



Full Length Research Paper

**EVALUATION OF DRIVING SKILLS IMPAIRMENT IN A DRIVING SIMULATOR
UNDER THE INFLUENCE OF ALCOHOLIC BEVERAGES**

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ABSTRACT

Driving Simulator is best described as a virtual activated technology that mimics the reality of driving. The safety advantage for research is based on the indoor versatility for performing all types of driving activities without risk of accident to the driver or passers-by in questions. This paper examines the role of driving simulator and impairments of driving under the influence of alcoholic beverages. A driving Simulator was used to screen volunteers in an indoor laboratory. Driving skills of volunteers was recorded after ingestion of drinking water as control and then followed by another group that ingested alcoholic beverages. Other modulating factors such as gender, weather, and diurnal variations were integrated into the Simulators to evaluate level of skills impairment in driving. The results illustrate that males were more likely at 75.59% to commit driving errors such as over-speeding, beating the red light and even lack of use of turn signals at respectively compared to their females counterpart at a lower level of 27.41% with a blood alcohol concentration (BAC) of 0.06-0.11. The findings here show that the simulator can also be deployed in future to diagnostic center to assist clinicians to establish level of neurological deficit in the event of any pathology or as a result of aging or ingestions of certain medications that has effect on the brain.

Keywords: Alcohol, Simulator, driving and skills.

INTRODUCTION

The actual skills required for driving have been studied in simulators, on the road, in instrumented cars and other devices. The complexity of the task and the number of variables to be considered in safe driving make simple models impossible. Driving simulators have been used because of the inherent safety advantage of simulated driving.

The more complex the driving challenge, the lower the BAC at which errors can occur, steering errors are noticed at an alcohol concentration of 0.03 percent and collision frequencies rise (Ogden and Markowitz, 2004). Subjects tend to ignore rules and instructions before reaching 0.05 percent. Subjects are more sluggish to correct positional errors and steering control responsiveness deteriorates after low to moderate doses of alcohol (Starmer, 1985). Laying aside issues of etiology, evidence indicates that some cognitive impairment in alcoholics is reversible. Researchers (Molino *et al.*, 2005, Albert *et al.*, 1982; Grant *et al.*, 1984; Goldman, 1986 and 1987) reported apparent “spontaneous” recovery of cognitive function (recovery seen after the passage of time with no active intervention) among abstinent alcoholics, a result that may be due solely to the absence of alcohol, but that may also be due in part to other changes, such as better nutrition and opportunities for social interaction provided in an alcohol treatment setting. There is some evidence that cognitive training and practice experience (remedial mental exercises) can facilitate recovery from impairment (Godfrey *et al.*, 1985; Goldman, 1986 and 1987; Bella 2005a). Because even with prolonged abstinence many alcoholic patients with chronic organic mental disorders may exhibit only modest clinical improvement in brain function, there is a need for pharmacological interventions to complement behavioral methods. Recent findings that pharmacological intervention may be useful in restoring some cognitive ability (McEntee and Mair, 1980) Godley *et al.*, 2002; Bella 2005a; Fairclough and Graham, 2005; Bham & Benekohal, 2004,) are encouraging. Several advantages of using the driving simulator are for its convenient and safe method of assessment; drivers at risk can be assessed under safe conditions with driving errors scientifically documented, Bella 2005a. It allows evaluation of a wider range of driving situations especially those that are dangerous and life threatening (Lee *et al.*, 2003; Reed and Green, 1999). It allows for assessment under well controlled and repeatable conditions with efficient data acquisition (Reed and Green, 1999). Most people with history of traumatic brain injury benefit greatly as predictor of driving performance (Lew *et al.*, 2005) Validation of driving simulators has been carried out in many studies. Vehicles’ speeds were used for validation in a study by Godley *et al.*, (2002). The driving simulator was shown to be behaviorally invalid in absolute terms but valid in relative terms. The relative and absolute validation of a driving simulator was also carried out using statistical tests based on speed data collected on a two-lane rural roadway (Bella, 2005a).

There are also disadvantages associated with driving simulators.

The simulator is considered an abstraction of reality (Molino *et al.*, 2005). It is impossible to accurately reproduce reality due to technological limitations as well as cost and time restrictions. Also, exact real road driving exercises cannot be replicated, and the driving environment in the simulator is simpler than that in the real world (Bella, 2005a).

Figure a.



JUSTIFICATION FOR RESEARCH

Several drivers are known to have learnt how to drive directly on a vehicle on the highways and thus leading to road traffic crashes and increasing the risk of drivers, motorists and pedestrians. The use of driving simulators as a template to practice in a controlled environment is known to considerably reduce the risk when the drivers now transit to real vehicles. Assessment of skills impairment due to ingestions of alcoholic beverages can endanger the lives of the motorists and pedestrians which are totally eradicated with the use of driving simulators.

This research is thus a major advocate or contribution to the use of driving simulators in screening for skills impairments due to ingestion of alcoholic beverages under various conditions.

METHODOLOGY

This involved the use of a driving simulator to assess risk potentials of consumption of alcohol similar to the works of Godley *et al.* (2002), Bella (2005a), Fairclough and Graham (2005), Bham & Benekohal, 2004). Twenty-two volunteers that met the criteria were randomly selected from the training group on the basis of screening them for driving with or without the ingestion of alcoholic beverages and training them to undergo cyber-kinetic adaptation. Eventually only fifteen were

successful based on the training and without any medical issues. The status of the participants at the time of initiating the training was that they were drug free and not impaired. They were then categorized into the following groups:

- a) Control group (placebo)
- b) Normal weather at day time in an urban setting when the blood alcohol concentration (BAC) was 0.00-0.05
- c) Normal weather at daytime in an urban setting when the BAC was 0.06-0.11
- d) Normal weather at night time in an urban setting when the BAC was 0.00-0.05
- e) Normal weather at night in an urban setting when the BAC was 0.06-0.11
- f) Bad weather in a rainy thunder storm when the BAC was 0.00-0.05 in an urban setting
- g) Bad weather in a rainy thunder storm when the BAC was 0.06-0.11 in an urban setting
- h) Normal weather in a rural setting under similar conditions as in urban setting above like in (b) and (c).

As a screening tool it is automated in the measurement of several skills for driving and thus eliminating several manual approaches to such screening. It's a digital laboratory on its own. Skills such as tracking, speeding, reaction times, divided attention task and several other skills are measured and displayed on the monitor. Encrypted into the simulator is variation of weathers, locations from urban settings to rural settings and several other modifying factors that enhance its versatility.

The basis for this grouping was to determine their driving errors on the simulator under each of the above categories. The Driving simulators are validated to ensure that they represent a useful research tool for studies related to driver safety. Usually, driving simulators have two levels of validity: physical and behavioral. Physical validity measures the degree to which the simulator dynamics and visual system reproduce the vehicle being simulated, (Yan *et al.*, 2008). The behavioral validity of a driving simulator, according to Blana, (1997) is defined as the comparison of driving performance indices from a particular experiment on a real road with indices from an experiment in a driving simulator which is as close as it can be to the real environment. Blaauw, (1982) proposed two types of driving behavioral validity: absolute and relative. A driving simulator is absolutely valid if the difference between the magnitudes of critical driver performance variables such as speed, acceleration etc., observed in the driving simulator and those in the real world is statistically insignificant. A driving simulator is relatively valid if the differences with experimental conditions are in the same direction, and have a similar magnitude (Yan *et al.*, 2008). A driving simulator is a useful tool for investigating and analyzing driver behavior. A simulator permits testing of scenarios that are too dangerous to replicate in a real car, and it gives researchers full control of all the parameters for both the car and the traffic

environment. Thus, tests performed using simulators are repeatable. Bella, (2005a) notes that driving simulators are chiefly used in the following traditional research areas: study of the human factors involved in driving tasks, assessment of the influence of alcohol on driving performance, study of driving performance based on driver age or weather conditions, design or assessment of in-vehicle systems that assist drivers with driving tasks, and driver training.

The research also determined the standard deviation from lateral position (SDLP) which is lack of sustained tracking of a moving vehicle. The culpability index, which is an Odds Ratio, (OR) was calculated for the control group and those who ingested alcohol, i.e., beverages with BAC from 0.00-0.11 at daytime to nighttime. The OR in this case is also regarded as the risk potential of driving with or without any alcohol. The Odds Ratio provided an index of whether the presence of a specific drug or alcohol can increase risk.

RESULTS

Incidence of Unsafe Driving Actions (UDAs) or traffic violations of the participants driving the simulator at day time for the control group (and BAC 0.00-0.05) as illustrated below in Table 1.00 are:

- (i) Those that strayed into an on-coming lane were lower in females at 24.07 percent compared to males at 75.93 percent.
- (ii) Those that were driving too slowly were fewer in males at 45.71 percent compared to 54.29 percent of females, while those that stopped at an intersection during a green light followed similar pattern with males at 44.44 percent while 55.56 percent were females.
- (iii) Those in intersection with red light showed 33.33 percent were females while the males were 66.67 percent; those who changed lanes without using turn signals showed that the females were 39.53 percent while the males were 60.47 percent.
- (iv) Changed lanes without checking mirrors the females were 36.36 percent while the males were 63.64 percent; strayed into adjacent lane less than five seconds showed females to be 40.82 percent while the males were 59.18 percent.
- (v) Males were predominantly speeding above the limit 15-25 kph at 65.58 percent compared to females at 34.15percent.
- (vi) Heavy braking at intersection showed lower in females at 41.37 percent while the males were 58.62 percent.
- (vii) Those who strayed into adjacent lane more than five seconds had females at 33.33 percent while the males were 66.67 percent.

(viii) Driving on shoulder more than five seconds showed females to be 30.00 percent while the males were 70.00 percent.

Table1. Incidence of unsafe driving actions after ingestion of alcoholic beverages

(i) Those under the influence of alcoholic beverages are more likely to take the risk of leaving their lanes by straying into on-coming lanes at 72.59 percent compare to the control at 27.41 percent.

(ii) The ones under the influence are more likely to cause obstruction by driving too slow at 62.07 percent compared to their control counterpart at 37.93 percent and even stop at intersections when the light is green more often at 62.50 percent compared to the control at 45.45 percent.

(iii) Several risky driving behaviors such as being at intersection when the light is red, changing lanes without using turn signals or checking mirrors, or straying into adjacent lanes or driving above the speed limit had those under the influence of alcohol dominating those that are control group with 74.47 percent, 64.15 percent, 67.86 percent, 69.49 percent and 77.05 percent compared to control at 25.53 percent, 35.85 percent, 32.14 percent. 30.51 percent and 22.95 percent respectively.

(iv) The participating volunteers under the influence maintain their dominance in unsafe driving errors by straying into an adjacent lane for more than five seconds at 67.65 percent, failing to engage turn signals before turning at 78.85 percent.

(v) Even at the level of straying off the road, those with high alcohol level at 60.47 percent dominate the control group that have just 39.53 percent to demonstrate riskier behaviors.

Figure 1, revealed that: Incidence of unsafe driving actions (UDAs) or traffic violations of the participants driving the simulator at daytime after the ingestion of alcoholic beverages with BAC of 0.06-0.11

(i) The males (M) are more likely to take the risk of leaving their lanes by straying into on-coming lanes at 72.59 percent compared to the females at 27.41 percent.

(ii) The females are more likely to cause obstruction by driving too slowly at 62.07 percent compared to their male counterparts at (M) 37.93 percent and even stop at intersections when the light is green more often at 62.50 percent, compared to the males at 37.50 percent.

(iii) Several risky driving behaviors such as being at an intersection when the light is red, changing lanes without using turn signals, or checking mirrors or straying into adjacent lanes or driving above the speed limit had males dominating the females with 68.08 percent, 58.50

percent, 67.86 percent, 69.49 percent and 77.05 percent compared to females at 31.92 percent, 41.50 percent, 32.14 percent, 30.51 percent, and 22.95 percent respectively.

(iv) The participating males maintained their dominance in unsafe driving errors by straying into an adjacent lane for more than five seconds at 64.71 percent, failing to engage turn signals before turning at 62.90 percent, straying into oncoming lanes longer than five seconds 60.42 percent, and straying into shoulders at 69.56 percent.

DISCUSSION

State-of-the-art driving simulators provide life-like experiences to drivers while reproducing the outside driving conditions and duplicating the operation of a vehicle. Recently a simulation manufacturer developed an impaired driving simulator for the DUI task force of the Tucson Arizona Police Department in the United States. This drunk-driving simulator has a custom interface that will let the user choose the desired level of impairment. The driving simulator can be calibrated to replicate the effects of driving while impaired.

Certain basic driving attributes or skills are needed on the highway in order to ensure safety of the driver, pedestrian, passengers, and all other stakeholders. Experienced drivers often take these exhibited positive attributes for granted while on the highway.

Some of these measurable attributes in a driving simulator with significant practical driving skills manifestations are:

- Straying into oncoming lane or lack of sustained tracking: Loss of steering control
- Driving too slow or speeding: Poor judgment and impulsiveness
- Stopping in an intersection even when the light is green: Poor light color perception, poor judgment, visual impairment, and slow reaction time
- Moving through the intersection when the traffic light now turns red: Same poor color perception, poor judgment and lack of self restraint
- Changing lanes or totally out of lane without using turn signals: Trafficator, poor tracking and judgment
- Changing lanes without checking mirrors: Lack of attention to task Straying into adjacent lane: Poor tracking
- Heavy sudden braking at intersection: Slow reaction time simple or choice Straying off the road totally: Poor judgment and tracking
- Strayed onto shoulder: Poor judgment and lack of tracking

The driving simulator utilized for the present study was highly sensitive to measure level of compliance of these variables from less than five seconds and above of all the participants that drove under control or under the influence of alcoholic beverages at various blood alcohol concentrations (BAC). Non-compliance with measurable attributes poses grave risks to motorists and the public. Hence, the risk potentials were the measured levels of non-compliance of the drivers. Other modulating variables such as weather, diurnal variation, and urbanization were applied to determine the level of unsafe driving errors.

Why the work focused on unsafe driving actions (UDAs)

The use of unsafe driving actions (UDAs) is based on previous work that showed its merit over that of traffic violations (Blower, 1998). The work of Blower (1998) illustrated clearly the rationale for use of UDAs over that of traffic violations as a major contributor to vehicle crashes. The reason is that police officers are less likely to lay a charge for a traffic violation that will lead to an incomplete picture of crash causes. In addition, not all contributing factors are chargeable offences. UDA coding allows the reporting officer to record their judgment just as we reported in this study and therefore providing a more detailed picture of the factors contributing to the crash.

The validity of UDAs has also been tested by comparing crash configurations that allow inference of crash responsibility, such as head-on, rear-end, and opposite direction collisions. The work of Blower, (1998), Perneger and Smith, (1991), Bedard and Meyers, (2004), and Bedard *et al.* (2007), has validated the view that drivers with higher UDAs are more to be likely to be involved in crashes or accidents than those with lower values. Therefore, our use of UDAs is validated and a very useful tool that serves as an index to determine the level of risk taking actions on the highways.

Prosecution of Driving Under the Influence of Drugs (DUID)

The zero-limit of DUID is gaining slowly on the global scale with few countries like Sweden including prescription drugs. The major device that assists with evidential scientific document is the driving simulator that can best illustrate the level of BAC or skills impairments that can warrant prosecution of the drivers. The prosecution must prove that the individual is under the influence of the drugs and, therefore, unfit to drive, or had overdosed or abused a particular medication. Nigeria is yet to demonstrate evidence based prosecution of impaired driving that will act as platform of deterrent. These requirements seem appropriate so as to give people who use a psychoactive medication properly the benefit of the doubt. For example, those receiving Palliative care often require morphine or other opiates often to control pain and they might not necessarily present a danger in traffic (Vainio *et al.*, 1995). It would be very difficult to motivate a prosecution for DUID with a therapeutic concentration of the mild analgesic codeine in a blood sample.

Moreover, some individuals might actually be safer drivers after taking a psychoactive medication such as a narcoleptic, anti-epileptic, or anti-depressant drug. The idea of enacting threshold concentration limit for licit and illicit drugs akin to the per se law for alcohol is not recommended. The evidence base for such a law remains uncertain, making it difficult to reach such a consensus especially in a developing country like Nigeria, where BAC law is still very much unknown and negligible.

Unsafe driving actions (UDAs) at daytime with BAC 0.00-0.05

Based on sixteen measurable attributes, with BAC of 0.00-0.05, females surpassed their male counterparts in only driving too slow and stopping in an intersection with a green light. The implication for these errors is that, even in time of impairment there was gender bias with females being more cautious than their male counterparts. The driving attribute with widest margin of error between males and females is straying into an on-coming lane with males accounting for 78.18 percent and females accounting for 21.85 percent which is the same as the standard deviation from lateral position (SDLP). The SDLP is said to be the most sensitive measure for revealing the effect of hard drugs. Similar findings have been reported by Menetrey *et al.* (2005) and Makanjuola *et al.* (2007).

The implication of higher prevalence of UDAs by males demonstrates a higher preponderance for taking risks amongst males compared to females. Areas of UDAs with higher female values are reflection of extreme precaution by the drivers, which could also constitute a major hazard to highway safety, since unnecessary stopping and driving too slow can impair smooth movement by others. The UDAs difference between the genders is very significant $P < 0.001$ while accident risk, or relative risk or odds ratio 2.030 with 95% of CI (confidence interval) 2.56-1.61.

Findings based on BAC of 0.08 vs. control group in daytime from Table 1 result.

Total error committed by control group (placebo) was 39.13 percent compared to that of BAC 0.08 at 60.94 percent. Loss of sustained tracking regarded as standard deviation from lateral position (SDLP) remains the highest errors committed by those with BAC 0.08 which is in conformity with previous studies by Menetrey *et al.* (2005) using other psychoactive drugs. The practical implication of this on the highway is that an impaired driver with such BAC level cannot maintain the lane and the danger of this is vividly illustrated with the case of the popular BRT (bus rapid transit) presently being operated in Lagos state where a single narrow lane is strictly reserved for them. Therefore, loss of sustained tracking or SDLP is a recipe for an unimaginable accident precipitated by impairment.

The ratio of this error of straying into an oncoming lane was 3.3:1 (for over 3 errors committed by straying of the lane with BAC of 0.08, only one was committed by the control group). Total SDLP of errors committed by those with BAC of 0.08 was 144 compared to just 58 errors by control group with BAC: Control ratio of 2.2:1.0 (for over two errors committed in SDLP of the BAC of 0.08 only one was committed by the control group).

The SDLP is the main parameter that measures the extent to which the car weaves within a traffic lane and it is assumed that the SDLP represents overall highway driving ability since it encompasses several levels of information processing which are combined in an integrated driving model. It thus illustrates the risk-potential or hazard posed in driving on the highway and, therefore, regarded as an index for safe driving. Other risk errors that were committed were: inappropriate change of lane either without checking mirrors or using turn signals with BAC and control group ratio of 1.1.6:1.0 while speeding was 2:1.

Hence, in virtually all measurable safe driving attributes those with elevated BAC were more likely to commit unsafe driving actions (or traffic violation) and increase accident risk on the highway. Evaluation of these tasks and other driving performances on a driving simulator are standardized and can be scientifically proven to correlate with real highway driving performances (Hoffmann *et al*, 2002).

Don't drive when you are drunk" is well-validated scientifically from our laboratory driving simulators' research in this world. There are several validations by previous works such as Blaauw, (1982), Hoffman *et al*. (2002), and Godley *et al*. (2002).

The total traffic violations or unsafe driving actions (UDAs) found for the control group and those with elevated BAC after ingestion of alcoholic beverages further confirms that just one drink impairs driving.

Decades of scientific evidence based on sound research concludes how very low levels of alcohol impair driving, even from one standard drink (Moskowitz, 2001). If the control group or placebo can cause some level of UDAs due to natural dip in alertness, the role of gradual elevation of BAC to the driver in question can aggravate the UDAs.

Besides alcohol and drugs, other factors such as bereavement, lack of sleep, fatigue, huge emotional crisis and other form of pathology can cause considerable dips in alertness and lead to impaired driving, (Home *et al*., 2003). Extrapolation of our simulator findings to real highway driving activities is the revelation of impairment of wakefulness that produces drowsiness at low BAC of 0.005-0.05 that causes considerable high level of SDLP (by straying into oncoming lane, adjacent lane, shoulder or totally off the road). Impact of vehicle crashes can be completed in just one fifth of a second, Philip *et al*. (2001), hence our documented five seconds is more than sufficient to record several accidents.

Therefore, a millisecond doze at the wheel, whether caused by a natural dip in alertness or elevated BAC, can cause drowsiness with the consequences of a fatal impact or RTA.

Apart from drowsiness, other factors such as poor psychomotor skills, tracking, cognitive tasks (i.e., information processing, such as the time a driver needs to read a street sign or recognize and respond to a traffic signal, or make a decision). In real life situations, the problem is that most people feel fine at low BAC so they don't realize they are already at risk. The implication is a downward spiral; thus, as the BAC level increases more and more, components of behavior are involved in producing a more complex set of impairments, similar to findings by Moskowitz, (2001).

The laboratory driving simulator recording impairments due to elevated BAC is not a case of obscure laboratory theory. Previous reports have provided against evidence myths of drinking-driven folklore i.e., the delusion that a few drinks make you a more relaxed, less risky driver; that is the assumption that small amount of alcohol actually improves performance (Morkowitz, 2001). Therefore, in real life every drink impairs driving, increases risk of collision, increases risk of injury and death to other road users. Hence, the only option is drink free driving.

In real life, the morning after an elevated BAC level, is still very hazardous to the driver and society in general. With past demonstrated results that memory and psychomotor performance are known to be impaired on the morning after heavy social drinking even with a BAC level of zero or very near zero (Moskowitz, 2001). This evidence indicates that the fly-wheel effect of impairment from alcohol continues into the next day, even after a return to zero BAC. The fear of this complex behavioral impairment of driving skills with the anticipated consequences of an accident made the use of the driving simulator for this research much more imperative.

In conclusion, to avoid being a risk or potential risk to highway safety, never ever drink and drive, including the morning after—even the daytime after—a major night out.

Odd-Ratio (OR) or relative risk or accident risk; The culpability index, an Odds Ratio, was calculated for the control group and those who ingested alcohol, i.e., beverages with BAC from 0.00-0.11 at daytime to nighttime. The OR in this case is also regarded as the risk potential of driving with or without any alcohol. The Odds Ratio provided an index of whether the presence of a specific drug was associated with an increase in the risk of driving, causing a crash. For instance, an Odds Ratio of 1 or less indicates no increased risk relative to a reference group (drug free) and an Odds Ratio of 1.5 indicates a 50 percent increase risk (relative to a reference group) of a driver causing a crash. Previous research on Odds Ratio (OR) or accident risk or relative risk can be found in the work of Mura *et al.* (2003), Asbridge *et al.* (2005), Blows *et al.* (2005), Gerberich *et al.* (2003), Jones *et al.* (2005), and Wadsworth & Moss,(2006). Calculation of OR

or relative risk is the same for responsibility analysis, i.e., to investigate whether there is an association between driving under the influence of alcohol (drugs) and responsibility for unsafe driving actions (UDAs). Findings from our work calculated and compared OR as: Control group: with odds of exposure being 0.7222 Odds of exposure to BAC of 0.00-0.05 being 1.4658 or 1.47. That is, 47 percent increase in relative risk to higher unsafe driving actions compared to control. Odds ratio OR)=2.030 with CI (confidence interval) 1.61-2.56 at 95 percent which translates to 103 percent increase in risk relative to the reference group. Our findings compared favorably with the work of Drummer *et al* (2004) that used THC (tetrahydrocannabinol) or cannabis and found an OR of 2.7 (95 percent confidence interval 1.02-7.0 percent while their amphetamine use recorded OR of 2.3 (95 percent CI 0.9-5.6). Similar work in Australia by Dussault *et al.* (2002) with use of cannabis was associated with an OR of 2.2 (95 percent CI 1.5-3.4) when combined with alcohol BAC >0.08 and cannabis was associated with an increase accident risk as high as 80.5 percent OR with 95 percent CI A significant stronger positive association with accident responsibility was seen in drivers positive for cannabis and with a BAC of 0.05 percent. The combination of alcohol and cannabis produced a significant increase in responsibility i.e. OR 5.4 percent, 95 percent CI: 1.2-24.0. The effects of alcohol with elevated BAC were adjusted for different co-factors, including diurnal variation, age, sex, and weather. With higher BAC of 0.06-0.11 the odds of exposure was 1.56 (i.e., 56 percent higher risk of errors) while control was 0.722 the OR was 2.15 with 95 percent CI of 2.05-2.27. Hence, the risk factor is significant since it is greater than 1. In comparing the BAC of 0.00-0.05 and 0.06-0.11, the OR is 1.0612 which is significant at 95 percent CI of range 1.16-1.31. This risk analysis or OR clearly indicates that alcohol use can have a detrimental impact on driving ability as it impairs some cognitive and psychomotor skills that are necessary in driving. Most of these effects increase in a dose-dependent way to a level. Some of the users are fully aware of the impairment but can only partially compensate for the deficit in skills.

Table 1: Incidence of Unsafe Driving Actions (UDAs) at Day Time after Ingestion of Alcoholic Beverages at BAC Level of 0.00-0.08 and control group (Placebo)

Action Description	Alcohol	Control	Total
Strayed into oncoming lane less than 5 secs	82 (75.93)	26 (24.07)	108 (17.91)
Driving too slow 10 mph/15 kph under	38 (54.29)	32 (45.71)	70 (11.61)
Stopped in intersection during green light	20 (55.56)	16 (44.44)	36(5.97)
Light turned red while in intersection	18 (66.67)	9 (33.33)	27(4.48)
Changed lanes without using turn signal	26 (60.47)	17 (39.53)	43(7.13)
Changed lanes without checking mirrors	21 (63.64)	12 (36.36)	33(5.47)
Strayed into adjacent lane less than 5 secs	29 (59.18)	20 (40.82)	49(8.13)
Speeding 3-5 mph 15-25 kph over speed limit	27 (65.85)	14 (34.15)	41(6.80)
Heavy braking on intersection approach	17 (58.62)	12 (41.37)	29(4.81)
Strayed into adjacent lane more than 5 secs	16 (66.67)	08 (33.33)	24(3.97)
Failed to engage turn signal 100 ft before turn	20 (62.50)	12 (37.50)	32(5.31)
Stopped at green light	12 (57.14)	9 (42.85)	21(3.48)
Strayed into oncoming lane more than 5 secs	19 (67.85)	09 (32.15)	28(4.64)
Strayed off the road less than 5 secs	18 (66.67)	09 (32.14)	27(4.48)
Strayed onto shoulder less than 5 secs	9 (60.00)	6 (40.00)	15(2.49)
Driving on shoulder more than 5 secs	14 (70.00)	6 (30.00)	20(3.32)
Total	386 (64.01)	217(35.99)	603 (100)

Results showed that unsafe driving actions of the participants were $r=0.9144$, 95% Confidence Interval is 0.7591-0.9712 P value = 0.0001 (The variation results from control and those that have ingested alcoholic beverages at daytime is considered extremely significant.)

Figure 1; Unsafe Driving action (UDA) at BAC of 0.00-0.08% based on gender.

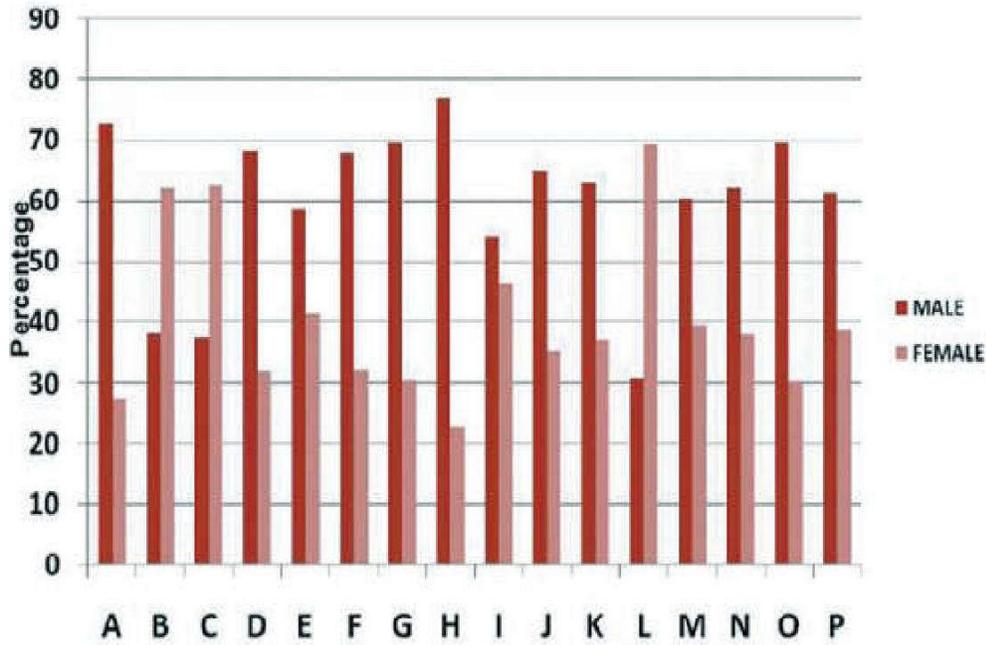
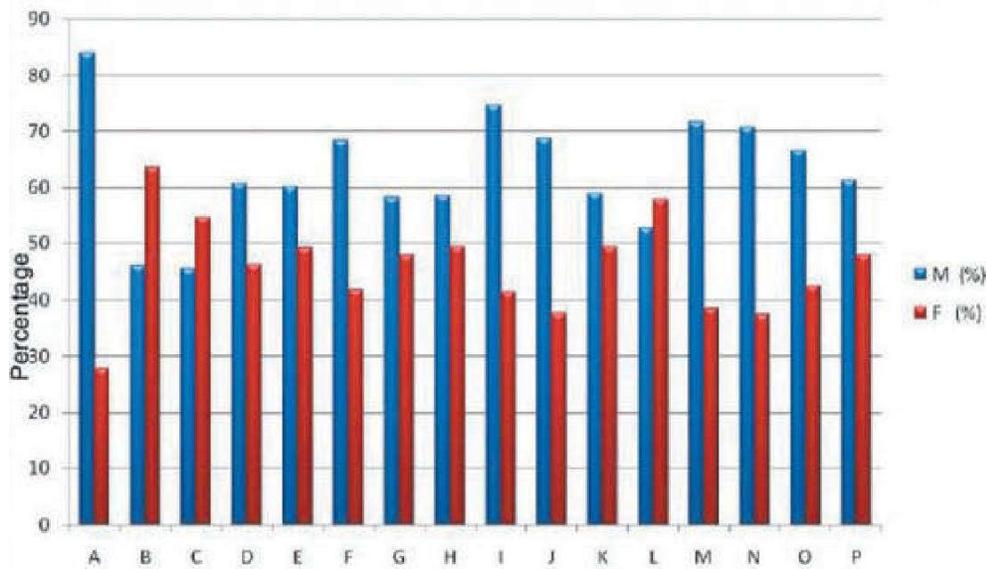


Figure 2; Unsafe Driving action(UDA) at BAC of 0.06-0.11 based on gender.



Unsafe Driving Errors at 0.06-0.11 recorded at night based on gender

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