DALIBOR PEŠIĆ, Ph.D.
E-mail: d.pesic@sf.bg.ac.rs
BORIS ANTIĆ, Ph.D.
E-mail: b.antic@sf.bg.ac.rs
University of Belgrade,
Faculty of Transport and Traffic Engineering
Vojvode Stepe 305, 11000 Belgrade, Serbia
DAVOR BRČIĆ, Ph.D.
E-mail: dbrcic@fpz.hr
University of Zagreb,
Faculty of Transport and Traffic Sciences
Vukelićeva 4, 10000 Zagreb, Croatia
JELICA DAVIDOVIĆ, M.Sc. (corresponding author)
E-mail: jelicadavidovic@yahoo.com
University of Belgrade,
Faculty of Transport and Traffic Engineering
Vojvode Stepe 305, 11000 Belgrade, Serbia

Human - Transport Interaction
Review
Submitted: Mar. 30, 2014
Approved: May 27, 2015

DRIVER'S ATTITUDES ABOUT THE IMPACT OF CAFFEINE AND ENERGY DRINKS ON ROAD TRAFFIC SAFETY

ABSTRACT

Large amounts of energy drinks and caffeine, which is the main ingredient of energy drinks, produce a negative effect on the drivers, and therefore affect traffic safety.

In order to determine the attitudes of drivers toward the impact of energy drinks and caffeine, a research was conducted using a questionnaire form and the targeted group of the survey were drivers. The research was conducted in the City of Belgrade in December 2012. There were 420 survey papers distributed to drivers of different age groups of which 412 were returned. The survey was completely anonymous and consisted of two parts. The first part was related to basic demographic information about the respondents and it had 8 closed type questions. These questions were responded by circling one of the offered answers. The second part of the survey referred to determining the driver's attitudes about energy drinks and caffeine. The second part consisted of 26 questions and respondents were to use a five-level scale in order to show to what extent they agree or disagree with any of the listed statements.

The results show that energy drinks are consumed mostly by young people, less than 25 years old. The effect of caffeine on gender is statistically significant. Headache is the reason why caffeine (25%) is consumed more than energy drinks (8%).

Major impact of energy drinks and caffeine on road safety indicates a required activity in this area such as education.

KEY WORDS

traffic safety; energy drinks; caffeine; the influence on drivers' behaviour;

1. INTRODUCTION

Nowadays, fatigue as the cause of traffic accidents attracts a lot of attention around the world. Traffic accidents that occur as result of fatigue have severe consequences, as they usually happen when speeding and the driver often fails to react. The largest number of accidents related to fatigue occurs in the morning, between 04:00 and 06:00. In order to overcome fatigue, drivers avoid driving in the early hours of the morning, but some also use a psychostimulant, most commonly caffeine [1]. Beside caffeine, drivers often consume energy drinks whose effects are several times stronger than those of caffeine [2].

In the last decade an increase in the consumption of energy drinks and caffeine was recorded, especially among teenagers and young students. Energy drinks contain caffeine, taurine, glucuronolactone, B vitamins, and Inositol. Larger doses (100-300 mg) of caffeine show improvement of driving performance [3-4].

Some studies show positive effects of small doses of caffeine, which gives positive effects on the time of reaction, performance and mood [5-6]. Studies showed that taurine as an integral part of energy drinks, visually reduces fatigue [7]. The influence of taurine on the central nervous system is not clear [8]. The influence of B vitamins on driving is also unknown. Neither is known the impact of glucuronolactone [9]. Glucose produces a positive impact of both beverages because it contains sugar. Their combination has a

positive effect on observation, attention and driving performance. In the laboratory tests, mental abilities, such as the time of reaction, arousal, subjective alertness, concentration and memory [10], as well as the driver capability in a stressful situation are improved [11]. In all previous studies where energy drinks were consumed there was an improvement in driving [12]. Some of energy drinks, such as Red-Bull, improve driving performance significantly and reduce sleepiness of drivers during long drives on the highway [13].

Caffeine has a significant effect on sleeping. Caffeine acts as an agent that facilitates the production of resources required to sustain a consistently high level of signal detection over time [14]. Truck drivers ingest the equivalent amount of caffeine as if they drank 3.3 cups or 6.6 cups of coffee in a row, which signifies a large amount of caffeine. This leads the drivers to lose their concentration and attention ability, and increases the probability of accidents [15]. Moreover, there is caffeine in drinks that can produce energy very quickly, such as energy drinks. The caffeine in combination with taking a "nap'' is not favourable in the early morning hours, especially for drivers who did not sleep the previous night, because they might fall into a deep

Table 1 - Review of literature

Authors	Target	Method	Finding
Monique, 2010	To examine if Red Bull® Energy Drink can counteract sleepiness and driving impairment during prolonged driving.	Twenty-four healthy volunteers participated in this double-blind placebo-controlled crossover study. After 2 h of highway driving in the STISIM driving simulator, subjects had a 15-min break and consumed Red Bull® Energy Drink (250 ml) or placebo (Red Bull® Energy Drink without the functional ingredients: caffeine, taurine, glucuronolactone, B vitamins (niacin, pantothenic acid, B6, B12), and inositol) before driving for two additional hours. A third condition comprised 4 h of uninterrupted driving. Primary parameter was the standard deviation of lateral position (SDLP), i.e., the weaving of the car. Secondary parameters included SD speed, subjective driving quality, sleepiness, and mental effort to perform the test.	Red Bull® Energy Drink significantly improves driving performance and reduces driver sleepiness during prolonged highway driving.
Biggs et al., 2007	To determine whether caffeine, a common countermeasure to driver sleepiness, affected a sleepy driver's ability to monitor their simulated driving performance.	Twelve healthy young adults (six males, six females) participated in three counterbalanced, blinded, daytime conditions: control [9 h time in bed (TIB)], 100 mg caffeine (4 h TIB), and placebo (4 h TIB). Driving performance was measured through lane drift on a series of 30-min simulated driving sessions. Subjective sleepiness and perception of driving performance were measured at 5-min intervals during driving sessions via the Karolinska Sleepiness Scale and a corresponding perception scale.	Strong correlation between subjective measures supports the postulation that sleepiness is used as a cue for performance prediction when sleep restricted. The relationship between perceived and actual performance after fatigue countermeasures remains inconclusive.
Yildirim, 2003	To evaluate the use of Gripin by long-distance drivers and its adverse effects.	A questionnaire was distributed to 500 truck drivers who volunteered to take part in the study. They answered the questionnaire face to face. The questionnaire comprised 20 questions about drivers and the subject.	Long-distance drivers use substances containing caffeine in order to prevent sleep and headache.
Horne and Reyner, 2002	To investigate the effectiveness of a well-known FED in reducing sleepiness in drivers.	Twelve healthy young adults drove an instrumented car simulator between 14:00 and 17:00 h. Their sleepiness was enhanced by sleep restriction to 5 h the night before. Following a pretreatment 30-min drive and at the beginning of a 30-min break, participants were given double-blind 250-ml FED (containing sucrose, glucose, 80-mg caffeine, taurine, glucuronolactone and vitamins) vs. a control drink with the same volume and the same taste but without caffeine, taurine and glucuronolactone. Two hours of continuous driving ensued. Lane drifting, subjective sleepiness and the electroencephalogram (EEG) were monitored throughout.	Compared with the control, the FED significantly reduced sleep-related driving incidents and subjective sleepiness for the first 90 min of the drive. There was a trend for the EEG to reflect less sleepiness during this period. It was concluded that the FED is beneficial in reducing sleepiness and sleep-related driving incidents under conditions of afternoon monotonous driving following sleep restriction the night before.

sleep, instead of a 15-minute snooze [1]. As in long-duration vigils, performance on the abbreviated vigil can be enhanced by caffeine; however, as is the case with long-duration tasks, caffeine does not reduce task-induced stress, suggesting that independent mechanisms subserve signal detection and the emotional sequelae of performing demanding vigilance tasks [14]. Yildirim [15] suggests that energy drinks

Table 1 - Review of literature (continued)

Authors	Target	Method	Finding
Horne and Reyner, 2000	To evaluate caffeine as a countermeasure to driver sleepiness.	In two independent studies following a night of either restricted or nil sleep, young experienced drivers drove for 2 hr (06:00–08:00) continuously in an immobile car on an interactive, computer-generated, dull, and monotonous roadway. This exercise followed ingestion (at 05:30) of 200 mg caffeine (=2–3 cups of coffee) versus placebo, counterbalanced, double blind. Driving incidents (lane drifting), subjective sleepiness, and 4–11 Hz electroencephalogram (EEG) activity were logged.	In Study 1 (sleeping 00:00–05:00h), caffeine significantly reduced incidents and subjective sleepiness throughout the 2-hr drive, and EEG power for the second 30-min period. In Study 2 (no sleep), sleepiness affected all measures profoundly, and driving was terminated after 1 hr. Nevertheless, caffeine reduced incidents significantly for the first 30 min and subjective sleepiness for the hour. This caffeine dose, feasibly taken via coffee, effectively reduces early morning driver sleepiness for about 30 min following nil sleep, and for around 2 hr after sleep restriction.
Regina et al., 1974	To evaluate caffeine as a countermeasure of alertness	30 min after ingesting 200 mg of caffeine or a placebo, each of 24, 21-26 yr old males drove an automobile simulator for 90 min. Immediately thereafter, the S ingested a supplemental dose of 200 mg of the medication taken initially and then drove for another 90 min.	Both the initial and the supplemental doses of caffeine significantly enhanced performance beyond that found with placebo, on each of 4 measures of alertness.
Childs and Wit, 2006	To investigate the physiological, subjective, and behavioral effects of 0, 50, 150, and 450 mg caffeine in 102 light, non-dependent caffeine users.	Using a within-subjects design, subjects participated in four experimental sessions, in which they received each of the four drug conditions in random order under double-blind conditions. Participants completed subjective effects questionnaires and vital signs were measured before and at repeated time points after drug administration. Forty minutes after the capsules were ingested, subjects completed behavioral tasks that included tests of sustained attention, short-term memory, psychomotor performance, and behavioral inhibition.	Acute doses of caffeine, at levels typically found in a cup of coffee, produce stimulant-like subjective effects and enhance performance in light, non-dependent caffeine users. These findings support the idea that the drug has psychoactive effects even in the absence of withdrawal.
Haskell et al., 2005	To investigate the acute cognitive and mood effects of caffeine in habitual users and habitual non-users of caffeine.	Following overnight caffeine withdrawal, 24 habitual caffeine consumers (mean=217 mg/day) and 24 habitual non-consumers (20 mg/day) received a 150 ml drink containing either 75 or 150 mg of caffeine or a matching placebo, at intervals of > or =48 h. Cognitive and mood assessments were undertaken at baseline and 30 min post-drink. These included the Cognitive Drug Research computerised test battery, two serial subtraction tasks, a sentence verification task and subjective visual analogue mood scales.	These results do not support a withdrawal alleviation model. Differences in the patterns of responses to caffeine by habitual consumers and habitual non-consumers may go some way to explaining why some individuals become caffeine consumers.
Zhang et al., 2004	To evaluate the effects of dietary taurine supplementation on visual fatigue induced by visual display terminals (VDT) work	25 male college students aged from 20 to 24 years who were not engaged in VDT work were selected to participate in the study. Volunteers were randomly assigned to either the taurine supplementation (n=13) or the placebo supplementation control group (n=12).	The results suggest that taurine supplementation alleviates visual fatigue induced by VDT work.

can be slightly more effective at mild sleepiness than caffeine under the same conditions. Consuming energy drinks that contain 80 mg of caffeine and other ingredients such as taurine, is much more effective than coffee with the same amount of caffeine [12]. Some psychotropic drugs containing caffeine are known to play an important role in road traffic accidents as they cause sleepiness and stumbling after a certain period. In view of this fact, drivers should be made aware of the dangers of driving for long periods, and the use of caffeine containing substances which can cause dependency must be prevented [15].

This paper confirms previous research findings that caffeine and energy drinks (containing also caffeine) are good counter-measures to eliminate sleepiness. In contrast to previous studies which used simulators, or interviewed professional drivers, we have shown driver's attitudes about the impact of caffeine and energy drinks on their driving in one city.

The aim of this study is to determine the attitudes of drivers toward the impact of energy drinks and caffeine, and to give a basis for further research, considering that in this area no similar studies have been conducted up to now.

In addition to the introduction giving a review of previous research, the second chapter presents the basic hypotheses and methodology, also the way and methods of the research. The third chapter presents the results of research. The fourth chapter is a discussion of the results. At the end of the paper is the conclusion of the proposed measures and the future course of action.

Table 1 - Review of literature (continued)

Authors	Target	Method	Finding
Kim, 2003	It is hypothesized that the combinatorial influences of these ingredients are responsible for Red Bull's proposed effects (9,10).	Critical reviews of hypothesis.	Concludes that caffeine alone may be responsible for the proposed effects.
Warburton et al., 2001	To test participants who had minimal deprivation from caffeine (an hour or less) with an 80-mg caffeinated (80 mg/250 ml), taurine-containing beverage (commercially available) verum, which also contained sugars, glucuronolactone and vitamins. The placebos in the two studies were a sugar-free and a sugar-containing drink, in order to examine the effects of sugar.	In total, 42 participants were tested with a rapid visual information test, a verbal reasoning test, a verbal and non-verbal memory test and a set of mood measures. Prior to testing, they were allowed ad libitum caffeinated beverages until 1 h before testing (study 1) and unrestricted caffeine use before testing (study 2).	Moderate doses of caffeine and taurine can improve information processing in individuals who could not have been in caffeine withdrawal.
Seidl et al., 2000	Caffeine - and taurine-containing drinks have been on the European market for about a decade, and research on the individual constituents of these drinks indicates an improvement in cognitive performance resulting from consumption of such drinks	In this double-blind, placebo-controlled study using 10 graduate students, we obtained the P300 components of event-related potential (ERP) waveforms following an auditory oddball paradigm, measured motor reaction time, and applied the d2 test for the assessment of attention. Status of mood was assessed by the "Basler-Befindlichkeitsbogen" questionnaire, a standard test for evaluation of feelings of wellbeing.	The findings clearly indicate that the mixture of three key ingredients of Red Bull Energy Drink used in the study (caffeine, taurine, glucuronolactone) have positive effects upon human mental performance and mood.

2. BASIC HYPOTHESIS AND RESEARCH METHODOLOGY

In order to determine the impact and the attitudes of drivers about energy drinks and caffeine, this research was conducted using a questionnaire. The survey was completely anonymous and consisted of two parts. First, a survey is made to collect data about impressions/sensations related to consumption of caffeine and energy drinks related to driving security. Second, such data were analyzed by applying a set of statistical tests in order to determine which factors influence the different answers.

The first part was related to basic demographic information about the respondents and it had 8 questions, responded by circling one of the offered answers.

All questions were closed type questions, and the respondents in the first part responded by circling one of the offered answers. In the second part the respondents were to use the five-level scale in order to show to what extent they agree or disagree with any of the listed statements (1 – ''I completely disagree''; 2 – ''I disagree''; 3 – ''neither agree nor disagree''; 4 – ''I agree''; 5 – ''I completely agree''.

The first part of the survey consists of questions to collect the basic data on the respondents (gender, age, education level), and the length and duration of driving (average weekly mileage, how often they drive more than 30 minutes at a time). Then, issues related to the frequency of consumption (How often do you consume energy drinks? How often do you consume coffee, tea? How much caffeine do you intake in your organism, except through coffee and tea?).

The second part of the survey referred to determining driver's attitudes about energy drinks and caffeine and consisted of 26 questions (13 about energy drinks and 13 about caffeine).

The survey contained repeated questions concerning both energy drinks and caffeine in order to determine the reliability of the questionnaire.

The research was conducted in the City of Belgrade in December 2012. The survey was distributed randomly. Just during the analysis of the results these were divided according to gender, age and education. There were 420 survey papers distributed to drivers of different age groups of which 412 were returned.

The basic hypothesis is that energy drinks and caffeine have a negative impact on driving. During the research the survey method in combination with a statistical method was used. In order to compare the driver's attitudes toward gender, age and level of education, as well as with the results of other similar studies methods of analysis and comparison were used.

The database of the responses was formed and the data were analysed using SPSS Statistics, version 20.0. Normality of distribution was tested by inspection of histograms and Kolmogorov-Smirnov test. Since the distribution of all the measured variables significantly deviated from the normal distribution, non-parametric tests were used. Median (Md), absolute (n) and relative (% n) frequencies were used for the description, and Pearson's $\chi 2$ test, Kruskal-Wallis's H test and Mann-Whitney's U test were used to evaluate the significance of differences.

The limit of statistical significance (α) was set at 5%. If $p \leq 0.05$, H_0 is rejected and H_a accepted, and if $p > 0.05$ H_0 is accepted. When the Sig. value is 0.05 or less, the probability that the difference between the Observed N and Expected N value was due to chance is 5% or less.

The null hypothesis for Pearson's $\chi 2$ test was set (H_0) as follows: there is no statistically significant difference between variables, and also the working hypothesis (H_a) as follows: There is a statistically significant difference between variables.

The null hypothesis for Man Whitney and Kruskal-Wallis test was set (H_0) as follows: there is no statistically significant difference between treatments and also the working hypothesis (H_a) as follows: there is a statistically significant difference between treatments.

There were 412 drivers participating in the research, 48.1% females and 51.9% males. Most of the respondents were in the age group of 18-25 years, 68.9%, then 11.2% of those aged between 36 and 45 years, 8.3% that belong to the age group 26-35, 5.8% belonging to the age group 46 -55, 3.9% were those who belong to the age group of 56-65, and 1.9% of the respondents were older than 65 years. Among the respondents 56.3% had secondary school education, 31.1% tertiary education, whereas 7.3% had elementary education.

The results show that in 64% of cases the respondents drive less than 100 km a week, whereas 4.4% travel more than 400 km in an average week. Ten percent of respondents drive more than 30 minutes at a time every day, whereas 30% do so rarely.

3. RESULTS

The results show that in 64% of cases the respondents drive less than 100 km a week, whereas 4.4% travel more than 400 km in an average week. Ten percent of respondents drive more than 30 minutes at a time every day, whereas 30% do so rarely.

In the second part of the survey two questions were repeated, one concerning the attitude to energy drinks and the other one concerning caffeine. It was done in order to determine and verify the reliability of the survey. The Cronbach's Alpha reliability Coefficient of the questions that deals with the energy drinks was 0.74 and that dealing with caffeine was 0.8.

3.1 Frequency of consuming energy drinks and coffee, tea

The study found that more than half of the respondents never consume energy drinks (53%), whereas 34% consume these only once a month, the remaining 13% consume more often, 1% of them consume them several times a day.

When we compare the questions: "How often do you consume energy drinks?" and "How often do you consume coffee, tea?", we get the data that show the percentage of respondents who never consume either energy drinks or coffee and tea (about 9% of the total sample). The daily intake of caffeine (through coffee and tea) in case of 42% of the respondents is 1-2 cups, 19% consume 3-4 cups per day and 2% consume more than five cups a day (*Figure 1*). The previous studies have indicated that this dose of caffeine affects concentration and driving behaviour, and thus the occurrence of traffic accidents. We know that, on the average, 9 mg of caffeine is found in one cup of coffee (200 ml) and 30 mg of caffeine in one pill of Gripin (tablets containing 30 mg of caffeine and 500 mg of paracetamol). According to these amounts, if a person took a pill of Gripin, it would be as if they drank 3.3 cups of coffee. When these data are compared to the daily doses in the study done by Yildirim [15] where 72.3% of the drivers took 1-2 tablets per day, 20% took 3-4 and 7.7% more than 5 tablets a day, it can be noticed that the respondents in this study consumed much less caffeine.

When making this comparison, one should have in mind that in Turkey professional drivers were surveyed, and they drive quite more than those in this study.

3.2 Gender differences

The results show that there is only a slight difference in energy drink consumption between the genders, so that there is no statistically significant difference between females and males in the frequency of energy drinks consumption ($\chi 2 = 2.538$, $p = 0.638$). As for the frequency of the consumption of coffee and/or tea, it can be seen that 12% never consume these beverages, whereas most of the respondents consume 1-2 cups a day, which is considered a moderate amount. Even in this case, there was no significant difference between male and female gender ($\chi 2 = 4.095$, $p = 0.536$).

About 75% of respondents do not consume energy drinks as a replacement for resting. Out of 8% of the respondents who consume energy drinks so that they need no rest, 3% are women and 5% are men.

A statistical significance of the difference in the statements that energy drinks affect their driving was determined for women (Md = 3, n = 198) and men (Md = 2, n = 214), U = 4,503, z = -1.94, p = 0.05, r = 0.13. The results of the research whether energy drinks have a positive effect on driving for women and men were compared using U-test. There is a statistically significant difference for women (Md = 3, n = 198) and men (Md = 3, n = 214), U = 4,435, z = -2.08, p = 0.04, r = 0.14, more men than women (15.1% vs. 8.4%) sup-

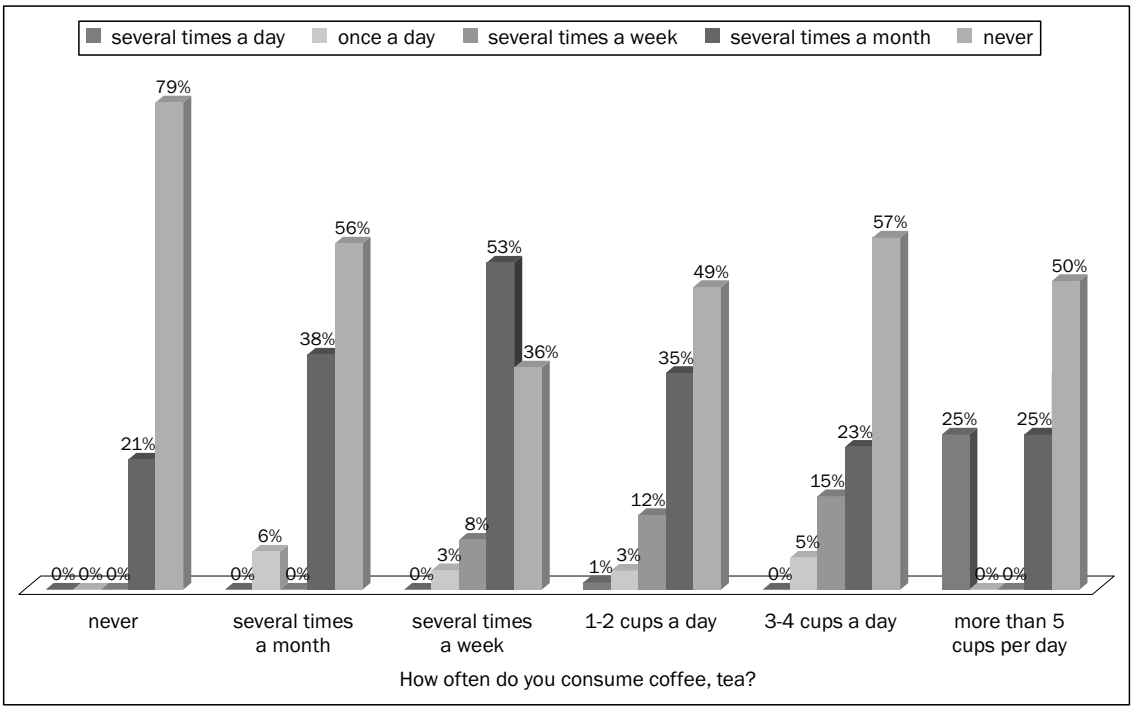

Figure 1 - The frequency of consumption of energy drinks and coffee and tea

port the view that energy drinks have a positive impact on their driving.

The respondents disagreed with the statement that for them caffeine is a replacement for sleep, 41% disagreed completely, 32% disagreed, 11% were abstained. Only 16% use caffeine as a substitute for sleep and there are no statistically significant differences between women and men.

In the following results, there are more men than women who believe that caffeine makes them feel more relaxed, but energy drinks do not. A quarter of the respondents agree that caffeine makes them calmer, but only 3.5% of them agree that after consuming energy drinks they also feel calmer. The caffeine calms more women than men, but most of them believe that energy drinks do not affect them in the same way. Very few respondents believe that caffeine (10%) and energy drinks (10%) affect their body causing anxiety. Most respondents feel more rested after taking caffeine, 14% of women and 15.5% men.

Very few respondents reported that they felt calmer after consuming energy drinks. The results show that there are more women who consume caffeine, and more men who consume both caffeine and energy drinks when they are sleepy and need to drive. Due to headache, more respondents consume caffeine (about 24%) than energy drinks (about 8%). However, when it comes to preventing sleep, the research revealed that energy drinks and caffeine are consumed equally, but women consume more caffeine, and men consume more energy drinks. About 9% of the respondents believe that in short-terms caffeine reduces fatigue when driving, but energy drinks do not. Also, 9% of respondents believe that energy drinks briefly relieve fatigue when driving, but the caffeine does not. About 18% of respondents believe that both caffeine and energy drinks briefly relieve fatigue when driving.

Statistical analysis of driver's attitudes to the impact of energy drinks and caffeine on driving according to gender was performed using the Mann-Withney test. *Table 2* shows the results. It should be noted that we determined statistically significant difference between gender and driver attitude "Energy drinks make me feel rested" (U=4,465.5, Z=-2.020, p=0.043). Men are less prone to support this view. When looking at the distribution by gender statistically significant correlation with the attitude "I do not notice the impact of energy drinks on my driving" was shown.

Drivers attitudes of the impact of caffeine on driving showed no significant differences between women and men.

3.3 Education level differences

We found a statistically significant difference between the participant's level of education and frequency of consumption of caffeine ($\chi2$ = 23.098, p = 0.027). Caffeine is least frequently consumed by people with secondary education (37% never, 33.7% rarely, 29.3 daily). Pearson's $\chi2$ test does not indicate significant difference between the participant's level of education and frequency of consumption of energy drinks ($\chi2$ = 12.226, p = 0.428), nor coffee/tea ($\chi2$ = 14.773, p = 0.468).

A statistical significance difference was determined in the level of education for the statements that energy drinks make them feel calmer ($\chi2$ = 8.657, p = 0.034) and that energy drinks make them feel nervous ($\chi2$ = 8.826, p = 0.032). It was found that significantly more respondents with university education feel calmer, and more nervous.

Participants with higher education consume energy drinks significantly more when they are sleepy and need to drive ($\chi2$ = 9.307, p= 0.025).

A statistical significance of the difference in the statements "I do not notice the effects of energy drinks on my driving" was determined for the level of education ($\chi2$ = 9.254, p = 0.026). Respondents with primary education least agree with this statement. Similar results are determined in the attitude "I do not notice the effects of caffeine on my driving" between level of education ($\chi2$ = 8.412, p = 0.038).

Kruskal-Wallis's H test showed a statistical significance difference between level of education ($\chi2$ = 12.850, p = 0.005) for the attitude: "Energy drinks make me feel more relaxed''. The most who agree are those with higher education (26.5%), while most disapproving participants are with primary education (6.6%).

Kruskal-Wallis's H test showed significant differences between level of education ($\chi2$ = 9.099, p = 0.028). Most respondents have secondary education (56.3%), followed by post-secondary education (31.1%). The survey covered 7.3% with primary and 5.3% with higher education.

Statistical analysis of driver's attitudes of the impact of energy drinks and caffeine on driving according to education level was performed using the Kruskal-Wallis test (*Table 2*).

The results showed a statistically significant difference between the level of education and attitude "My concentration is better after consuming energy drinks" ($\chi2$ =9.099, p= 0.028). This attitude was least supported by respondents with primary education (66% completely disagree), and most by respondents with higher education (23% agree).

There was also a statistically significant difference between the level of education and attitude "I feel more rested after taking caffeine" ($\chi2$ =8.412, p= 0.038). Least agree the respondents with secondary education (15.5%), and most the respondents with higher education (40.6%).

3.4 Age differences

Kruskal-Wallis's H test showed a statistical significance of the difference in the frequency of consumption of energy drinks ($\chi2 = 27.77$, $p = 0.000$), coffee/tea ($\chi2 = 35.24$, $p = 0.000$), caffeine – except coffee/tea ($\chi2 = 11.686$, $p = 0.039$) between 6 age groups. 82% of participants who consume energy drinks several times a week are young drivers (18-25), while participants who are over 56 never consume energy drinks. Coffee/tea is most often consumed by drivers 36-45 years old (more than 3 cups per day); whereas participants who are over 56 never consume energy drinks. One third of respondents over 46 years daily intake caffeine in some other way, unlike other age groups.

Kruskal-Wallis's H test showed a statistical significance difference between age groups ($\chi2 = 13.072$, $p = 0.023$) for the attitude: "Energy drinks make me feel more relaxed''. Most agree young people (17%), while all old persons disapprove (0%).

Kruskal-Wallis's H test showed significant differences between the age groups ($\chi2 = 17.823$, $p = 0.003$) for the statement that consumption of energy drinks improves concentration while driving.

A statistical significance of the difference in the statements "I do not notice the effects of energy drinks on my driving" was determined for age groups ($\chi2 = 15.666$, $p = 0.008$), where 47.8% respondents aged 36-45 support this position, which is significantly higher than other groups. The similar results are determined in the attitude "I do not notice the effects of caffeine on my driving", between age groups ($\chi2 = 18.797$, $p = 0.002$).

3.5 The influence of energy drinks on driving

Figure 2 shows a crossing of attitudes towards the statements "Energy drinks have a positive effect on my driving," and "I do not notice the effects of energy

Table 2 - Overview of statistical analyses of driver's attitudes about the impact of energy drinks and caffeine on their driving

Attitudes	Mann-Withney test (by gender)			Kruskal-Wallis test (by education)	
	U	Z	p	χ2	p
Energy drinks make me feel more relaxed.	4,465.5	-2.020	**0.043**	12.850	**0.005**
Energy drinks make me feel calmer.	5,021.5	-0.676	0.499	8.657	**0.034**
Energy drinks make me feel more nervous.	5,290	-0.016	0.987	8.826	**0.032**
Energy drinks improve my concentration when driving.	5,073.5	-0.542	0.588	7.234	0.065
I consume energy drinks because of headache.	5,204	-0.237	0.813	3.611	0.307
I consume energy drinks when I'm sleepy, and should drive.	4,619	-1.640	0.101	9.307	**0.025**
I consume energy drinks before a long drive.	5,100	-0.475	0.635	7.247	0.064
Energy drinks are a replacement for sleep.	5,235	-0.153	0.879	6.146	0.105
I do not notice the impact of energy drinks on my driving.	4,435	-2.076	**0.038**	9.254	**0.026**
Energy drinks eliminate short-term fatigue at the wheel.	4,879.5	-1.006	0.314	3.423	0.331
Energy drinks have a positive effect on my driving.	4,503	-1.940	0.052	6.687	0.083
My reflexes are better after consuming energy drinks.	4,780.5	-1.264	0.206	4.390	0.222
My concentration is better after consuming energy drinks.	4,425.5	-2.109	0.035	9.099	**0.028**
Caffeine makes me feel more relaxed.	4,989.5	-0.740	0.459	3.337	0.343
Caffeine makes me feel calmer.	4,795.5	-1.219	0.223	3.472	0.324
Caffeine makes me feel more nervous.	4,725.5	-1.405	0.160	1.458	0.692
Caffeine improves my concentration when driving.	5,039	-0.624	0.533	2.487	0.478
I consume caffeine because of headache.	4,821.5	-1.145	0.252	5.876	0.118
I consume caffeine when I'm sleepy, and should drive.	5,293.5	-0.007	0.994	7.545	0.056
I consume caffeine before a long drive.	4,568.5	-1.751	0.080	1.912	0.591
Caffeine is a replacement for sleep.	5,289.5	-0.017	0.986	1.407	0.704
I do not notice the effects of caffeine on my driving.	4,617.5	-1.642	0.101	7.268	0.064
Caffeine eliminates short-term fatigue at the wheel.	5,077.5	-0.529	0.597	5.891	0.117
Caffeine has a positive effect on my driving.	5,231.5	-0.157	0.875	3.275	0.351
My reflexes are better after consuming caffeine.	5,159.5	-0.335	0.737	1.462	0.691
I feel more rested after taking caffeine.	5,148.5	-0.358	0.720	8.412	**0.038**

drinks on my driving." On the x-axis the numbers from 1 to 5 represent the level of agreement of the respondents, from "I completely disagree" to "I completely agree", and on the y-axis is the percentage distribution of attitudes concerning the question: "Energy drinks have a positive effect on my driving". It was noticed that about 75% of respondents do not agree with any of the attitudes, that is, they notice that energy drinks affect their driving, but those are not positive effects. This may lead to the conclusion that if the influence is noticed, and it is not positive, then it is negative. About 1% of the respondents consider that the influence is positive. About 6% of the respondents who disagreed with the statement: "I do not notice the effects of energy drinks on my driving," believe that this influence is positive. Of those who do not notice the influence, approximately 1% agrees that energy drinks have a positive effect on their driving. This may be one of the additional indicators that the survey was conducted successfully, and that a very small number of respondents filled the survey irresponsibly.

3.6 The influence of caffeine on driving

Figure 3 shows the crossing of attitudes towards the statements: "Caffeine has positive effects on my driving," and "I do not notice the effects of caffeine." About 15% of respondents believe that they noticed positive effects of caffeine. About 5% of respondents gave a contradictory attitude toward the effects of caffeine on their driving, because they stated: "I do not notice the effects of caffeine; caffeine has positive effects on my driving."

Based on the analysis of the obtained results it is concluded that attitudes are more affected by the type of the substance than by gender (*Table 3*).

3.7 The influence of energy drinks vs. caffeine

When comparing the results of the effects of energy drinks and caffeine, it can be noticed that after consuming energy drinks 6% of respondents feel calmer and 11% more nervous. After consuming caffeine 20% of respondents feel calmer and 10% more nervous. These results are drastically different than the results of the research done by [15] which shows that 78.5% of drivers feel calmer after consuming Gripin, and 3.1% more nervous. Unlike the Turkish drivers, in our research most of the drivers in Serbia do not agree with any of the three statements about the effects of energy drinks. About 50% of respondents in Serbia believe that caffeine improves concentration while driving.

We assume that the above mentioned reason is because our Study included all drivers, while Yildirim [15] included just professional drivers, who drive much more, so the impact of these drinks is stronger (e.g., 78.5% vs. 20%).

4. DISCUSSION

Fatigue is one of the important elements that affect the drivers and their behaviour while driving. In order to reach the destination earlier, many choose to eliminate fatigue by consuming beverages that will

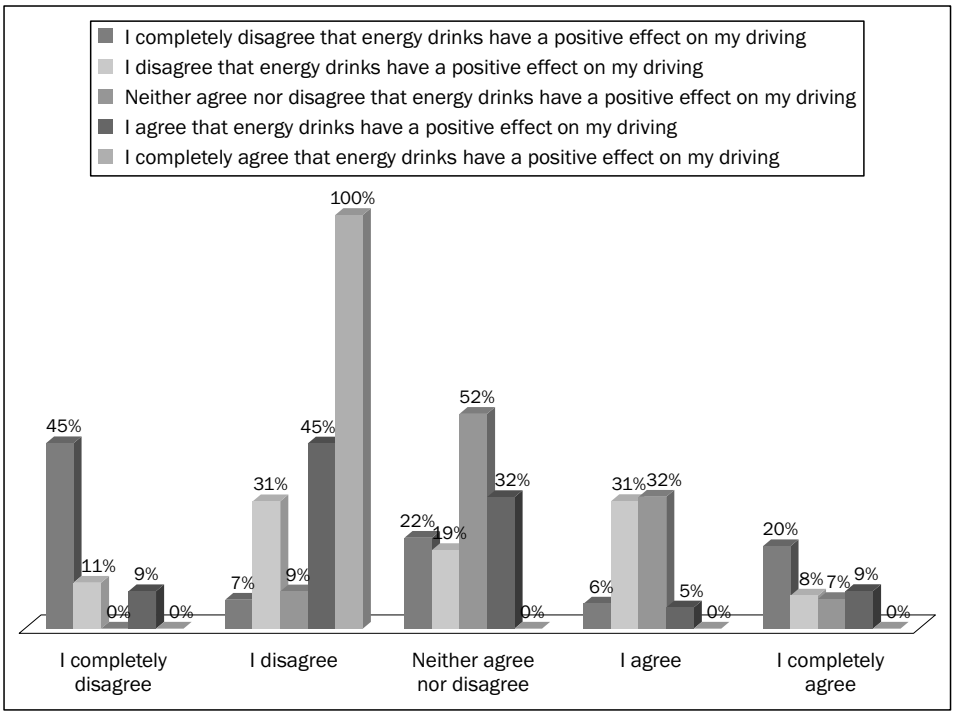

Figure 2 - The influence of energy drinks on driving

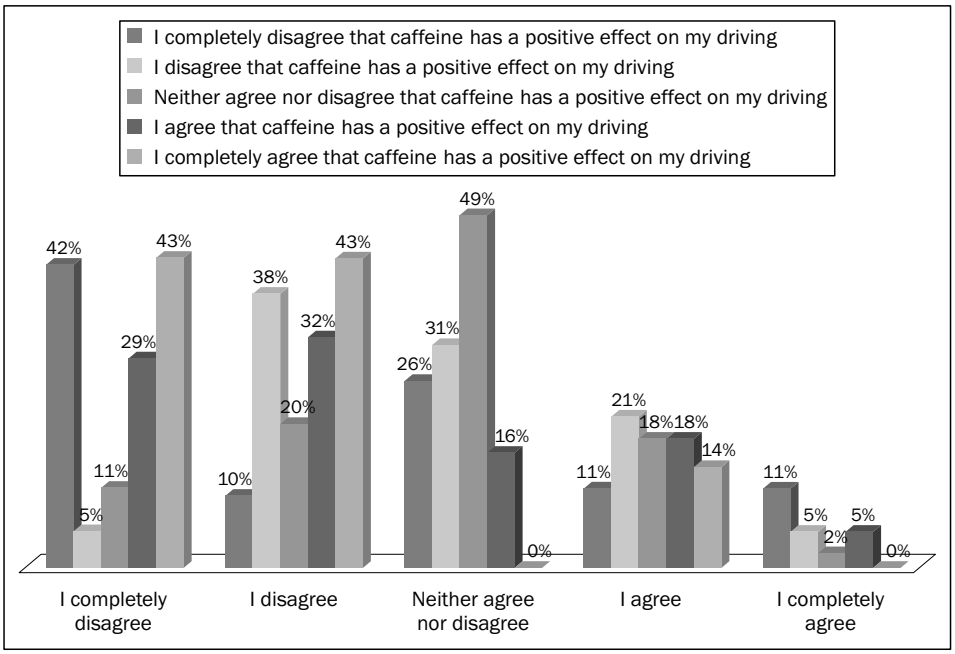

Figure 3 - The influence of caffeine on driving

Table 3 - Effect size type of substance /gender

Type of substance	Feeling after consumption	ω^2_{type}	ω^2_{gender}	$\omega^2_{type \times gender}$
Energy drinks	More rested	0.113934	-0.000800	0.028977
	Calmer	0.081764	0.001241	0.015889
	More nervous	0.019854	-0.000630	-0.003430
Caffeine	More rested	0.024632	-0.000040	0.022031
	Calmer	0.017899	0.007565	0.024246
	More nervous	0.013683	0.000403	0.003853

affect their central nervous system by removing fatigue and suppressing the need for sleep. They usually choose an energy drink that is sold in cans, easy to use and acting fast. Many studies indicated that the effects of energy drinks are strongest 30 minutes after consumption, and that their effect decreases during the next hour. Beside energy drinks, caffeine is also consumed, especially by older drivers. Caffeine is consumed in different ways, through fizzy drinks, chocolate, tea, but most often through coffee.

Energy drinks and caffeine, which is the main ingredient of energy drinks, in large quantities might affect the health very adversely, thus affecting traffic safety, because large amounts of energy drinks may have effects similar to those of alcohol. They affect reflexes, perception and response of drivers. In order to prevent the consequences of taking large amounts of energy drinks, particularly among young drivers, education is proposed.

According to the statements of the respondents, 8% consume energy drinks due to headaches, 14% to prevent sleep and about 4% for both reasons, whereas 24% of respondents consume caffeine due to headaches, 31% to prevent sleep and 15% for both reasons. The results of the research conducted in Turkey [15] indicate that as for the drivers who take Gripin, 47.7% of them take it due to headaches, 38.5% to prevent sleep and 13.8% for both reasons. Hence, it can be concluded that the results obtained in the conducted survey are similar to the research results in Turkey [15].

This survey covered all age groups, and it was found that people who are over 55 almost never consume energy drinks, whereas 60% of respondents younger than 25 consume energy drink at least a couple of times a month. All age groups consume caffeine through coffee and tea, but the respondents who are under 55 consume it more than the older ones.

We also found that respondents with higher education consume significantly more energy drinks when they are sleepy and need to drive than those with primary education (40% vs. 2%). However, participants with higher education least perceive the impact of energy drinks. Energy drinks are usually consumed by young drivers (18-25). Forty percent of them noticed their impact on driving. Older drivers rarely consume energy drinks, but more often consume coffee and/or tea than younger drivers.

Unlike previous studies, this Study shows the participant's opinions and attitudes about the consumption of energy drinks and caffeine, not only by gender but also by age and education. In this way the most dangerous groups of drivers can be determined.

The main limitation of this paper is the big difference in the distributions by age, time of driving, the frequency of the consumption of coffee / energy drinks. It is the consequence of the method of data collection. This study was conducted on a random sample. Because of that, it was not possible to know in advance the certain participation of observed categories.

Numerically uneven size group can be explained as the consequence of the age structure of the study area. Specifically, Belgrade has the largest university in Serbia, and a large proportion of young people (18-25 years) in the total population.

5. CONCLUSION

Numerous studies have been conducted in the world, and they show that caffeine has a significant influence on sleep. However, it was also found that it has a negative effect on the central nervous system, attention and concentration decrease. During the last ten years, there has been a considerable increase in the consumption of energy drinks. Energy drinks are most often consumed by young people, especially students.

Due to the resulting structure of the respondents, who were randomly generated, the findings on attitudes about the effects of energy drinks and caffeine may not be representative, but it was found that age structures representative for research on the impact of energy drinks and caffeine. This has eliminated a large part of the population; a target group does not consist of all drivers, especially drivers who consume energy drinks (18-35 years). Based on the results of the research, young drivers are categorized as a risk group, because 60% of the drivers who are under 25 consume energy drinks.

Education should be conducted among young people before they pass the driving test, in order to affect their consciousness so that they understand, before they begin to participate in traffic independently, why one needs to start driving rested, and that when they feel the signs of fatigue they should stop, take a break, and then continue their journey. If one wants the education to give results, it is necessary, beside the theory, to point out the practical examples, to show the consequences of accidents caused by fatigue and the negative effects of caffeine. On the basis of the analysis of the obtained results it is concluded that attitudes are more affected by the type of the substance than by gender

It is also necessary to give advice to future drivers what is the right way to eliminate fatigue, like a short nap up to 15 minutes or, if fatigue is to be removed in short term, to exercise for 15 minutes. It should be emphasized that it is considerably better to drink a cup of coffee than a can of energy drink. Finally, it is necessary to affect the consciousness of young people, because if they are aware of the severity of consequences in most cases they will not expose themselves to risk.

A huge problem everywhere in the world is that there is no legal limit for the intake of energy drinks in the driver's body. As a necessary measure it has been proposed to clearly define the allowed levels of energy drinks in blood, as well as to define the penalties for exceeding, as defined for the BAC level.

We should keep in mind that this is quite an unexplored area, especially on the territory of Serbia, so it has been proposed to make more detailed studies in this area, which will be based on laboratory tests modelled on foreign experiences, but also on the real situation, not only the attitudes of drivers. The aim is to determine not only the driver's attitudes but also the reality on the roads, in order to define the legal limits. In Serbia, no research about driver's attitudes to the impact of caffeine and energy drinks on road traffic safety have been conducted, so this paper investigates this research space and thus represents the basis for future research.

Doc. Dr **DALIBOR PEŠIĆ**
e-mail: d.pesic@sf.bg.ac.rs
Doc. Dr **BORIS ANTIĆ**
e-mail: b.antic@sf.bg.ac.rs
Univerzitet u Beogradu, Saobraćajni fakultet
Vojvode Stepe 305, 11000 Beograd, Srbija
Prof. Dr **DAVOR BRČIĆ**
e-mail: dbrcic@fpz.hr
Sveučilište u Zagrebu, Fakultet prometnih znanosti
Vukelićeva 4, 10000 Zagreb, Hrvatska
JELICA DAVIDOVIĆ, mast. inž. saobraćaja
e-mail: jelicadavidovic@yahoo.com
Univerzitet u Beogradu, Saobraćajni fakultet
Vojvode Stepe 305, 11000 Beograd, Srbija

REZIME

STAVOVI VOZAČA O UTICAJU KOFEINA I ENERGETSKIH NAPITAKA NA BEZBEDNOST SAOBRAĆAJA

Velike količine energetskih napitaka i kofeina, koji su glavni sastojak energetskih napitaka proizvode negativan uticaj na vozače i bezbednost saobraćaja.

U cilju utvrđivanja stavova vozača o uticaju energetskih napitaka i kofeina, sprovedeno je anketno istraživanje gde su ciljna grupa vozači. Istraživanje je sprovedeno u Beogradu, u decembru 2012. godine. Podeljeno je 420 upitnika vozačima različite starosne kategorije od kojih je 412 vraćeno. Ankete su anonimne i sastoje se iz dva dela. Prvi deo je namenjen za prikupljanje demografskih informacija, zaokruživanjem jednog od ponuđenih odgovora i sastojao se od 8 pitanja. Drugi deo je namenjen za prikupljanje stavova o energetskim napicima i kofeinu i sastoji se od 26 pitanja.

Ispitanici su popunjavanjem petostepenih skala pokazivali nivo slaganja sa datim stavovima.

Drugi deo je namenjen za prikupljanje stavova o energetskim napicima i kofeinu i sastoji se od 26 pitanja. Ispitanici su popunjavanjem petostepenih skala pokazivali nivo slaganja sa datim stavovima.

Rezultati pokazuju da energetske napitke najčešće konzumiraju mladi ljudi, mlađi od 25 godina. Uticaj kofeina na pol vozača je statistički značajan. Zbog glavobolje češće konzumiraju kofein (25%) nego energetske napitke (8%).

Veliki uticaj energetskih napitaka i kofeina na bezbednost saobraćaja ukazuje na neophodne preventivne mere poput edukacije.

KLJUČNE REČI

bezbednost saobraćaja; energetski napici; kofein; uticaj na ponašanje vozača;

REFERENCES

[1] Reyner LA, Horne JA. Early morning driver sleepiness: effectiveness of 200 mg caffeine. Psychophysiol. 2000;37:251-256.

[2] Dragač R, Vujanić M. Road safety, Faculty of Transport and Traffic Engineering, Belgrade; 2002.

[3] Brice C, Smith A. The effects of caffeine on simulated driving, subjective alertness and sustained attention. Hum Psychopharmacol Clin Exp. 2001;16:523-531.

[4] Regina EG, Smith GM, Keiper CG, McKelvey RK. Effects of caffeine on alertness in simulated automobile driving. J Appl Psychol. 1974;59:483-489.

[5] Childs E, De Wit H. Subjective, behavioral, and physiological effects of acute caffeine in light, nondependent caffeine users. Psychopharmacol. 2006;185:514-523.

[6] Haskell CF, Kennedy DO, Wesnes KA, Scholey AB. Cognitive and mood improvements of caffeine in habitual consumers and habitual non-consumers of caffeine. Psychopharmacol. 2005;179:813-825.

[7] Zhang M, Bi LF, Ai YD, Yang LP, Wang HB, Liu ZY, Sekine M, Kagamimori S. Effects of taurine supplementation on VDT work induced visual stress. Amino Acids. 2004;26:59-63.

[8] Shved DW, Godsey JL, Ledyard SL, Mahoney AP, Stetson PL, Ho S, et al. Absorption, tissue distribution, metabolism and elimination of taurine given orally to rats. Amino Acids. 2007;32:459-466.

[9] Kim W. Debunking the effects of taurine in Red Bull Energy Drink. Nutr Bytes. 2003;9:1-7.

[10] Warburton DM, Bersellini E, Sweeney E. An evaluation of a caffeinated taurine drink on mood, memory and information processing in healthy volunteers without caffeine abstinence. Psychopharmacol. 2001;158:322-328.

[11] Seidl R, Peyrl A, Nicham R, Hauser E. A taurine and caffeine-containing drink stimulates cognitive performance and wellbeing. Amino Acids. 2000;19:635-642.

[12] Reyner LA, Horne JA. Efficacy of a 'functional energy drink' in counteracting driver sleepiness. Physiology & Behavior. 2002;75:331-335.

[13] Monique AJ, Ketzer S, Blom K, Maartje H, van Gerven, van Willigenburg G, Olivier B, Verster C. Positive effects of Red Bull® Energy Drink on driving performance during prolonged driving. Psychopharma. 2011;214:737-745.

[14] Temple GJ, Warm SJ, Dember NW, Jones SK, LaGrange MC, Matthews G. The Effects of Signal Salience and Caffeine on Performance, and Stress in an Abbreviated Vigilance Task. Human Factors: The Journal of the Human Factors and Ergonomics Society. 2000;42:183.

[15] Yildirim CR. Caffeine consumption in drivers of heavy vehicles in Turkey. Journal of the Royal Institute of Public Health. 2003;117:329-332.