviors with positive social image. Therefore, we can encourage young generation to perform safe driving behavior by forming a positive image of those behaviors [14].

2.3. Health Beliefs Model

The Health Beliefs Model (HBM) is one of significant conceptual framework in researches related to health behavior [15]. This theory elaborated in 1950s and aimed to clarify and forescen health behaviors.
The HBM focus on attitude and beliefs of one to explain the probability of engaging in healthy behavior in order to avoid any situation that lead to a disease or casualty [16]. The health beliefs model consist of four main component as follow: Perceived severity, Perceived susceptibility, Perceived barriers, and Perceived benefits.

The factor of Perceived seriousness (severity) evaluate an individual’s belief about the seriousness of a disease. However this factor influenced by one’s information or knowledge, but it also depend on opinion of people about Borden and hassles that a disease can create in her or his normal life [17]. Second component is perceived susceptibility or personal risk which is considered as strong motivation for people to adopt a healthy behavior. This factor is based on the fact that, when people understand there is a high risk to involve in a dangerous situation or disease, they will do their best to prevent from that situation. The greater the perceived susceptibility, the greater the probability to adopting behavior to avoid or decrease the risk. These two components (Perceived severity, Perceived susceptibility) construct the perceived threat. Perceived benefits explain the person’s belief about the usefulness or benefits of a behavior in reducing the risk of disease. The higher the benefits, the higher the acceptance of healthy behavior, when people find new behavior has a positive effect on decreasing the risk they tend to adopt the healthier behavior. The perceived barriers refer to one’s estimating on obstacles to change and adopting new behavior since change is not easy for all people in order to adopt a new behavior it is necessary to people believe that behavior’s advantages are overweight the barriers and disadvantages [17].

In addition to four mentioned main factors another two components were add to original model, cue to action and self-efficacy [15]. Cues to action refer to events, people or things that encourage a person to adopt a new behavior. Such as media, family, peers or even illnesses. Self-efficacy explain one’s confidence about his or her ability to perform a specific behavior. Figure 3 shows the typical HBM framework.

Figure 3. Health Beliefs Model framework

The HBM has an intensive use in previous healthy behavior related researches especially in case of investigating road user behavior, such as helmet use among motorcyclist and cyclists and driver’s attitude toward seatbelt [18-21]. These studies were successful to develop the HBM to analysis and give an insight through road user’s attitude toward use of safety equipment. However they reveal the fact that this model failed to consider the normative beliefs as well as cultural factors, prior experiences and socioeconomic status [22]. While other studies showed the importance of normative beliefs which is one of main components of Theory of planned behavior [24, 25]. There for, it could be maintained that the HBM is not a really proper instrument to evaluate and explain road users’ healthy behavior because it does not consider social factors and norms’ beliefs as they are known as two important factors which influence road users’ safe behavior.
3. Driving experiences and hazard perception

Hazard perception or ability to detect dangerous circumstances on roadway is one of driving skills which is related to accident. This skill normally assets by showing a video of a driving scenario to drivers and ask them to detect the dangerous conditions as soon as they can. The shorter response shows the higher level of hazard perception skill among drivers. Studies show that the more experienced is driver the faster they detect the potential hazard [25-27]. In spite of hazard perception ability differences between beginner and experienced drivers, it seems drivers need a lot of time to acquire this ability due to very slow procedure of development of hazard perception ability. Studies show that typically drivers with age of 45-50 years have enough experience to detect the hazardous situation on the road [28], when drivers normally have 30 years driving experience. Also hazard perception training can have a tremendous effect on improvement of this ability despite the novice and experienced differences [29].

One of the significant reasons for slow development of hazard perception ability is poor quality of driving performance ability. Typically crashes are considered as outcome of poor hazard prediction and negative feedback which drivers normally receive it each ten years [30]. As a result, they get a positive feedback most of the time because they were not in an accident for a long time. This phenomenon can lead drivers to have a self-overestimating and always consider themselves better than normal and rookie drivers [31-33]. Therefore, drivers do not have good insight about how excel they are in compares with other drivers, it can explain why the procedure of improvement in hazard perception ability is so slow. Obviously they are not willing to improve the ability which they think they are already better than most of other people [34].

Studies show that improvement in quality of driving feedback consecutively improve the ability of hazard detection by drivers. Thus researchers recommend using artificial feedback in order to provide a great insight into their ability of hazard perception. In this method, drivers are subjected to complete a video-based hazard perception test and they received the feedback in form of scores and some information which help them to understand the meaning of scores. This test showed that drivers with low marks (negative feedback) tend to ask about the credibility of the test in lieu of accepting the feedback [33,35]. Drummond study showed that drivers with poor hazard perception probability to have died in traffic crash is higher in subsequent 12 months [36].

According to a number of studies on hazard perception test policy makers decided to introduce this test as one of compulsory steps of driver-licensing, for example, conducting this test in driver-licensing procedure in UK indicate a significant effect on road safety and mitigate road crashes quantity and severity [37]. There is two main factors which made the positive mitigation on road incidents, first, this test help authority to filter out unsafe drivers before they get the driver license and second factor is adding hazard perception skill training to driver licensing procedure and give drivers a good insight of their hazard perception skill.

4. Young driver’s characteristics

Young drivers are most over-represented age group among drivers all around the world. Any person in age of 17-24 faced with fast physical and psychological development and moreover, increase in their cognitive ability, decision-making capacity and social skills which lead them to influence by society, friends and peers [38], undoubtedly young people are affected by their emotions more than others, so a number of studies conducted to investigate their behavior in different circumstances.

4.1. Emotions and driving risks

Psychologists believe that emotions and risk perception of young people are inseparable and their studies show a fundamental difference of varies emotions on their risky behavior. Positive emotions like happiness lead them to perform more risky behavior and over speeding, normally positive emotion lead them to take more risk, while negative emotions decrease their risk perception and make a delay in detection of driving hazards [39], these emotions can emerge from different sources such as driver anxiety threats to safety and other road users [40], it seems both conscious and unconscious feeling have a tremendous effect on youth driving behavior in decision making and hazard perception mechanisms.
4.2. Anger
Another strong emotion which influences young drivers is anger. Anger is varying depend on a lot of factors like gender, policy or even countries. Studies show that driver in America and Australia tend to drive angrily while in UK and Japan less angry driving observed. In addition to this, there is some evidence to prove that driver sex and policy has impact on driving anger, it appears, male drivers experience greater anger in presence of police while female drivers show more anger through the traffic obstruction [41]. There is some comprehensive research show that lower emotional stability anticipates more aggressive driving behavior.

The relationship between emotions, young people and risky driving behavior competence further consideration. Especially, when distracted driving like texting during driving or ruminating is associated with aggressive or emotional driving. Moreover, this research shows that using of mobile phone has a negative effect on young drivers’ emotions and consciousness.

4.3. Peer pressure and risk taking
One of main causes of young drivers incidents is driving after using alcohol and or/drugs, speeding and exhaustion [42, 43]. There is some evidence which show that presence of peers or passenger in car can be a factor to decrease the risky driving because when young drivers go somewhere with peers are more tend to follow traffic regulations such as speed limitation, stop signs and so lower risk of accident [44, 45]. But on other hand, some studies show that young drivers have higher tendency to take more risk and it can increase the accident risk. Because of less attention to driving, over speeding, driving bumper to bumper and drinking and driving [46].

Presence of peers in car can distract driver’s attention to driving activities because a part of driver’s attention will distract to interact with passengers. Thus the young drivers are more likely to ignore some driving rules like speed limits or stop sign or signal light in junction. Moreover, presence of peer passengers can lead the young drivers to perform risky driving behavior to prove themselves. Especially if risky behavior is acceptable or expectable by group of peers and that group like to drive risky, it can motivate driver to take more risk. In addition to this peer pressure can persuade them to drive regardless of driving rules and break the law but this kind of behavior is not permanent and they will not perform that particular behavior in absence of peer passengers.

5. Impact of police presence on driving behaviour
One of most important factors in developing and maintaining safe roads and also improving road user behavior are laws and regulations which define appropriate behavior on roadways [47]. Law enforcement is very useful to increase road safety by decreasing the number of behavior with high risk of getting injury or fatality. Moreover, police enforcement has been shown to decrease mean speed and variance in speed on different roadways. In addition to this, studies show that police enforcement made a big reduction in driving while inebriated [48], establishing rules on compulsory use of seat belt is the best way to increase the use of seat belt among divers and arrange some punishment as well.

Although it’s proven that the presence of police enforcement is effective in decreasing amount of driving behavior with high risk of crash. However, there is some evidence of increasing anger among male drivers in presence of police enforcement, but angry driving is more common in area with absence of police. Furthermore, being aware of consequences of being arrested by police because of driving violation is depend on traffic enforcement strictness. In absence of police enforcement drivers tend to show aggressive reaction through other drivers misbehaviors while it is difficult or almost impossible to apologize or show your regret to other drivers and deduct their anger.

6. Young driver education
In most of countries around the world, driver education has been typical method used to prepare young and novice drivers and reduce the number of road fatalities. Few studies have been conducted to evaluate the driver education system and some of them show a reduction in road crashes while some indicate
increasing road crashes which caused by young drivers. A big number of meta-analyses regarding to historical investigations have been performed on driver education and most of these meta-analyses show that driver education cannot transfer enough driving skill to the drivers due to the poor structure of education system [49, 50]. There are a few reasons that explain why common driver education system failed to be successful in adequately transfer the skills and decrease the number road crashes. For instance, short period of training time, unsuccessful in transferring skills to habits, deficiency of focus on attitudes and allowing teens to get the driving license [51].

However, it is important to consider that driver licensing programs are different around the world, some countries comply with integration of graduated driver license (GDL) program to increase the drivers’ skills and consequently decrease the traffic accidents. For example, in the United States of America, government support of continued driver education and any other programs to reform the driver education system. The proposed standards to enhance the requirement of driver licensing procedure is 45-h classroom program include more active learning methods and use of interactive tools, also simulations and computer programs have been presented to increase the efficiency of education by engaging young drivers in computer-based training (CBT),[52].

There are various type of licensing program around the world that have different procedure to prepare young and novice driver to join the driving population. One of the most successful programs is graduated driver licensing (GDL) this system designed to introduce young drivers to the transportation system in ways that protect them while they are learning. GDL is typically divided into three different stage. First step: driver can drive if only accompanied by a full license holder. And at the end of the first stage they have to pass a driving test to go to next step. Step 2: drivers can drive without any supervising but under some restrictions and if they follow all the rules with respect to those restrictions they can finish the step two, step three: receiving a full driving license [53].

Conducted studies prove that GDL has appositive effect on mitigation of accident risk among young and novice drivers [54, 55]. Results of previous studies indicate that GDL program can reduce traffic accidents by 20% to 40%. Effectiveness of GDL program is depend on some factors such as a minimum of 6 months learning period, set a minimum age for full licensing, restriction for driving during night, compulsory driving lessons and restriction on the number of teenage passengers [56-58].

In spite of a lot of positive outcome of GDL program which evaluated by researchers, still young driver are over represented in road fatalities, in order to investigate the factors associated with successfulness and acceptability of this program among young drivers it is necessary to consider the role of informal and formal social control [59, 60].

7. Conclusion

One of the most important objectives for transport policymaker is enhancing road safety. In order to achieve this aim it is necessary to indicate and understand all the factors that affect road safety. Statistics show that high percentage of road fatalities caused by human errors, therefore, this paper offered a review of previous research on impact of human factors on road safety especially young and novice drivers as main contributor to traffic accidents. It has been found that there are few number of theories to analyses and probe driver behaviors base on psychological characteristic of this group but all these theories failed to explain young drivers behavior comprehensively.

In addition to this, conducted studies show that there is a direct relationship between driving experiences and hazard perception it means the more the driving experiences the more the hazard perception. Moreover, young and novice drivers’ behavior depends on many factors such as their emotional condition and social norms like peer pressure this factors can increase their willingness to take more risk. After considering all these factors, transportation experts and policymakers decided to establish a new procedure for driver licensing named GDL which has been conducted in many countries and shown a positive change in road fatalities.

For future research, some factors need to examine more because of current studies still unsuccessful to certify the relationships and effect of some factors on young drivers’ behavior for example presence of police made some positive effect on road safety but in other hand it can increase young male drivers’
anger. And also effect of social pressure on changing of risky driving behavior among young people. Also it is recommended to improve the driver licensing procedure by focusing on their cognitive ability and emotional condition.

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