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Assessing the Effect of Eating as a Distraction Factor While Driving on Drivers' Performance

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HIGHLIGHTS

- Food and drink intake are a major driving distraction which evaluated using driving simulator.
- Drivers mental work is affected with dual tasks of driving and food intake.
- Driving risk is increased as drivers increased distraction due to food and drink intake.
- The result of current work emphasizes the effect of distractions on driving performance.

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ABSTRACT

The increase in the number of traffic accidents, deaths, and injuries is a major concern for traffic and safety professionals. Distraction from the road is common, but increases safety concerns. Drivers engage in many behaviors that are a distraction from the task of driving, and these sources may be inside or outside the vehicle. The driver may not have a clear idea of the negative impact of such activities on achieving safe driving. The paper focused on one type of distraction that occurs inside the car, the factor of eating while driving in order to address the question of whether such activities cause anxiety. The effect of eating while driving as an additional task (dual task) compared to driving baseline (single task) on each driver's performance and safety was studied. This research was conducted at the University of Technology-Iraq uses a fixed and medium accuracy driving simulator. To measure driver performance, the driver's ability to maintain a set speed limit was tested. For safety, the driver's ability to avoid accidents was measured. The highway environment scenario was adopted to perform driving experiences for the 42 participants, the length of the road was 15 km, and the driving experience took (30) minutes at a rate of (10-15) minutes for each driving task. The results revealed a decrease in the mean journey speed of all participants during the (dual driving) experiment compared to the results of the mean journey speed (single driving). The speed of females decreased more than males. The youngest age group (19-29) years led at a faster rate than the age groups (30-39), (40-49), and (50-55). No accidents were recorded during the baseline driving task. In the dual driving task, females recorded a higher number of accidents than males. The youth category (19-29) was characterized by recording the largest number of accidents.

1. Introduction

The level of road safety has increased and decreased with the advancement of technology. Some technologies and tools help the driver to drive more efficiently, and the other has a bad effect by being incompatible with the driver's basic task of driving, It distracts attention to unimportant things, which constitutes cognitive, visual, and manual pressure [1]. Concentration is one of the most important requirements for correct and safe driving [2]. Driving a car necessitates the execution of manual, visual, and perceptual functions all at the same time. Drivers often engage in tasks other than driving that distract them from their primary task [3]. This leads to distracted driving, which is one of the reasons linked to traffic crashes [4]. It is a form of inattention in which the driver's attention is diverted from driving to some mission or operation (e.g., using a mobile phone, eating and drinking, conversing with passengers, etc. [5].

According to international reports, the driver engages in various distraction activities inside or outside the vehicle for about (25-30) % of the driving time, the increase in distracted driving habits has been described as a major cause of accidents that lead to death and serious injury. According to the death analysis reporting system in the United States of America, the statistics for the years (1999-2008) showed that there were 51,857 deaths due to dispersed driving [6]. When looking at traffic collisions that resulted in injury or collateral loss, distraction was found to be a factor 68.3 percent of the time. In total, the probability of an accident while driving due to a distraction was two times greater than when the driver was not distracted [7]. Distraction is a

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factor of between 5% to 25% of all road traffic incidents worldwide[8]. According to the National Highway Traffic Safety Administration (NHTSA), in the United States of America (3,154) people died and an estimated (424,000) people were injured in scattered driving crashes in 2013 [9]. During the past ten years, (66000) accidents occurred in Iraq, which caused the death of (22,952) people. The accident report for the years 2018 and 2019 prepared by the Central Bureau of Statistics in the Iraqi Ministry of Planning revealed that the number of accidents due to the driver's behavior, which represents the highest cause, reached (9852) and (10753) respectively {10.11]. [12] Revealed that 69.70% of accidents in Iraq are caused by traffic disturbances, of which human factors are the main cause. In Iraq, the largest number of accidents was recorded during daylight hours and on highways[13]. And the age group (15-29) recorded the highest percentage of accidents, followed by the age group (30-35) {14.15]. Most drivers consider eating while driving a harmless activity, ignoring the great danger of this activity for both the driver and road users [4]. Manual distraction tends to have a negative effect on driving efficiency, resulting in increased lane deviation, turbulence in driving speed and response time to sudden events, and increased collision risk [16]. Given the habits involved, it's also likely that eating and drinking will cause drivers to become distracted, but few studies have looked into this. Eating is a common form of distraction that has received less attention in terms of influencing driving performance [17]. According to previous studies, 71% of drivers consume food or alcohol on a daily. Other typical behaviors when driving, such as sleeping, remain uncertain in terms of their possible crash risk [5]. Where the drivers eat and drink for 3.16 percent of their commuting time [18]. According to a survey undertaken by the National Highway Traffic Safety Administration (NHTSA) in 2003, nearly half of US drivers confess to eating or drinking while driving, though only 17% claim this action makes driving risky. About a third of all trips were affected [19]. The aim of this study is to find out how eating while driving affects driver behavior and safety. Due to the fact that real driving experiences pose risks to the driver, road users, property, and other negatives, it has been relied upon to conduct driving experiments on a driving simulator for the purpose of conducting safe driving experiments and under controlled examination conditions such as conditions (weather, traffic, and environment) and to obtain more data in a Less time and less cost.

2. Literature Review

There is no evidence that eating and drinking while driving may be a problem, according to the reports. The majority of research has focused on the prevalence of these activities and their potential risks, rather than their true effects on performance [20]. The two studies by (Klauer et al., 2006) and (Olson et al., 2009) showed that natural experiments could not determine the relationship between eating while driving and the likelihood of accidents. Instead, driving simulation studies proved otherwise [21]. There is proof that drivers use a number of self-control techniques to prepare for the elevated demands caused by secondary activities. Reduced driving speed is one of the results that has been identified in several studies [22]. Using a driving simulator (rather than real crash data), scientists at the University of Leeds discovered that when the subject (the driver) was eating from behind the wheel or had his hand on the steering wheel, reaction speed slowed significantly. In the case of a crash, drivers with hands on the steering wheel had a five-second average reaction time. Drivers who ate with one hand at the wheel had a ten-second average reaction time [23]. Eating and drinking increase the number of accidents during hazardous road conditions. The negative effects of these activities while driving is due to increased physical, not cognitive, demands. The results of this study showed that the large physical workload resulting from eating and drinking while driving leads to weakness and significant deterioration in the driver's performance [24][22]. Conducted an experimental study on the effect of eating on the efficiency of an individual driver Compare eating a burger with listening to music on a CD player, reading maps, or using a phone without holding it by hand with a simulator. CD reading and playing have caused most of the lane keeping errors, speed breaching, and off-road sight time. Although phone use and eating did not have the same effect on results, they were both worse than when compared to basic driving. Several studies investigated driver distraction and inattention using normal driving manuals, particularly in terms of their prevalence and implications for road safety. For example [25] monitored the behavior of 70 drivers and for a week, their cars were equipped with different video cameras and found that they perform various secondary behaviors and activities, including using a mobile phone, eating/drinking, or reading/writing; With the exception of basic passenger conversations (14.5%) of the time the cars were driving, drivers were distracted and that these disturbances often culminated in accidents as a result of incorrect vehicle movement resulting in (for example) lane turning, lane crossing, sudden braking, an increase or decrease in Speed, increased number of accidents).

3. Materials and Methods

3.1 Participants

The total number of participants is (42) who participated in performing driving experiences in the driving simulator to study the effect of practicing a distraction factor, which is eating while driving, on the behavior and performance of drivers. The test sample consisted of (29) males (69%) and (13) females (31%), as shown in Figure 1. Their ages ranged between (19-55) years, and they were distributed into four groups, and their proportions are shown in Figure 2 and their average age (mean = 33.14, standard deviation = 10.26). The average years of experience of the participants were (mean = 9.83 years, standard deviation = 8.44).

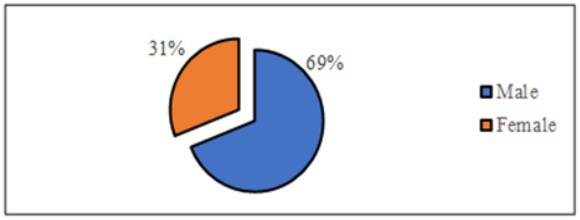

Figure 1: Percept of Participants

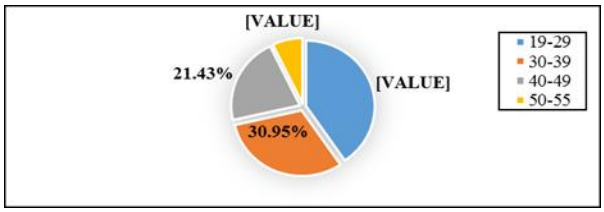

Figure 2: Participants by age groups

3.2 Apparatus

3.2.1 Equipment

A fixed base driving simulator located at the University of Technology in Iraq was used for driving tests. The device consists of three screens and an integrated cockpit (driver's seat, steering wheel, transmission, accelerator and brake pedal) and a device (triple heads 2go) that connects the three screens to become one screen that displays the road scene in an integrated manner for three directions (front, left and right side). The driver sees it when driving into reality. All of these parts are mounted on a base made of a steel frame. They contain four frames that allow moving the device from one place to another, with a vertical iron structure that works as a stand for installing the screens on it. A driving simulation program has been adopted with many advantages to controlling the choice of the examination environment, traffic conditions, weather conditions, and the time of examination (day or night), as well as the presence of sound effects (vehicle movement sound, the use of horn, pedestrians and collisions). Loudspeakers were used to show these acoustic indicators to the participants. Two cameras were used to film the entire driving experience from the front and rear sides of the participant. As shown in Figure 3.

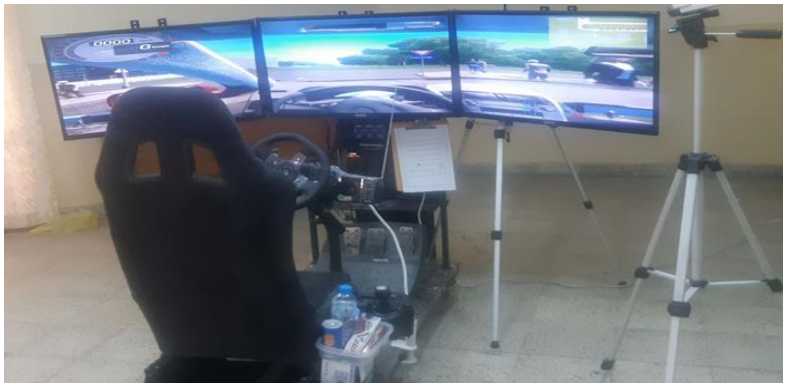

Figure 3: Driving simulator device (Researchers Work)

3.2.2 Driving Scenario

The test environment consisted of a 15-kilometer highway, which consisted of straight lines with few horizontal curves, and entrances and exits. It is divided into three lanes with a width of 3.5 meters, with all-highway furniture, including traffic lights and road signs. Moreover, billboards, numerous buildings on both sides of the road, and maintenance centers, giving a realistic feel of driving were, also, included. The volume of traffic on the road was average as the number of vehicles within the road and the nature of the traffic. The climatic conditions were chosen to be clear and sunny in the summer.

3.3 Experimental Design and Procedure

3.3.1 1. Design

Two driving experiences were prepared, the first is a single driving task (baseline driving) and the other is a double driving task. The participant should drive in the middle lane of the highway at a maximum speed of 90 km/h. The participant has been alerted if he/she exceeds the speed limit and there is no allowance to change his/her lane. When the participant comes to the laboratory, the researcher introduces the participant to the driving simulator, how to operate it, and the goal of conducting these tests, in addition to giving an idea of driving tasks that he/she will be asked. After that, the participant is asked to conduct a training driving task to be familiar with the simulator and the testing environment for a period of (15) minutes. After making sure that the participant is not exposed to any kind of simulating disease, driving experiments to begin. Within the highway route, three programmed events occur in three locations concurrently with performing the dispersion task, as these events are represented by the following, and as detailed in Table 1.

1) The first and third events, which are the sudden change of lane of the vehicle from the right lane in which the participant is driving.

2) The second event is the sudden stopping of a vehicle in front of the participant's vehicle.

Where the driver's behavior is measured due to the occurrence of the event, whether he/she is attentive to it and his/her reaction is to stop or change lanes to avoid a collision or the lack of attention due to distraction that leads to a collision. In a dual-drive task, the participant drives without knowing the locations or times of the start and end of the distraction task. The researcher asks the participant to start and end each task according to the pre-determined locations along the road. All participants start the experiment from the same location where the participant finds himself standing on the side of the highway in a designated parking lot and begins to move to the right lane while trying to reach the central lane for a test drive. The time spent on one driving task (single or double) ranges from (10-15) minutes, and the time required to perform one eating task is about (0.45-0.8) minutes. After the eating task is finished, the participant returns the food to the food basket that is located next to the driver's seat and then drives for (0.8) minutes and then repeats the eating task, which is repeated six times during the double driving experience. The total time to complete two driving mission scenarios is limited (30 minutes). Noting that the whole experience of each participant takes longer, because between each leadership task and another, the participant is given a period of rest and make sure that he is healthy and does not enter into a simulated disease, and this period varies from one participant to another.

Table 1: The experimental design of the driving tasks

Phase	Baseline (single) driving task	Dual driving Task	Event	Duration of effectiveness of distraction (minute)
1	driving	Driving	-	< 0.8
2	=	Driving distraction	-	(0.45-0.8)
3	=	Driving	-	< 0.8
4	=	Driving distraction	First	(0.45-0.8)
5	=	Driving	-	< 0.8
6	=	driving distraction	-	(0.45-1)
7	=	Driving	-	< 0.8
8	=	driving distraction	second	0.45-0.8
9	=	Driving	-	<0.8
10	=	driving distraction	-	(0.45-0.8)
11	=	Driving	-	< 0.8
12	=	driving distraction	Third	(0.45-0.8)
13	=	Driving	-	< 0.8

3.4 Procedures and details of each task

3.4.1 The first task / the single task (baseline driving)

In the basic driving mission, or as it is known as the single mission, participation begins with moving his/her car from the parking lot and driving in the central lane assigned to him at a maximum speed of 90 km/h without performing any additional task. After a period of driving, the first event begins as one of the cars rotates, and the sudden maneuver in front of the participant's vehicle changes its position from the right lane and move into the lane in which the participant is driving. After a period of free driving, the second event occurs, which is the sudden stop of the car in front of it, and after a period of free driving, the driver approaches the end of the starting road and reaches the intersection. After a period of driving, the second event occurs, which is the sudden stopping of the car in front of it, and after a period of driving, the third event appears and a car in the left lane of the participant's car makes a sudden turn in front of the participant's vehicle. Thus ends the first task of the basic leadership as detailed in Table 1.

3.4.2 The second task is the dual driving task (the eating task)

The participant drives the vehicle from the same position in which it was parked as previously described in the Basic Driving Mission Description. In this mission, the order will be required with an additional task, which is eating, because after a period of free driving, he/she is asked to start the task of eating in a certain place, where the driver chooses what he/she wants from the food items placed in the basket next to him as shown in Figure 4. After a distance of travel, until reaching a certain point, he/she

is asked to leave the food and return it to its place inside a basket. The task is repeated (6) times during the road, as the surprise appears in the second, fourth, and sixth tasks, as detailed in Table 1.

Figure 4: The side basket of food items

3.5 Parameter test

The researchers chose an important factor that is measured to study the driver's behavior as driving performance, which is speed and a factor to detect risk, which is (the number of errors that lead to collisions), and they are among the factors that researchers adopt in previous studies {4, 18, 23].

3.5.1 . Journey speed

It is an important indicator of the safety and mobility of transportation systems. It has a major impact on collision risk and road user safety. In this work, the researchers used to measure the mean journey speed for each of the two driving tasks (single and dual), by calculating (speed = distance/time), the distance traveled is the length of the highway (15) km and time is the time taken by each participant to complete one driving task.

3.5.2 Number of crashes (collisions)

The number of driver faults is a universal safety measure that includes the sum of all driving errors. The researchers relied on collision errors, including the number of times the driver's car touched another vehicle or a fixed object such as a building, tree, or safety fence on the road and along the highway designated for examination, in addition to the collision that occurs as a result of the three sudden programmed events that appear in front of the driver (the sudden movement of the vehicle in the lane next to the participant's vehicle and the sudden stopping of the vehicle in front of the participant's vehicle in the same lane).

4. Results

4.1 Mean Journey Speed

4.1.1 All participants

The average driving speed of (42) participants in the single driving task (basic driving) was (80.63) km/hr., and the speed decreased for most of the participants during the dual driving task (Eating task), where mean journey speed was (75.45) km/hr., as shown in Figure 5.

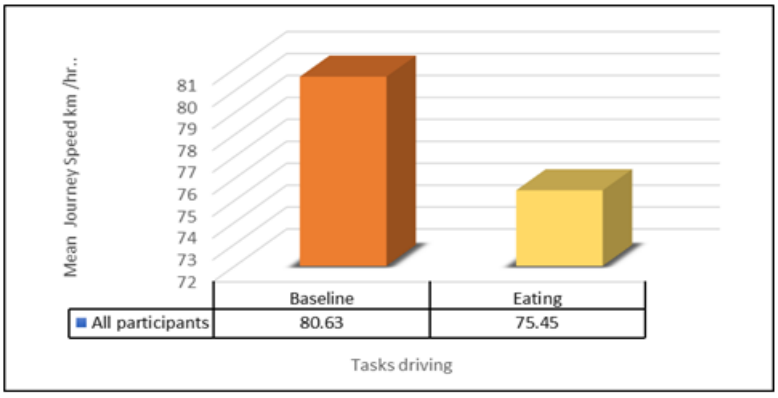

Figure 5: Mean Journey Speed for All participants

4.1.2 Gender comparison (male, female)

When comparing the speed results of driving under the influence of the double task (eating) between each of the (29) male participants with the (13) female participants, the results showed that the female speed was affected by the decrease more than

the speed of the males. The baseline driving speed for females reached (77.64 km/hr.) and the speed during the tasks were (72.78 Km/hr.). As for the males' speed, it reached (81.97 km/hr.) for basic driving and (76.65 km/hr.) for driving during the mission, as presented in Figure 6.

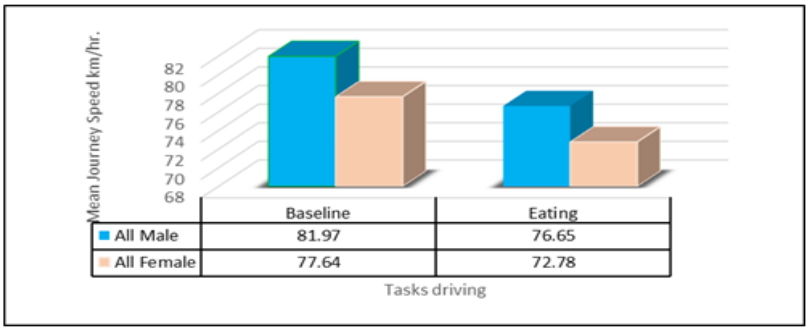

Figure 6: Mean Journey Speed by gender

4.1.3 Speed Comparison for Age Group

The age of the participants was divided into four groups, namely the youth group (19-29), the group (30-39) and (40-49), and finally the elderly (50-55), the average speed of the participants in the four groups during the double driving task was less than their speed in the single driving task. The results revealed differences in the average Speed among the age groups. The youth group (19-29) drove with a higher average speed than the rest of the groups in both driving tasks (baseline and eating) (82.67) km/h and (77.25) km/h, respectively. The age group (50-55) led the elderly with the lowest average speed in both driving tasks compared to other groups, as shown in Figure 7.

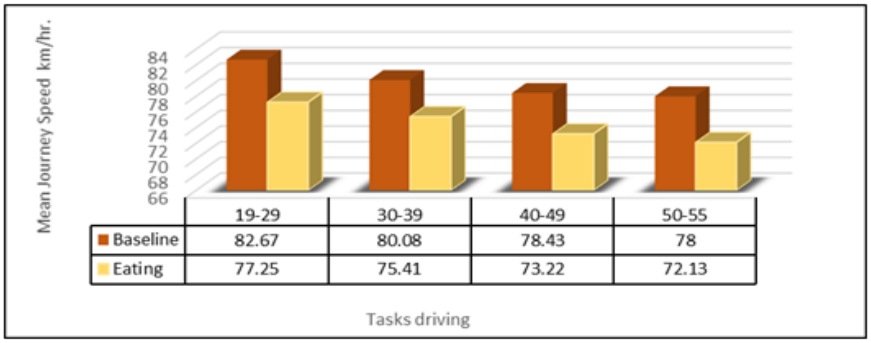

Figure 7: Mean Journey Speed by Groups

4.2 Number of Crashes (Collisions)

4.2.1 All participants

All participants (42) in the single driving task (baseline driving) completed the driving test without any crashes being recorded. On the other hand, most of the participants had a crash during the dual driving task (eating task) and the number of accidents was (12), as shown in Figure 8.

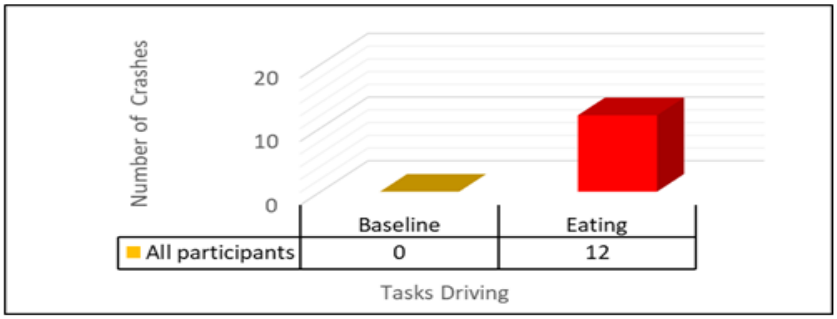

Figure 8: Number of Crashes for all participants

4.2.2 Comparing the number of crashes by gender

When comparing the results of the number of crashes for participants under the influence of the double task (eating) between (29) male participants and (13) participants, it was noted that females were exposed to a number of crashes are (7), which is higher than the number of crashes recorded by males are (5). As for basic driving, neither gender recorded any accidents, as shown in Figure 9.

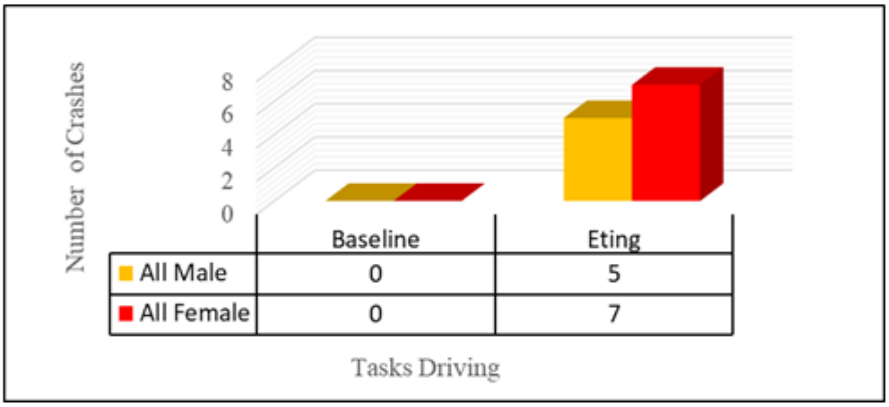

Figure 9: Number of Crashes by gender

4.2.3 Number of Crashes by Groups.

The age of the participants was divided into four groups as mentioned previously. The number of baseline driving crashes was (0). As for driving with the task of eating, crashes occurred with a difference in their number between the age groups. The youth group (19-29) recorded the number of crashes was (6), which is the highest number compared to the rest of the groups. The age group (50-55) recorded the lowest number of crashes, which is (1), as shown in Figure 10.

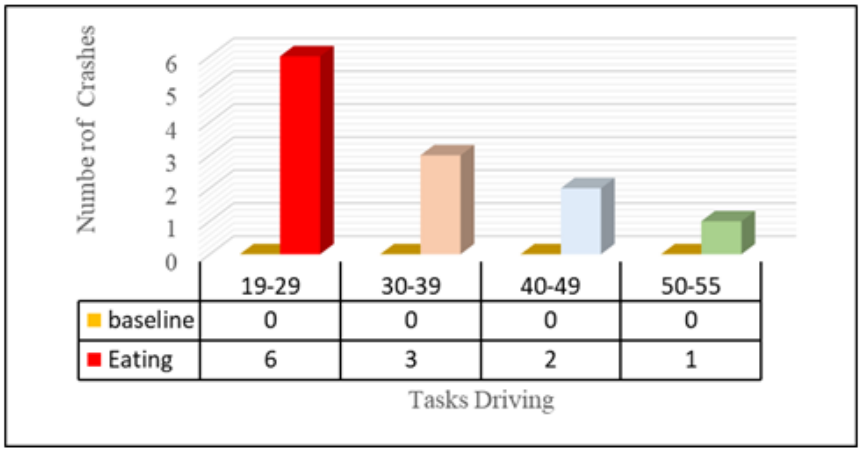

Figure 10: Number of Crashes by categories

5. Discussion and conclusions

This study sought to clarify the effects of food intake on driving performance in a highway scenario while dealing with a serious accident. There have been a few such experimental studies published in the literature, including the study by {4, 22, 24, 25]. The results of this study support the question of whether practicing an eating task while driving distracts the driver and affects their performance with regard to speed and maintaining safe driving. While the driver performance deterioration associated with poor performance was observed during the dual driving task compared to the base driving. The mental work of the driver is the result of increased requirements for the purpose of adapting to the additional driving task, and these requirements lead to physical effort accompanied by little cognitive effort as well as visual distraction, which requires the driver more time than taking the hands off the steering wheel and the driver's thought of maintaining food Spilling it on his clothes, and all this is accompanied by keeping the eyes off the road while the driver tries to take the food from its place or trying to open its cover or even when returning the food to its place. This is what was observed in most participants in the current study's trials attempting to adapt to this extra effort by reducing their speed with the scarcity of participants maintaining their average speed or even performing a significant and distracting effect to increase their abilities. Speed as in the youth category (19-29). Another evidence of deteriorating driving performance during the dual-task is the participants' exposure to accidents when encountering a serious accident. Accordingly, drivers can adapt to the conditions and the task to a certain extent, but this adaptation breaks down during abnormal situations, as a result of an increased workload. When reviewing previous research, it can be concluded that the current

study provides evidence for the hypothesis that eating while driving can have a negative effect on driving safety because drivers are not necessarily aware of the risks. Empirical research is needed in the future to determine if these results are generalizable to real-world driving in terms of the influence of different types of conditions (traffic, atmospheric, and environmental), the influence of road engineering design, or even the effect of vehicle type, to develop strategies to reduce distracted driving.

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Author contribution

All authors contributed equally to this work.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

Conflicts of interest

The authors declare that there is no conflict of interest.

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