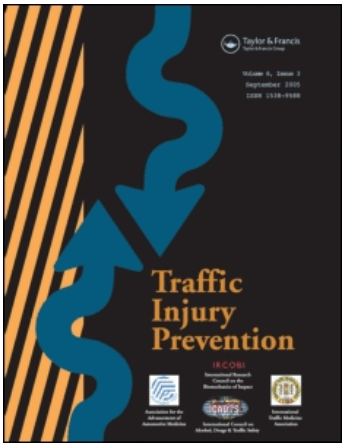

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Digital Screening for Blood Alcohol Concentration (BAC) in a Southern Nigeria City

Edeaghe E. Ehikhamenor [a]; Hope O. Obianwuho [a]
[a] College of Medical Sciences, University of Benin, Benin City, Nigeria

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Case Study

Digital Screening for Blood Alcohol Concentration (BAC) in a Southern Nigeria City

EDEAGHE E. EHIKHAMENOR and HOPE O. OBIANWUHO
College of Medical Sciences, University of Benin, Benin City, Nigeria

Objective. *Blood alcohol concentration (BAC) was digitally determined for transport operators, passengers, and pedestrians in a southern Nigeria city.*

Methods. *The subjects were screened with a digital breathalyzer, Alco Scan CA 2000, for BAC along major accident-prone highways, resting spots, and hospitals. The mouthpieces were complemented with disposable straws for rapid and hygienic screening of the subjects.*

Results. *Based on convenience sampling, a significant proportion of Nigerians has a BAC level above 0.06 on accident-prone highways (44.60%), at resting spots (54.50%), and in hospitals (47.80%).*

Conclusion. *This research confirms that digital breathalyzer BAC levels are reliable and empirical means for determining incidents of alcohol-impaired driving.*

Keywords Blood Alcohol Concentration (BAC); Impaired Driving; Road Traffic Accident (RTA); Transportation

Automobile crashes cause substantial death and injury globally. Alcohol's contribution to increased risk of traffic accidents is well-documented. The role of alcohol as a major factor in traumatic death worldwide is inestimable, ranging from mortality due to motor vehicle accidents or road traffic accidents (RTA), to falls, fires, drowning, homicides, cultism, and suicides (Ehikhamenor & Ojo, 2004).

Research has documented that the risk of a motor vehicle crash increases as blood alcohol concentration (BAC) increases, and that the more demanding the driving task, the greater the impairment caused by low doses of alcohol (Starmer, 1989; Howat & Zador, 1991). Compared with drivers who have not consumed alcohol, the risk of a single-vehicle fatal crash for drivers with BACs between 0.02 and 0.04 percent is estimated to be 1.4 times higher. For drivers with BACs between 0.05 and 0.09 percent, the risk is 11.1 times higher; for drivers with BACs between 0.10 and 0.14 percent, 48 times higher; and for those with BACs at or above 0.15 percent, the risk is estimated to be 380 times higher (Zador, 1991).

The increasing awareness of RTAs as a major cause of morbidity/mortality with resulting disability and economic loss has led international attentions to focus on developing policies and strategies for the prevention of injuries and fatalities resulting from alcohol-impaired driving (Zwi, 1993). The consumption of alcoholic beverages in countless different settings globally cannot be disputed. It is well recognized that irresponsible drinking patterns coupled with certain behaviors such as driving may result in a range of harmful outcomes (Grant & Litvak, 1998).

Based on various degrees of impairment with special reference to automobiles on public roads, maximum allowable BAC levels became imperative as a tool for enforcement and for prevention. The most significant aspect of BAC is the numeric value attached as a legal limit. While almost all developed countries adhere strictly to the BAC legislation, transition countries such as Nigeria seem totally unfamiliar with BAC and its implications. Except for South Africa and Zimbabwe, no other African country seems to have any substantial BAC research or legislation. It has been almost 100 years since it became apparent that drivers' use of alcohol leads to an increased risk of crash (Borkenstein, 1985). As early as 1910 traffic codes prohibiting alcohol-impaired driving had appeared in the United States. The major approach to prevention then, as now and in the future, will be deterrence by legal prohibition and law enforcement.

Countries with legislation against drunk driving can be sorted into three groups according to the permitted blood alcohol level. Countries with a legal limit less than or equal to 0.08 mg/deciliter include: South Africa, Austria, Belgium, Canada, Denmark, Spain, Great Britain, Italy, Luxembourg, Germany, Switzerland, and the United States. Countries with a legal limit less than or equal to 0.05 mg/deciliter include: Australia, Finland, France, Greece, Iceland, Israel, Japan, Norway, and the Netherlands. The

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Address correspondence to E.E. Ehikhamenor, Clinical Therapeutics, Faculty of Dentistry, College of Medical Sciences, University of Benin, Benin City, Nigeria. E-mail: savanngo@yahoo.com

legal limit less than 0.05 mg/deciliter in: Bulgaria, Hungary, Poland, Rumania, and Czechoslovakia. The legal limit is less than or equal to 0.02 mg/deciliter: Sweden (www.alcoweb.com, 2002). The issue of drinking and driving first began to attract attention as populations and automobile ownership increased in the late 19th and early 20th centuries (Moskowitz et al., 1991). In Nigeria, the more recent influx of fairly used motor vehicles and commercial motor bikes has led to increases in both alcohol- and non-alcohol-implicated RTAs.

Several other researchers have documented that trauma from RTAs is rising in Nigeria (Asogwa, 1992), and constitutes a major cause of accidental death in the developing world overall (Ohaegbulan, 1978; Hijar et al., 2000). A high proportion of accidents can be directly blamed on humans (Eke et al., 2000). The clearest example of a human-induced accident is that of drunken drivers of motor vehicles (Aguwa et al., 1982; Zador et al., 1996; Odero, 1998; Hijar et al., 2000). Preliminary research on morbidity/mortality associated with alcohol is well documented in several developing countries such as Nigeria by Aguwa et al. (1982) and Asogwa (1980) with 56% and 7.7% alcohol present. Other studies include Myers (1972) in South Africa, Kaye (1973, 1974) in Puerto Rico, Patel (1977) in Zambia, Sinha et al. (1981) in Papua New Guinea, and Wong et al. (1990) in Singapore.

The Federal Road Safety Commission in Nigeria as of 2002 recognized drunkenness and use of drugs as major causes of road accidents. As government and public concern about the issue grew and subjective evaluation of physical symptoms was gradually replaced by the measurement of ethanol in bodily fluids, the BAC level became a more reliable criterion for prosecuting alcohol-related impairment. However, the legal threshold for intoxication for operating a motor vehicle is not the only aspect of BAC that lacks international consensus. The mode of prevention, enforcement, punishment, and the treatment and processing of offenders varies widely as well.

An established BAC limit serves both as a legal threshold above which offending drivers may be punished and as a reminder to individuals of the illegality of drunk driving. Nigeria traffic laws have evolved at a snail's pace from the Road Traffic Act, to the Federal Road Safety Commission Decree, and to the Federal Highway Act, all of which are geared towards enhancing road safety. In spite of overwhelming global research and legislation on BAC, the law on drinking and driving in Nigeria is based on CAP 148 (traffic code law), 10 sections 27 (1) Federal Road Safety Commission Federal Republic of Nigeria Highway Code (2002) that states thus:

> "Any person who when driving or attempting to drive when in charge of a motor vehicle on a highway is under the influence of drink or drunk to an extent as to be incapable of having proper control of such vehicle, shall be liable. . . "

The interpretation of this law is a call to anarchy, implying that there is no scientific benchmark to assess level of impairment. The law enforcement agents are therefore compelled to use discretion at the expense of science to determine the legal limit.

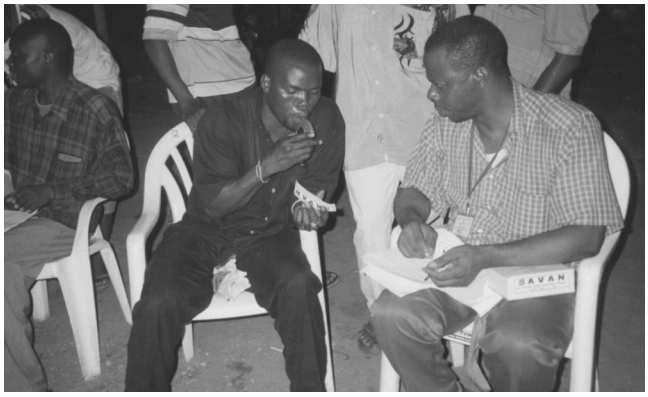

Figure 1 Night screening at resting spot of drivers and other road users.

Figure 1 shows the typical BAC screening location. The BAC of several drivers, passengers, pedestrians, and auto bike riders were determined with the use of a premium digital alcohol breath analyzer with the brand name Alco Scan Ca2000 (Craig Medical). The Alco Scan Ca2000 premium digital analyzer is described as a compact, highly sensitive, scientific instrument with automatic visual and audio test indicators employing the most integrated gas sensor microchips for rapid determination of breath alcohol.

Extracts from the manufacturer's instructions reveal that the advantages of the Model Ca-2000 include:

- Accurate readings to within (+/−) 0.01% of calculated BAC @ 0.10% BAC
- Large digital display, power warning message, compact case
- Automatic Power on Self Test, automated self calibration, Visual and Audible Progress Indicators.
- Reusable mouthpiece automatically regulates breath sample.

The mouthpiece was not convenient for mass screening. Hence, disposable straws were trimmed to size to maintain hygiene, expediency, and to facilitate the screening exercise by complementing the four mouthpieces packaged with the instrument. Alco Scan Ca2000 is unique because of its capacity to instantaneously convert breath alcohol to equivalent blood alcohol content within a range of 0.00% to 0.40% BAC. For optimal accuracy, all users were advised to wait for at least 15–20 minutes after alcohol consumption and two to three minutes after smoking.

Locations were selected for the screening based on availability of the targeted population with increased frequency of accident. Screening centers were hospitals where the victims were admitted, relaxation spots along the highways, and motor parks and auto bike parks where several transport operators collected their passengers. All participants were advised to blow steadily and continuously into the mouthpiece or straw for about 30 seconds until they heard a loud whistle sound. The BAC value was displayed on the screen within 20 seconds.

The candidates were randomly selected based on cooperation and availability except for those screened on the highways, who were selected based on violations of traffic regulations such as speeding, driving in wrong lanes, illegal parking, disobeying the

Table I Distribution of locations screened

Locations	Number	%
Hospital	297	33
Resting Spot	382	42
Highways	222	25
Total (n)	901	100%

traffic warden or traffic light, and rough driving with or without accident. The criteria for screening at various locations varied.

For hospitals, one out every three patients involved only in traffic accidents, irrespective of age or sex were selected. Along the highways, subgroup collations targeted only traffic offenders irrespective of age or sex. The resting spot candidates showed more enthusiasm and were selected randomly like those from the hospital. Excluded were victims who were either unconscious or had severe injury to the oral cavity involving the musculatures, non-cooperative patients, patients with airways impairment, and dead victims. The refusal rate was highest along the highways at 12%, much more with the females and pedestrians in spite of police intervention in some cases. The resting spots were the most receptive to the screening, with virtually everyone queuing to be screened with 0% refusal rate. The hospital refusal rate was about 5.5% of the selected candidates.

RESULTS

Table I shows the distribution of screened locations for BAC. The BAC screening shows that the resting spots had the highest screened candidates with 42%, followed by hospitals with 33%, and then highways with 25%. Table II shows the distribution of gender based on screening location. This shows that 74% of males and 26% of females reported to the hospital, a total of 33% (shown in parentheses) of the entire population screened. Resting spots had the highest number of females at 33%, while the highways had the highest number of males with 84%, with a total contribution of 42% and 25%, respectively. Figure 2 shows the level of education of the candidates. Those with primary education were predominant with about 30%, secondary with 27%, university with 18%, and none and others (not sure) at 18% and 14%, respectively.

Table III shows the BAC distribution based on age in hospitals. The BAC levelsof age group 21–30 years are more significantly elevated with 32% and 33% and 38% having 0.06–0.11, 0.12–0.17, and above 0.17, respectively. Table IV shows the distribution of BAC levels in the hospitals. Of the accident victims

Table II Distribution of gender based on location

	Male		Female		
Locations	Number	%	Number	%	Total %
Hospital	220	74	77	26	297 (33)
Resting Spot	258	68	124	33	382 (42)
Highways	185	85	37	17	222 (25)
Total	663	74	238	26	901 (100)
FEM.02	16.51%	32.44%			

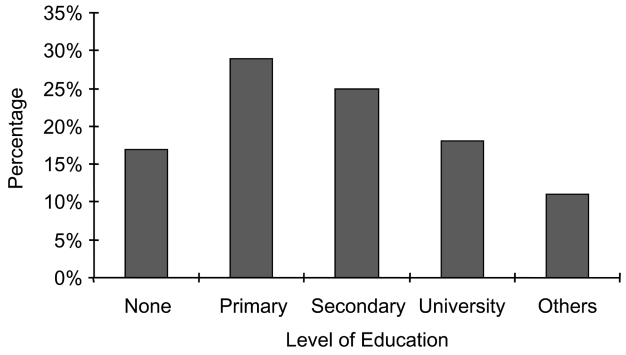

Figure 2 The level of education illustrated with the above graph shows that those with primary education were predominant.

screened in hospitals, 42% had a BAC of 0.00–0.05 while over 58% had a BAC above 0.05%. Table V compares BAC levels of candidates on the highways with those from the hospitals. The number of hospital candidates with BAC above 0.06 (47.81%) is higher than that of the candidates from highways (44.59%) (Chi-Square = 0.5283, df = 1, probability $0.5 < P < 0.10$).

Table VI compares the BAC of hospital candidates with that of the resting spot candidates. The number of resting spot candidates with BAC of 0.06 or more (54.45%) is higher than that of the hospital candidates (47.81%) (Chi-Square = 2.948, df = 1, probability is $0.10 < P < 0.05$). Table VII shows the distribution of victims injured from alcohol-related accidents. Of the screened victims, the drivers constituted 34%, bike riders 32%, pedestrians 17%, and others (passengers and unclassified) 17%.

DISCUSSION

The resting spots had the highest number of screened candidates (42%) compared to hospitals (33%) and highways (25%). The resting spots had higher participation rates because of less pressure and the higher number of female participants compared to other locations. The highway screenings were regarded as sobriety checkpoints, which applied only to traffic violators and therefore had considerably lower participation due to increased resistance to screening.

Several countries are known to have benefited from sobriety checkpoints, especially if they are well publicized, conducted

Table III BAC distribution based on age in hospitals

BAC (g/dl)	0.00–0.05	0.06–0.11	0.12–0.17	Above 0.17	Total
Ages	10%	2%	0%	0%	5%
0–10	15 (94%)	1 (6%)	0 (0%)	0 (0%)	16.00
11–20	25%	19%	20%	16%	22%
	38 (59%)	11 (17%)	8 (13%)	7 (11%)	64
21–30	34%	32%	33%	38%	34
	52 (52%)	18 (18%)	13 (13%)	17 (17%)	100 (100%)
31–40	16%	26%	23%	24%	20%
	24 (40%)	15 (25%)	9 (15%)	11 (19%)	59 (100)
41–50	9%	14%	15%	20%	12%
	14 (38)	8 (21)	6 (16)	9 (24)	35 (100)
Above 50	8%	7%	10%	7%	8%
	12 (52%)	4 (17)	4 (17%)	3 (13)	23 (100)
Total	155	57	40	45	297

Table IV Distribution of BAC in hospitals

BAC	Number	%
0.00–0.02	116	39
0.03–0.05	39	13
0.06–0.08	33	11
0.09–0.11	24	8
0.12–0.14	22	8
0.15–0.17	18	6
0.18–0.20	12	4
0.21–0.23	9	3
0.24–0.26	10	3
Above 0.26	14	5
Total	297	100%

frequently, and have high public visibility. Researchers have found significant decline in alcohol-related crashes associated with use of sobriety checkpoints (Epperlein, 1985; Lacey, 1986; Voas, et al., 1985; Ross, 1992). Examples of screening in hospitals documenting the prevalence of pre-injury alcohol use among large numbers of admitted patients can be found in papers by Treno et al. (1994) and Sodestrom et al. (2001). Some trauma care centers are known to have clinical protocols requiring screening for alcohol and other drugs for all patients at the time of admission.

Even in developing countries, trauma care centers are too busy to be involved in routine alcohol screening. In the Nigerian study, the males were predominantly screened with an approximate ratio of 3:1 on the highways, 2:1 at the resting spots, and 3:1 in the hospitals. General research had previously found that males were more mobile and involved in RTAs. Previous research by Micheal et al., 2004, found that over two-thirds of the male motor vehicle crash (MVC) victims (67.8%) tested positive for alcohol. They also found that male MVC victims (32.6%) were much more likely than female MVC victims (8.7%) to have consumed alcohol prior to trauma center admission ($p < 0.0001$).

The general distribution of BAC levels in Table III shows that the majority of the screened candidates had elevated BAC levels. However, this result is due to biased screening, since resting spots were used instead of churches, mosques, or other sacred places where the majority of road users do not drink while only violators of traffic rules on the highways were used due to the difficulty of getting other motorist to stop for screening. Perhaps if the screening on the highways had been strictly randomized irrespective of the traffic stations, significantly lower BAC levels would have been found. Previous researchers like Michael et al. (2004) found MVC victims in the 18–25 age group (42.3% male's vs 4.5% females, $P < 0.001$) with more elevated BAC levels than other groups.

Table V Comparison of BAC on highways and in hospitals

Location/BAC	0.00–0.05	0.06 and Above	Total
Hospital	155 (52%)	142 (48%)	297
Highways	123 (55%)	99 (45%)	222
Total	278	241	519

Table VI Comparison of hospital BAC with resting spot BAC

	0.00–0.05	0.06 and Above	Total
Hospital	155 (52%)	142 (48%)	297
Resting Spot	174 (46%)	208 (55%)	382
Total	329	350	679

This element of bias could not be avoided since the resting spots were the most appropriate location to find drivers and other active owners of transportation. The timing was also significant since most candidates at these locations were screened when they had just ingested alcohol. The findings do not reflect the overall Nigerian population since the locations and timing resulted in artificially inflated percentages of elevated BACs.

Driving skills are not uniformly impaired at the same BAC level (Howat et al., 1991). For example, a driver's ability to divide attention between two or more sources of visual information can be impaired by BACs of 0.02 percent or lower (Moskowitz, 1985; Howat et al., 1991; Hindmarch, 1992). However, it is not until BACs of 0.05 percent or more are reached that impairment occurs consistently in eye movements, glare resistance, visual perception, reaction time, certain types of steering tasks, information processing, and other aspects of psychomotor performance (Moskowitz et al., 1985; Aguwa et al., 1982; Finnigan & Hammersley, 1992; Hindmarch et al., 1992).

This study is a baseline research to determine the numeric value of BAC levels of transport operators in southern Nigeria. Previous studies were done with interviews and subjective methods. The prevailing global legislation on BAC and driving is a compelling factor for this research, with a view to establishing a rationale for advocacies and enacting legislation. The level of inconsistencies in methodologies and results have created a major impediment for advocacy of legislation in Nigeria. The work of using a sample size of only 32 for one year, and Aguwa (1980) with over one thousand participants, show gross inconsistencies of alcohol prevalence in Nigeria with 56% and 7.7%, respectively. Fosseus (1983) in South Africa sampled only motorcyclists, with blood analysis showing 62% of alcohol prevalence in RTAs, far higher than our findings in this study.

The BAC results show that the motor parks had the highest value (58%) of BAC ranging from 0.00–0.04, while the resting spots show the overall highest BAC levels from this study. The resting spot screening was carried out at night, while the motor parks were screened during the day. The hospital screening was done both at night and day. A high proportion of those with elevated BAC levels were found to have been screened at night, irrespective of the locations, with a ratio of 2.5:1 in favor of night.

Table VII Distribution of victims injured from alcohol-related accident

Participants	%
Drivers	34
Bike Riders	32
Pedestrians	17
Others	17

Diurnal variations of BAC of drivers and riders were noticed, with Saturday recording the highest accident rate due to high BAC levels, since most travelers are on return journey after drinking at parties, followed by Friday with the next highest level, followed by Wednesday, Monday, Thursday, and Sunday, respectively. The fact that significant parts of the screening were also done on weekends, so as not to interfere with office work, could also contribute to bias, since the majority of the candidates were involved in one drinking party or the other. Although drunk driving is known to be a potentially dangerous behavior, there is evidence that most Nigerians are neither aware of the legal limit for drivers, nor of how much alcohol they may consume before reaching that limit.

Nigeria therefore lacks both a legal threshold for alcohol intoxication and public education campaigns to raise general awareness of local BAC limits, which would be an effective means of reducing drunk driving and associated harm. Scheinberg and Stouffer (1999), as well as Bloomberg (1992), have indicated that campaigns for BAC legal limits implemented in a range of countries worldwide by government agencies and industrial bodies, including advocacy groups such as Mothers Against Drunk Driving (MADD), had yielded reductions in the number of reported drunk-driving trips and injurious or fatal accidents. Hence, the goal of setting a maximum allowable BAC level as a tool for enforcement of legislation and prevention of road traffic accidents should be pursued with vigor in Nigeria. It is expected that legislation and enforcement of a BAC threshold in Nigeria will bring about reduced incidence of duink driving and alcohol-related road trauma.

CONCLUSION

This research highlights the prevalence of elevated BAC levels among road users in Nigeria, ranging from drivers and bike riders, to pedestrians and passengers. Screening of the pre-crash phase as exemplified at the resting spots, to the violation/crash phase at highways, to the post-crash phase in hospitals screenings revealed that high BAC levels are a major attributable factor in road traffic accidents. Biased screening notwithstanding, it is appalling to know that such significant proportion of Nigerians have elevated BAC levels.

Current evidence suggests that Nigeria has not yet established a BAC threshold amid an increased incidence of drunk-driving accidents. The absence of such a vital reference point creates more problems in prosecuting alcohol-induced accidents.

There is a need for adoption and publication of practical, valid, and reliable alcohol measurement techniques and devices that are affordable for use in developing countries. Standardization of a case definition of alcohol involvement and criteria for inclusion and exclusion of subjects. Development and introduction of a reliable accident data recording system would provide more complete information on road traffic casualties, including objective assessment of alcohol involvement. Private sector participation in research, and the initiation, sustenance, and enforcement of legislation on BAC may reduce fatalities, injuries, and economic loss from alcohol-related RTAs in Nigeria.

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