International Journal of Innovation and Applied Studies
ISSN 2028-9324 Vol. 46 No. 1 Jul. 2025, pp. 38-45

http://www.ijias.issr-journals.org/

IMPACT OF MODERATE BLOOD ALCOHOL CONTENT ON THE EXPLICIT LEARNING OF A LIST OF WORDS IN YOUNG SCHOOLCHILDREN IN THE CITY OF ABIDJAN (CÔTE D'IVOIRE)

Koffi Serge Pacôme Kouadio[1], Emmanuel Diboh[2], Seydou Silue[1], and Antoine Némé Tako[1]

[1]Biology and Health Laboratory, Biosciences Training and Research Unit (UFR), Félix Houphouët Boigny University, Abidjan, Côte d'Ivoire

[2]Animal Physiology Unit, Environment Training and Research Unit (UFR), Jean Lorougnon Guédé University, Daloa, Côte d'Ivoire

ABSTRACT: Excessive alcohol consumption is associated with health, social and school problems. As for moderate drinking, opinions differ depending on authors. Taking account of the way young people drink alcohol and their particular sensibilities to alcoholism at neuroanatomical level, we are led to wonder about the impact of moderate alcohol consumption on their cognitive abilities. The aim of this study was to evaluate the effects of moderate alcohol consumption on memory capacity, and more specifically on explicit learning capacity using the California Verbal Learning Test (CVLT) that is to say a memory test for young people. To do this, 56 young people were selected and divided into four groups including one control group (with a blood alcohol content of 0.0 g/l) and three experimental groups (with blood alcohol contents of 0.2, 0.5 and 0.8 g/l). Each group comprised two sub-groups (occasional and regular drinkers). Participants were subjected to a neuropsychological test, namely learning words from list A of the CVLT. The results of this study showed that alcohol consumption, even in moderate doses, significantly perturb immediate memory, thereby significantly reducing the ability to learn words for occasional drinkers (OD), especially when the blood alcohol content is 0.8 g/l. It also appears that regular drinkers (RD) are better able to tolerate the acute effects of alcohol, when blood alcohol contents are above 0.5 g/l. Schoolchildren are therefore advised to avoid drinking even at moderate dose in the school environment.

KEYWORDS: CVLT, moderate drinking, consumers, learning, young people.

1 INTRODUCTION

The ability to learn is essential to adapt and to blossom in this constantly changing world. This cognitive ability (learning process) is essential for students in academic institutions. However, behaviours such as excessive consumption can damage the structure and functioning of brain, leading to death, health trouble and social problems [1], [2], as well as having an impact on young people's academic results. This type of consumption is linked to bad marks in class [3], [4] or even school abandonment [5]. It also causes profound structural damage, such as the reduction of frontal cortical areas and the cerebellum, which are important structures for learning [6], [7]. The toxic effects of alcohol on the brain have been demonstrated by medical imaging and a reduction in grey matter has been observed in alcohol-dependent individuals [8]. The more alcohol consumption begins early, the greater is grey matter alteration [9]. The problems caused by alcohol consumption on school performance are far from being resolved, especially as, according to [10], pupils drink alcohol in pub that are dangerously close to schools, in a climate of general indifference.

Even if there is a consensus on the harmful consequences of excessive alcohol consumption by young people, there is no consensus on the effects of moderate alcohol consumption, and there are contradictions between authors. Research has shown that a blood alcohol content of 0.5 g/l (corresponding to the consumption of two standard glasses of alcohol) is sufficient to impair performance on cognitive tasks [11]. In contrast, [12] and [13] concluded that moderate alcohol consumption had a beneficial effect on cognitive performance such as problem solving with young people. Very little research has been carried out on this issue in Africa, and particularly in Côte d'Ivoire. However, taking into account of particular neuroanatomical sensibility of young drinkers [14] and the large number of regular drinkers among students, estimated at 20.04% according to [15] in the city of Abidjan (Côte d'Ivoire), one might naturally wonder what consequences moderate alcohol consumption (BAC ≤ 0.8 g/l) might have on young people's ability to learn. The aim of this study is therefore to provide some answers about the impact of moderate drinking, corresponding to the ingestion of one to three standard glasses of alcohol, on explicit cognitive learning, using the California Verbal Learning Test (CVLT) memory test in these schoolchildren.

2 Materials And Methods

2.1 Participants

For this study, 56 participants were recruited using a non-random sampling method (convenience sampling) and divided into four groups including a control group (T) and three experimental groups (E1, E2 and E3). Participants in groups E1 (n = 15), E2 (n = 14) and E3 (n = 13) drink quantities of alcohol solution in order to obtain approximate blood alcohol content (BAC) of 0.2 g/l, 0.5 g/l and 0.8 g/l respectively. Participants in the T control group (n=14) did not drink any alcohol in this study (BAC of 0.0 g/l). Each group was made up of occasional drinkers (OD) and regular drinkers (RD). The OD were 8 in T control group, 9 in group E1, 7 in group E2 and 6 in group E3. The RD were 6 in group T, 6 in group E1, 7 in group E2 and 7 in group E3. All the participants (average age = 20.2 ± 3.4 years; average mass = 62.1 ± 6.3 kilograms) were males. All participants were in good physical and mental health, to have drunk at least alcohol once, and to be able to read and write. People with hypersensitivity to alcohol or with metabolic or cognitive disorders, were excluded.

2.2 Technical Material

The technical material consisted of pure ethanol (99.8%), distilled water, an aroma to improve the palatable taste of solutions; a graduated test tube; a weighing scale; a laptop computer; a drinking glass and list A of CVLT (California Verbal Learning Test).

2.3 Preparation And Administration Of The Alcohol Solution

On the day of the test, participants have to be sober for at least 24 hours and without having eaten for at least eight hours to allow rapid absorption of the alcohol [16], [17]. The test took place in a room isolated from all outside influences. The informed consent of each participant, was obtained in advance. Following an interview, participants who reported drinking five or more glasses of alcohol at least once a week were classified as regular drinkers and those who reported drinking three to four glasses at least once a month were classified as irregular drinkers [18], [10]. The mass of each participant was then determined using a weighing scale, in order to determine the quantity of drink to be ingested. The alcoholic solution absorbed by the participants had an ethanol concentration of 40%. It was prepared by diluting ethyl alcohol (99.8%) with distilled water using the following formula:

$$Ci \times Vi = Cf \times Vf$$

Ci = initial alcohol concentration

Vi = initial alcohol volume

Cf = final alcohol concentration

Vf = final volume of alcohol

From the alcoholic solution, the mass of the participants and the desired BAC, which depends on the group assigned, the volume of drink to be absorbed by the participant is determined according to Widmark's formula [19]:

$$\boxed{T = \frac{V \times P \times 0.8}{K \times M}}$$

Hence :

$$\boxed{V = \frac{T \times K \times M}{P \times 0.8}}$$

T = approximate blood alcohol content value

V = volume of alcohol consumed by the individual in ml

M = mass of the individual in kg

K = diffusion coefficient (K = 0.7 for men and k = 0.6 for women)

P = percentage of alcohol (40%)

2.4 = DENSITY OF ETHANOL.

Participants were given five minutes to drink the experimental alcohol solution. The tests were carried out 15 minutes after drinking alcohol.

2.5 EVALUATION OF EXPLICIT LEARNING ABILITY

The ability to learn words was assessed using the California Verbal Learning Test (CVLT). The CVLT is a memory test based on the 15-word test model of Rey [20]. It is composed of two lists of 16 words (list A and list B) belonging to four distinct semantic categories (in our case: spice, clothing, tool and fruit) and a recognition list of 40 words containing the 16 words from list A. List A is the list to be learned, while list B is an interference list. The normal procedure is as follows:

- Five immediate free recalls (after reading all the words in list A);
- An immediate free recalls from list B;
- One free recall from list A;
- An indexed recall (the indexes are made up of the categories) from list A;
- A retention interval of 15 or 20 minutes;
- Delayed free recall from the A list;
- Delayed indexed recall of the A list;
- Recognition of the words in list A among the words in the recognition list.

In the present study, only list A was used. The words in list A are: pincers, grape, jacket, pepper, orange, chili pepper, tie, drill, ginger, mandarin, chisel, coat, mustard, grapefruit, hammer, waistcoat.

The study consisted of presenting the words from list A five times in succession, followed by their immediate recall after each presentation. The words were presented at a rate of one per second. Participants were instructed to recall as many words as possible, in any order. The participant also had to recall the words, even if they had already been recalled on the previous trial. The data collected were the number of words from list A correctly recalled on each trial.

2.6 VARIABLES

The study variables were:

- The classification (or treatment) variables which are the groups (T; E1; E2; E3) and the drinker categories (OD; RD) and
- The dependent variable corresponding to the number of words correctly recalled on the five CVLT A-list trials.

2.7 STATISTICS

The data collected was first entered into a spreadsheet (created using Microsoft Excel 2016), then transferred and processed using STATISTICA® 7.1 software. This was used to generate graphs and compare the average performance of the different groups (T, E1, E2 and E3) using the Kruskal-Wallis Test (non-parametric test). To analyse performance between categories (OD; RD), the Mann-Whitney U Test (non-parametric test) was used. The probability (p) of 0.05 is considered to be the limit of significance. Thus, if 'p' is less than or equal to 0.05, the difference between the compared averages is significant. However, if 'p' is higher than 0.05, then the difference between the compared average is not significant.

3 RESULTS

3.1 COMPARISONS OF PERFORMANCE BETWEEN GROUPS

Analysis of performance (number of words correctly recalled on the five trials in list A) revealed significant differences between groups (H (3,56) = 15, 14; p = 0.002) (Figure 1). In detail (multiple comparisons), the analysis reveals that the average performance of individuals in group T (51.93 ± 2.43) is significantly higher than that of individuals in group E3 (44.54 ± 5.80) (p = 0.030). Similarly, the average performance of participants in group E1 (52.73 ± 7) was significantly higher than that of participants in group E3 (44.54 ± 5.80) (p = 0.015). This analysis also revealed that the average performance of individuals in group E2 (54.43 ± 6.67) was significantly higher than that of participants in group E3 (44.54 ± 5.80) (p = 0.002). However, participants in groups T, E1, and E2 performed almost identically (not significantly different) (p > 0.05).

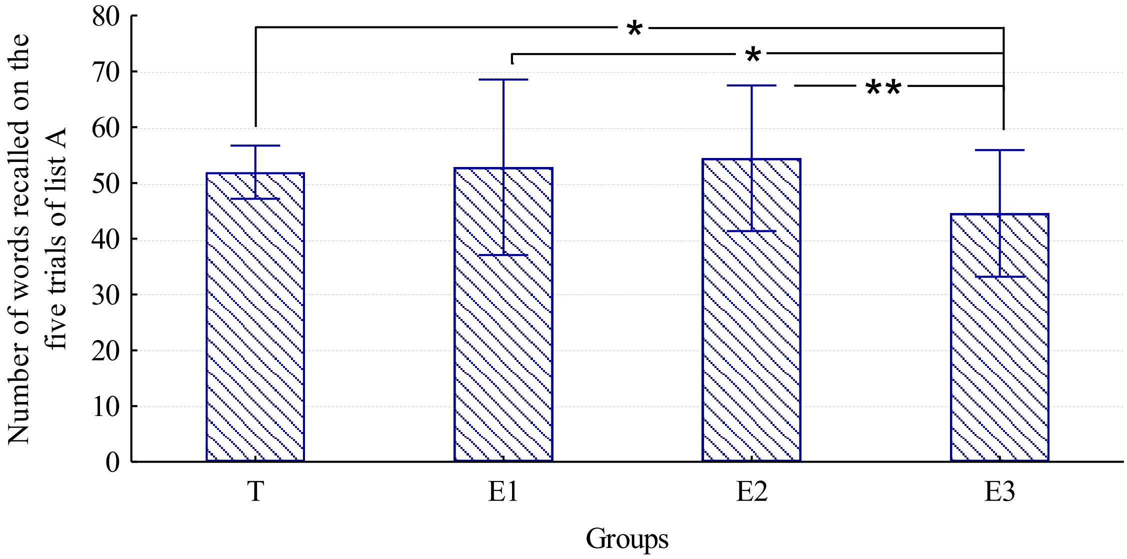

Fig. 1. Overall learning value according to each group

The average performance of participants in group E3 was lower than that of the other groups (p ≤ 0.05).
The statistical meanings shown in the figures are coded as follows:
** : p ≤ 0.05 ; ** : p ≤ 0.01*

3.2 COMPARISONS OF PERFORMANCE BETWEEN GROUPS FOR OCCASIONAL DRINKER (OD)

Analysis of the performance of the occasional drinkers (OD) indicates that at least two groups differ significantly (H (3,30) = 14.83; p = 0.002) (Figure 2 A). Multiple comparisons revealed a highly significant difference between group T (52.13 ± 1.13) and group E3 (41.17 ± 1.47) (p = 0.002). The analysis also revealed that the average performance of individuals in group E3 (41.17 ± 1.47) was significantly lower than that of individuals in group E1 (51.56 ± 2.92) (p = 0.016). Similarly, the performance of individuals in group E2 (52 ± 5.00) was significantly better than that of individuals in group E3 (41.17 ± 1.47) (p = 0.028). The other inter-group comparisons did not give significant results (p > 0.05).

3.3 COMPARISONS OF PERFORMANCE BETWEEN GROUPS FOR REGULAR DRINKER (RD)

At the level of regular alcohol drinker (RD), analysis of overall performance showed no statistically significant differences (H (3,26) = 6.33; p = 0.096) (Figure 2 B).

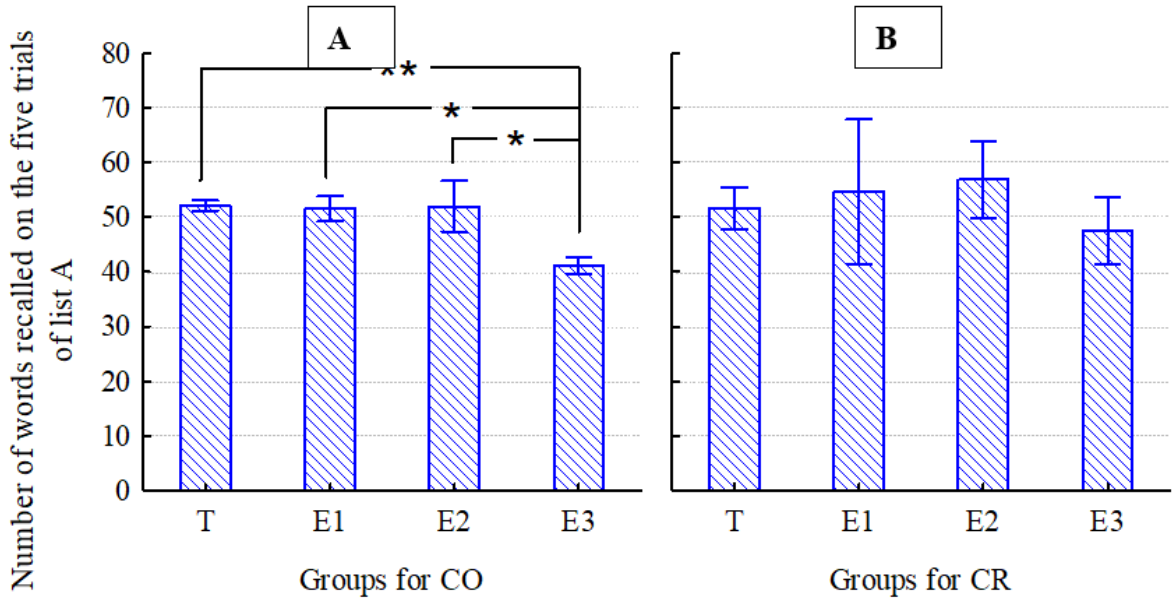

Fig. 2. Overall learning value as a function of group for the OD and CR categories

The average performance of participants in group E3 was lower than that of the other three groups for OD. For RD, the performances of the four groups are not statistically different.
The statistical meanings shown in the figures are reported as follows:
**: p ≤ 0.05; **: p ≤ 0.01*

3.4 Comparisons Of Performance Between Categories In Groups T, E1, E2 And E3

Table I shows the results of performance comparisons between occasional drinker (OD) and regular drinker (CR) in the different experimental groups (T, E1, E2 and E3). The results show that there were no significant differences between the categories for the different groups (p <0.05).

Table 1. Results of analyses between CO and CR for groups T, E1, E2 and E3

Groups	Means ± Standard deviation		P	Significance
	OD	RD		
T	52,13 ± 1,13	51,67 ± 2,61	0.662	ns
E1	51,56 ± 2,92	54,67 ± 8,03	0.388	ns
E2	52,00 ± 5,00	56,86 ± 7,86	0.128	ns
E3	41,17 ± 1,47	47,43 ± 7,85	0.073	ns

ns: not significant

There was no difference between the categories (OD and RD) for each of the groups (T, E1, E2 and E3). Moreover, the RD participants performed better than the OD one, although these differences were not significant.

4 Discussion

The aim of this study was to evaluate the effects of moderate blood alcohol content (BAC ≤ 0.8 g/l) on learning ability in young people, using the California Verbal Learning Test (CVLT). This blood alcohol content corresponds to consumption of one or three standard glasses of alcohol. Young non-alcohol-dependent drinkers were selected and divided into four groups: a control group (non-alcohol drinkers) and three experimental groups (BAC = 0.2 g/l, 0.5g/l and 0.8g/l). To comply with the recommendations of [21], the participants were all male. [22] have studied the vulnerability of women to alcohol, showing that the hormonal changes caused by the menstrual cycle do not allow effective conclusions to be drawn in the case of inter-group comparisons. In addition, it is well known that women (girls) tolerate alcohol less well than boys, due to their water deficit compared to men, since alcohol is miscible with water [23].

The results of this study show that moderate alcohol consumption significantly reduces the number of words learned by these young people. In addition, the performance of control participants was significantly better than that of occasional drinkers. These results are in accordance with those of [24], [25], who indicate that alcohol alters most brain functions. Similarly, according to an analysis conducted by [26], alcohol consumption significantly affects working memory. The learning difficulties caused by alcohol consumption can be explained by disruptions to the neuronal circuits involved in memory processes. [27] indicate that alcohol reduces memory capacity (especially when blood alcohol content exceed 0.5 g/l), particularly during explicit memory tasks. This performance drop, in the case of alcohol intoxication, is caused by a poor transfer of information from short-term to long-term memory [28]. [10] reached a similar conclusion when he found a disturbance in attentional and memory performance (with a blood alcohol level of 0.8 g/L) in occasional drinker of “Koutoukou”. “Koutoukou” is a local alcoholic beverage with a high alcohol content, produced by distilling the fermented sap of the palm tree (Elaeis guinéensis Jacq.). In addition to the ethanol common to all alcoholic beverages, it contains other alcohols such as methanol, butanol and propanol [29]. According to [30], a blood alcohol content of 0.50 g/l doubles the probability of an accident. It has been shown that, for such a dose of alcohol, a number of disorders capable of impairing the performance of cognitive tasks were observed. In particular, reaction times were lengthened and the visual field narrowed, especially when pursuing targets [31]. However, it is currently thought that the risks of accidents linked to alcohol consumption are mainly due to its disinhibiting effect, which has the effect of modifying risk-taking behaviour [32].

The results also show that participants in group E3 (with a BAC of 0.8 g/l) have significantly lower performance than those in the other groups (with BAC below 0.8 g/l). These results suggest that a blood alcohol content of 0.8 g/l constitutes a limit which, once exceeded, causes significant impairment of cognitive performance. For some authors, this value represents the threshold for acute alcohol intoxication [33], [34].

Another key fact of this study was observed. The performance of regular alcohol drinker (RD) did not appear to be impaired at any BAC considered. Moreover, within each group, the performance of the RD was better than that of the OD and even the control group, especially at BAC of 0.2 g/l and 0.5 g/l. However, this difference was not statistically significant and could be explained by the phenomenon of tolerance induced by prolonged exposure to alcohol and resulting from reactive cerebral homeostasis mechanisms [35], [36], [37]. Low-dose alcohol causes behavioural disinhibition [38] and reduces stress. This could improve cognitive performance (such as planning). These results tend to confirm the hypothesis put forward by a number of authors, including [39], [40], [41], that alcohol has beneficial effects on cognition.

It is also important to emphasise the variability of effects from one person to another, influenced by drinking habits [42]. [43] also assure that the effects of alcohol depend on the state of mind at the time. For someone who was already sad, angry or stressed before drinking, having a little alcohol may initially make them feel better. But this effect may then be reversed, and they may soon find themselves even sadder or angrier [44].

5 Conclusion

In this study, the aim was to assess the effect of moderate alcohol consumption (one to three standard glasses of alcohol) on the learning ability of schoolchildren, using a memory test, the CVLT (California Verbal Learning Test). The results show that moderate-dose alcohol consumption significantly disrupts immediate memory, reducing the ability to learn words among occasional drinkers (OD), especially when the blood alcohol content is 0.8 g/l. It also appears that regular drinkers (RD) are better able to tolerate the acute effects of alcohol, when BAC exceeds 0.5 g/l. For the time being, schoolchildren are advised to avoid drinking even moderate amounts of alcohol at school.

References

[1] Schneider M., Norman R., Parry C., Bradshaw D., Pluddemann A. Estimating the burden of disease attributable to alcohol use in South Africa in 2000. *South Africa medical journal*; 97 (8): 664-672, 2007.

[2] Ramsoomar L., Morojele N.K. Trends in alcohol prevalence, age of initiation and association with alcohol-related harm among South African youth: implications for policy. *South Africa medical journal*. 102 (7): 609-612, 2012.

[3] Feldstein Ewing S.W., Sakhardande A., Blakemore S-J. The effect of alcohol consumption on the adolescent brain: a systematic review of MRI and fMRI studies of alcohol-using youth. *NeuroImage Clinical,* 5: 420-437, 2014.

[4] Latvala A., Rose R.J., Pulkkinen L., Dick D.M., Korhonen T., Kaprio J. Drinking, smoking, and educational achievement: Cross-lagged associations from adolescence to adulthood. *Drug Alcohol. Depend*. 137: 106-113, 2014.

[5] Kelly A.B., Evans-Whipp T.J., Smith R., Chan G.C.K., Toumbourou J.W., Patton G.C., Hemphill S.A., Hall W.D., Catalano R.F. A longitudinal study of the association of adolescent polydrug use, alcohol use and high school non-completion. *Addiction*; 110 (4): 627-635, 2015.

[6] Monti P.M., Miranda R. Jr, Nixon K., Sher K.J., Swartzwelder H.S., Tapert S.F., White A., Crew F.T. Adolescence: booze, brains, and behavior. *Alcoholism, Clinical and Experimental Research,* 29 (2): 207-220, 2005.

[7] Lisdahl K.M., Thayer R., Squeglia L.M., Mcqueeny T.M., Tapert S.F. Recent binge drinking predicts smaller cerebellar volumes in adolescents. *Psychiatry Research,* 211 (1): 17-23, 2013.

[8] Chanraud S., Martelli C., Delain F., Kostogianni N., Douaud G., Aubin H.J., Reynaud M., Martinot J.L. Brain morphometry and cognitive performance in detoxified alcohol-dependents with preserved psychosocial functioning. *Neuropsychopharmacology;* 32 (2): 429-438, 2007.

[9] INSERM (Institut National de la Santé et de la Recherche Médicale). Communiqué de presse: Une étude en neuro-imagerie confirme les conséquences de l'alcool sur le cerveau; 78 p, 2006.

[10] Diboh E. Effets d'une alcoolisation aigue au Koutoukou sur l'attention et la mémoire des jeunes scolarisés de la ville d'Abidjan (Côte d'Ivoire), Thèse de Doctorat, Université Félix Houphouët - Boigny, 192p, 2014.

[11] West R., Wilding J., French D., Kemp R., Irving A. Effect of low and moderate doses of alcohol on driving hazard perception latency and driving speed. *Addiction,* 88 (4): 527-532, 1993.

[12] Baum-Baicker C. The psychological benefits of moderate alcohol consumption: a review of the literature. *Drug and Alcohol Dependence,* 15 (4): 305-322, 1985.

[13] Peele S., Brodsky A. Exploring psychological benefits associated with moderate alcohol use: a necessary corrective to assessments of drinking outcomes? *Drug Alcohol Dependence,* 60 (3): 221-247, 2000.

[14] Spear L.P. Effects of adolescent alcohol consumption on the brain and behaviour. *Nature Reviews Neuroscience*; 19 (4): 197-214, 2018.

[15] Diboh E, Yao KM, Tako NA, Bakou NF, Assi B. Alcoolisation chez les jeunes élèves en Côte d'Ivoire: préference et consommation effective. *European Scientific Journal,* 9: 380-393, 2013.

[16] Haber P.S., Gentry R.T., Mak K.M., Mirmiran-Yazdy S.A., Greenstein R.J., Lieber C.S. Metabolism of alcohol by human gastric cells: Relation to first-pass metabolism. *Gastroenterology*. 111 (4): 863-870, 1996.

[17] Song Y., Zhang S., Kang J., Chen J. and Cao Y. Water absorption dependence of the formation of poly (vinyl alcohol) -iodine complexes for poly (vinyl alcohol) films. *Royal Society of Chemistry Advances*. 11 (46): 28785-28796, 2021.

[18] Cahala D, Cisin IH. American drinking practices: Summary of finding from a natinal probabily sample. I. Extent of drinking dy population Subgroups. *QJstud Alcohol,* 29: 130-151, 1968.

[19] Widmark E.M.P. Die theoretischen grundlagen und die praktische Verwendbarkeit der gerichtlichmedizinischen alkoholbestimmung. Fortschritte der naturwissenschaftlichen forschung, Neue Folge, Berlin 11: 140, 1932.

[20] Rey A. L'examen clinique en psychologie. 2ème Edition, Presses Universitaires de France, Paris (France). Volume 1. 222 p, 1964.

[21] Ettorre E. Revisioning women and drug use: gender sensitivity, embodiment and reducing harm. *International Journal of Drug Policy,* 15 (5): 327-335, 2004.

[22] Perry BL., Miles D., Burruss K., Svikis D. S. Premenstrual symptomatology and alcohol consumption in college women. *Journal of Studies on Alcohol,* 65 (4): 464-468, 2004.

[23] Yao M., Adou J-B., Camara P., Bakou F., Tako A. et Seri B. Effets comparés de l'alcoolisation aigue au koutoukou de vin de palme (boisson alcoolique artisanale) et au pastis 45 (boisson alcoolique industrielle) sur la mémoire, chez l'homme. *International Journal of Biological and Chemical Sciences*. 5 (3): 1073-1081, 2011.

[24] Weiss E., Singewald E.M., Ruepp B., Marksteiner J. Alcoholinduced cognitive deficits. *Wiener Medizinische Wochenschrift,* 164 (1-2): 9-14, 2014.

[25] Harnett P.H., Lynch S.J., Gullo M.J., Dawe S., Loxton N. Personality, cognition and hazardous drinking: Support for the 2-Component Approach to Reinforcing Substances Model. *Addictive Behaviors*., 38 (12): 2945-2948, 2013.

[26] Spinola S., De Vita M. J., Gilmour C. E. Effets de l'administration d'alcool aigu sur la mémoire de travail: examen systématique et méta-analyse, *Psychopharmacologie (Berl),* 239 (3): 695-708, 2022.

[27] Duka T., Weissenborn R., Dienes Z. State-dependent effects of alcohol on recollective experience, familiarity and awareness of memories. *Psychopharmacology,* 153 (3): 295-306, 2001.

[28] Khan, A.U. Clinical disorders of memory. Plenum Medical Book Co., NewYork, 272 p, 1986.

[29] Camara P.A. Alcoolisation au koutoukou en Côte d'Ivoire: constat et propositions. *Alcoologie et Addictologie,* 24 (4): 319-328, 2002.

[30] Jongen S., Vermeeren A., Van der Sluiszen N.N., Schumacher M.B., Theunissen E.L., Kuypers K.P., Vuurman E.F., Ramaekers J.G. A pooled analysis of on-the-road highway driving studies in actual traffic measuring standard deviation of lateral

position (i.e., «weaving») while driving at a blood alcohol concentration of 0.5 g/L. *Psychopharmacology,* 234: 837–844, 2017.

[31] Berry R.A., Denton W.J. Tobacco-Alcohol Amblyopia: Combined Toxic and Nutritional Optic Neuropathy. *Clinical & Refractive Optometry* 31 (2): 220-224, 2021.

[32] Wickens C.M., Flam-Zalcman R., Mann R.E., Stoduto G., Docherty C., Thomas R.K. Characteristics and predictors of recidivist drink-drivers. *Trafic injury prevention,* 17 (6): 564-572, 2016.

[33] Parker, A.J., Marshall, E.J., Ball, D.L. Diagnosis and management of alcohol use disorders. *British medical journal,* 336 (7642): 496-501, 2008.

[34] Kelly, E.C., John, P. Binge Drinking Effects on EEG in Young Adult Humans. *International Journal of Environmental Research and Public Health,* 7 (5): 2325-2336, 2010.

[35] Goldstein A., Judson B.A. Alcohol dependence and opiate dependence: lack of relationship in mice. *Science,* 172 (3980): 290-292, 1971.

[36] Clapp P., Bhave S. V., Hoffman P. L. How Adaptation of the Brain to Alcohol Leads to Dependence: a pharmacological perspective. *Alcohol Research and Health*. 31 (4): 310–339, 2008.

[37] Kim S. Y., Jeong S. H., Park E-C. Age at onset of alcohol consumption and its association with alcohol misuse in adulthood. *Neuropsychopharmacology Reports*.43 (1): 40-49, 2023.

[38] INSERM (Institut National de la Santé et de la Recherche Médicale). Alcool: effets sur la santé. Rapport, Paris, France, 358 p, 2001.

[39] Mukamal K.J., Rimm E.B. Alcohol consumption: Risks and benefits. *Current Atherosclerosis Reports,* 10 (6): 536-543, 2008.

[40] Fernandez-Sola J. Cardiovascular risks and benefits of moderate and heavy alcohol consumption. *Nature Reviews Cardiology,* 12 (10): 576–587, 2015.

[41] Lundgaard I., Wang W., Eberhardt A., Vinitsky H.S., Reeves B.C., Peng S., Lou N., Hussain R., Nedergaard M. Beneficial effects of low alcohol exposure, but adverse effects of high alcohol intake on glymphatic function, *Scientific reports,* 8 (1): 2246, 2018.

[42] Aseltine R.H. and Gore S.L. The Variable Effects of Stress on Alcohol Use from Adolescence to Early Adulthood. *Substance Use & Misuse,* 35 (5): 643-668, 2000.

[43] Wanner P.B., Vitaro F., Ladouceur R., Brendgen M., Tremblay R.E. Joint trajectories of gambling, alcohol and marijuana use during adolescence: A person- and variable-centered developmental approach. *Addictive Behaviors,* 31 (4): 566-580, 2006.

[44] Ballway J.W. and Song B.J. Translational Approaches with Antioxidant Phytochemicals against Alcohol-Mediated Oxidative Stress, Gut Dysbiosis, Intestinal Barrier Dysfunction, and Fatty Liver Disease. *Antioxidants,* 10 (3): 1-34, 2021.