Open Access Library Journal
2025, Volume 12, e13101
ISSN Online: 2333-9721
ISSN Print: 2333-9705

To Assess the Reliability of Electronic Breathalyzer and QED (Quantitative Ethanol Detector) Test Kit as a Supportive Testing Method for Examination of Drunkenness

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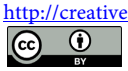
How to cite this paper: Peiris, J.S.D., Ruwanpura, P.R., Samadhi, D.A. and De Silva, D.T. (2025) To Assess the Reliability of Electronic Breathalyzer and QED (Quantitative Ethanol Detector) Test Kit as a supporttive Testing Method for Examination of Drunkenness. *Open Access Library Journal*, **12**: e13101.
https://doi.org/10.4236/oalib.1113101

Received: February 17, 2025
Accepted: April 18, 2025
Published: April 21, 2025



Abstract

Background: Ethanol is a common drug of abuse which leads to various medicolegal issues in Sri Lanka. It is clinically assessed currently and needs a supportive testing method during examination. **Methods:** An electronic breathalyzer and quantitative ethanol detector test kit were used as testing methods. The electronic breathalyzer was used to blow into the mouthpiece to get a value. The quantitative ethanol detector test kit was used by soaking the cotton bulb end with saliva within the mouth, and then inserting it into the device to get a value. **Results:** 112 cases were analysed using QED and breathalyser. 46 Cases were analysed using GC-MS. Analysis of QED with GC-MS was done using Chi-square tests and symmetric measures. P value error of QED with GC-MS was 0.024. Analysis of breathalyzer with GC-MS was done using Chi-square tests and symmetric measures. P value error of breathalyser with GC-MS was 0.009. Other variables were calculated as a percentage. **Conclusion:** The breathalyzer and QED test results correlated with Gas Chromatography, with a p-value error of <0.05 confirming their reliability in assessing drunkenness. However, the breathalyzer test showed a lower p-value error compared to the QED test, indicating better precision. Additionally, history, clinical tests, and Gas Chromatography results correlated more strongly with the breathalyzer test than with the QED saliva test. Therefore, the breathalyzer test is superior to the QED saliva test for assessing drunkenness.

Subject Areas

Drugs & Devices

Keywords

Alcohol, Breathalyzer, Quantitative Ethanol Detector

1. Introduction

Ethanol, the oldest and most commonly abused substance, has been a part of human societies since antiquity. It is not only the most widely used recreational drug but also one of the most essential compounds in the chemical industry and fuel production. Alcolism is a major health burden in Sri Lanka. Nearly 28% of the Sri Lankan population is known to consume alcohol in 2021 with 48% of males and 1.2% of females. It is more prevalent in urban areas [1].

Moderate ethanol consumption is associated with stress reduction, increased feelings of happiness, and improved well-being, with potential benefits such as a reduced risk of coronary heart disease. However, excessive alcohol consumption can lead to addiction and increase the risk of various types of injury and trauma. Both environmental and genetic factors contribute to an individual's susceptibility to alcoholism. The effects of alcohol on the human body vary depending on the dose. At lower doses (below 100 mg%), alcohol can reduce anxiety, impair motor skills, and induce euphoria. At higher doses (above 200 mg%), alcohol can lead to intoxication, stupor, unconsciousness, memory blackouts, and central nervous system depression. Ethanol is rapidly absorbed through all mucosal surfaces of the gastrointestinal tract, with the majority (70% - 75%) absorbed through the small intestine. Food delays alcohol absorption, and peak blood concentration is typically reached within 1.5 to 2 hours after consumption. Once absorbed, ethanol is distributed throughout the body and accumulates more in tissues with higher water content. Notably, alcohol concentration in arterial and venous blood may differ during the absorptive phase, with concentrations in urine and the vitreous humour generally higher than in blood. Alcohol is also produced in the intestines of living persons and in decomposing bodies, though in insignificant concentrations (about 0.1% - 1%) [2].

Ethanol undergoes immediate metabolism in the body, progressing through the following pathway: Ethanol → Acetaldehyde → Acetic Acid → CO_2 + Water. Approximately 95% of alcohol metabolism occurs in the liver, facilitated by various enzyme systems, at an average rate of 15 mg/dL per hour [3]. The majority of alcohol is excreted through urine, with smaller amounts expelled through breath, saliva, and sweat. Alcohol metabolites can be detected in urine for several days after consumption. Alcohol consumption is linked to a wide range of medico-legal issues, including driving under the influence (DUI), sexual offenses, domestic violence, murder, mental health disorders, withdrawal symptoms, exacerbation of existing medical conditions, and alterations of clinical signs in head injuries. Under Sri Lankan law, driving with a blood alcohol level exceeding 80 mg% is a punishable offense. As such, blood alcohol level estimation is a frequent aspect of

medico-legal practice in both clinical and pathological contexts. While on-site screening tests for drunk drivers are typically conducted by the police, cases involving intoxicated individuals are often referred to medical professionals for further examination.

According to the Motor Traffic (Amendment) Act (No. 31 of 1979), if a police officer suspects that a driver has consumed any drug, they may produce the individual before a government medical officer for examination. Medical assessment of intoxication involves evaluating clinical signs such as impaired visual acuity, slurred speech, and unsteady gait. However, it is important to consider that other factors, such as other substances of abuse or natural conditions (e.g., epilepsy, hypoglycaemia), can mimic alcohol intoxication. Therefore, doctors must have access to reliable laboratory testing to make informed conclusions.

The estimation of blood alcohol levels is often conducted using Gas Chromatography-Mass Spectrometry (GC-MS) technology, which is available at the Government Analysts Department [4]. However, this method is expensive, time-consuming, and primarily used for criminal cases. Blood sample collection is subject to fundamental rights and legal procedures, such as maintaining the chain of custody, which can be complex in a court of law. While urine analysis is less complicated, the correlation between blood and urine alcohol levels remains debated. Other methods for alcohol testing include breath and saliva samples. Studies show that ethanol concentrations in saliva are similar to those in venous blood. The QED saliva alcohol test kit, which uses alcohol dehydrogenase enzyme reactivity, offers a quick and reliable method for alcohol testing [5]. However, further validation is needed for its widespread use in local settings. The QED test could also be applied to other clear body fluids obtained during autopsies [6].

Breath alcohol analysis using an electronic breathalyzer is another common method. The breathalyzer operates on the assumption that the average blood-to-breath alcohol ratio is 1:2100, providing highly accurate results when used according to manufacturer instructions [7]. This method is convenient, as it can be performed by medical or technical personnel. A combination of clinical examination and reliable alcohol testing methods, such as breath or saliva alcohol tests, can enable medical examiners to make more precise and legally sound conclusions about intoxication in both clinical and medico-legal contexts.

The general objective was to assess the reliability of electronic breathalyzer and QED (quantitative enzymatic determination) test kit as a supportive testing method for examination of drunkenness. Specific objectives were to compare the alcohol level estimated by using the Electronic Breathalyzer with the alcohol level of the QED alcohol test kit, to cross check selected proportion of the samples with Gas Chromatography Mass Spectrometry (GC/MS) technology for assessment of reliability of the Electronic Breathalyzer and QED alcohol test kit results, to compare clinical findings relative to alcohol consumption with alcohol levels estimated by using Electronic Breathalyzer and QED alcohol test kit, to recommend rational non-invasive testing procedures for examination of drunkenness.

The multidrug urine test kit detects metabolites of various drugs. It is an immunoassay based on the principle of competitive binding of drugs for binding sites on their specific antibody [8]. This study tested the participants urine for narcotics as well to identify any concomitant use of other drugs.

2. Material and Methods

A descriptive population study at the office of the Judicial Medical Officer, Karapitiya Teaching Hospital, Galle, Sri Lanka.

In demographic selection criteria; The data for this study was obtained from routine medico-legal examinations of individuals referred by the police using medico-legal Examination Forms (MLEF) for suspected drunkenness. Elderly individuals, patients with severe mental illness, and those with life-threatening conditions were excluded from the study due to their inability to provide consent for the examination. In cases where court proceedings are pending (e.g., in sexual assault cases) or if the examinee completely denies alcohol consumption (which occurs in approximately 25% of cases based on past experience), the individual was referred for further blood alcohol assessment at the Government Analysts Department or the Institute of Forensic Medicine and Toxicology in Colombo. This follows the standard practice in Sri Lanka. It should be noted that no blood samples were taken solely for the purposes of this study.

The examination proceeded according to established standards of practice, beginning only after obtaining informed written consent from the examinee. A consent form was given in Sinhala/Tamil and English with an information sheet in Sinhala/Tamil and English. The examinee was encouraged to ask any questions and clarify any doubts before consenting. The examinee had the right to refuse participation in the survey.

A study sample of 110 samples were calculated by using computed formula available at https://www.surveymonkey.com/mp/sample-size-calculator with an expected population 152. A random sampling method was used. Informed written consent was given from only 46 participants to withdraw blood and analyse via GC-MS.

The medico-legal examination for suspected drunkenness was conducted in a comprehensive manner, including a detailed history of alcohol and drug use. The clinical examination followed the guidelines set by the College of Forensic Pathologists of Sri Lanka. The individual was then further assessed using an evidential breathalyzer, a portable breathalyzer for screening, and QED alcohol test kits for saliva alcohol levels.

The study Instruments used were clinical and chemical tests of medico-legal examination for drunkenness to assess reliability of supporting laboratory systems. Clinical tests used were history, general observation, lateral nystagmus, one leg stand test, walking on a straight-line test and other cerebellar tests. Chemical tests used were QED saliva, breathalyzer test, Gas Chromatography Mass Spectrometry (GC/MS) test, multidrug test kit for narcotics.

When assessed using the breathalyzer, the participant had to blow to the mouthpiece continuously and a percentage was recorded. When assessed using the QED, the cotton bulb of the QED was soaked in saliva after mopping the buccal mucosa of the mouth, and then placed in the QED device, a percentage was read.

In addition to using the Electronic Breathalyzer and QED alcohol test kits, examinees underwent a urine screening test for narcotics (Multidrug urine test). After urine collection, the multidrug urine test kit was inserted to get a reading of positive substances. Two lines indicate negative results, whereas one line indicates positivity.

The data obtained from the examinations of individuals suspected of drunkenness were entered into a separate master sheet, with only case numbers included, and analysed using the Statistical Package for Social Sciences (SPSS). Correlation of QED test results with Breathalyzer test results, Correlation of QED test results and Breathalyzer test results with GC/MS, Correlation of QED test results and Breathalyzer test results with GC/MS was analysed using the formula. Other variables were calculated as a percentage.

Data management and analysis were conducted under strict anonymity. Data specifically related to this study were securely maintained by the principal investigator and disposed of after the publication of the project.

When individuals were found to be unstable and require further therapeutic support, they were admitted to the Emergency Treatment Centre (ETC) at the Teaching Hospital Karapitiya, where clinical examination for drunkenness proceeded under the direction of the emergency physician.

The study did not cause any harm or discomfort to the examinees, as the results of the experimental data were not forwarded to legal authorities. The final outcome of the study is expected to greatly benefit both medical examiners and detainees by introducing a reliable, non-invasive approach for assessing drunkenness, in addition to the anticipated financial and resource benefits. There was no risk to the examinees as a result of their participation in this study.

The study was carried out for a period of eighteen months, tentatively from June 2019 to December 2020 (Figure 1).

	2019	**2020**	**2020**
Activity	**June-December**	**January-June**	**July-December**
Literature survey			
Proposal writing			
Ethical clearance			
Data collection			
Data entry/analysis			

Figure 1. Study time table over 18 months.

3. Results

112 cases were analysed using QED and breathalyser. 46 Cases were analysed using GC-MS. Analysis of QED with GC-MS was done using Chi-square tests (Table 1) and symmetric measures (Table 2). P value error of QED with GC-MS was 0.024.

Table 1. Chi-square test of QED with GC-MS.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	334.048[a]	300	0.086
Likelihood Ratio	173.734	300	1.000
Linear-by-Linear Association	37.368	1	0.000
N of Valid Cases	46		

a. 341 cells (100.0%) have expected count less than 5. The minimum expected count is 0.02.

Table 2. Symmetric Measures of QED with GC-MS.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	0.911	0.024	14.678	0.000[c]
Ordinal by Ordinal	Spearman Correlation	0.899	0.030	13.648	0.000[c]
N of Valid Cases		46			

a. Not assuming the null hypothesis. b. Using the asymptotic standard error assuming the null hypothesis. c. Based on normal approximation.

Table 3. Chi-square test of Breathalyzer with GC-MS.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	342.371[a]	270	0.002
Likelihood Ratio	172.227	270	1.000
Linear-by-Linear Association	41.514	1	0.000
N of Valid Cases	46		

a. 310 cells (100.0%) have expected count less than 5. The minimum expected count is 0.02.

Table 4. Symmetric measures of Breathalyzer with GC-MS.

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	0.960	0.009	22.891	0.000[c]
Ordinal by Ordinal	Spearman Correlation	0.966	0.009	24.777	0.000[c]
N of Valid Cases		46			

a. Not assuming the null hypothesis. b. Using the asymptotic standard error assuming the null hypothesis. c. Based on normal approximation.

Analysis of Breathalyzer with GC-MS was done using Chi-square tests (Table 3) and symmetric measures (Table 4). P value error of breathalyser with GC-MS

was 0.009.

Below is a graph representation (Figure 2) of the correlation of values of 112 cases of breathalyzer test results (red) and 112 cases of QED test results (blue) with 46 cases of GC-MS test results (green).

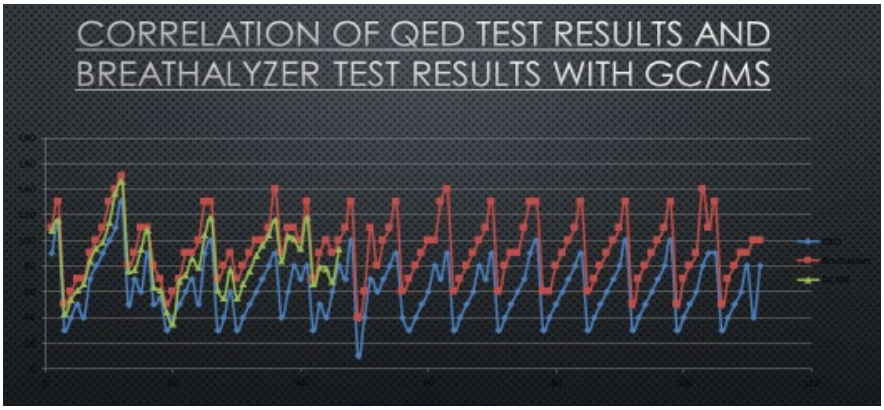


Figure 2. Correlation of breathalyzer test results (red) and QED test results (blue) with GC-MS test results (green).

Other variables were calculated as a percentage. 100% of the individuals were male. Drunkenness was 88% in individuals in the 35 - 55 age group. 92% were night-time consumers. 84% consumed arrack, while 16% consumed beer. 23% of individuals used marijuana concomitantly with alcohol. Breathalyzer test results were consistent with the reported history in 89% of cases. QED test results were consistent with the reported history in 67% of cases. Clinical test results correlated with the Breathalyzer results in 83% of cases. Clinical test results correlated with the QED test results in 72% of cases.

4. Discussion

The breathalyzer and QED test results correlated with Gas Chromatography, with a p-value error of <0.05. The correlation with the breathalyzer test showed fewer errors than the QED test. History, clinical tests, and Gas Chromatography test results showed a stronger correlation with the breathalyzer test than with the QED saliva test. The majority of individuals were night-time consumers, predominantly males in the 35 - 55 age group. There was a gender imbalance compared to other studies which could be due to the location not being urban and police being biased during producing for drunkenness. The reason for police bias could be due to male police officers performing night duty and female police officers not being available. Arrack was the most commonly consumed beverage, and 23% of individuals used marijuana concomitantly with alcohol. This was detected using the urine screening test for narcotics (Multidrug urine test).

The use of these test results in court proceedings should be approved by the courts. Currently, only the police breathalyser test results have been approved for court proceedings in Sri Lanka. This highlights the importance of this study and

future studies on supportive testing methods to assess for drunkenness during the clinical examination by the medical officers.

The limitations of self-reported alcohol consumption are loss of memory, social desirability, cognitive impairment, potential consequences of revealing information highlights the importance of conducting these studies as supportive testing methods to assess for drunkenness during clinical examination by medical officers, especially in legal proceedings.

5. Conclusion

Both the breathalyzer and QED tests are reliable supportive tests in assessing drunkenness. However, the breathalyzer test showed a lower p-value error compared to the QED test, indicating better precision. Additionally, history, clinical tests, and Gas Chromatography results correlated more strongly with the breathalyzer test than with the QED saliva test. Therefore, the breathalyzer test is superior to the QED saliva test for assessing drunkenness. It is recommended that the breathalyzer and QED tests be used as reliable supportive tests in assessing drunkenness. Substance abuse concomitant with alcohol is a growing issue in Sri Lanka, with marijuana emerging as a commonly abused substance, as highlighted in this study. It is recommended that authorities take action to reduce its misuse in the community.

Limitations of the Study

Elderly individuals, patients with severe mental illness, and those with life-threatening conditions were excluded from the study due to their inability to provide consent for the examination. Gender imbalance with only males being produced by the police for examination. Informed written consent was given from only 46 participants to withdraw blood and analyse via GC-MS.

Ethical Approval

Ethical approval was given by the Ethical Review Committee of Faculty of Medicine, University of Ruhuna, Galle, Sri Lanka.

Conflicts of Interest

The authors declare that they have no objection to the publication of this paper.

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