

# Association between Metabolic Syndrome and Substance Dependence: A Cross-sectional Study in Kenya

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## Research

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## Abstract

**Background:** Metabolic syndrome and its defining components remain an understudied area of human health research in Kenya and Africa. Understanding the relationship between substance dependence and the occurrence of metabolic syndrome is critical in prevention and clinical management of the related complications.

**Methods:** This was a cross-sectional study in 6 rehabilitative centers in 3 counties in Kenya with a conveniently selected sample size of 166 participants. A signed informed consent was obtained from each participant following which anthropometric and biochemical measurements were obtained. Descriptive statistics and chi-square test were used to describe the prevalence of metabolic syndrome and the relationship of the defining criteria with the substance of dependence.

**Results:** A quarter of the respondents were overweight and 6% obese. Fasting blood glucose was elevated in 62% of the sampled population with triglycerides having a significant variation with a mean of 216.95mg/dl and a standard deviation of 151.107. A prevalence rate of 4.8% was established based on the Harmonized Joint Scientific Statement on Metabolic syndrome for the African region. 87.34% of the population showed at least one elevated defining criteria with alcohol as the most prevalent substance of dependence. There was statistical difference of fasting blood glucose and triglycerides with alcohol use.

**Conclusion:** The findings indicate that alcohol use resulted to elevated levels of fasting blood glucose and triglycerides. There is need for emphasis on a multidisciplinary approach to substance dependence and metabolic syndrome management integrating physical activity interventions, dietary modifications and psychotherapeutic approaches.

## Background

Metabolic syndrome is the co-existence of delineated clinical and biochemical risk factors that increases the propensity of having a cardiovascular disease or event by about three-fold [1]. It's a complex disorder defined by a cluster of inter-related factors that increase the proclivity of cardiovascular atherosclerotic diseases and type 2 diabetes. Metabolic syndrome remains a subject of considerable curiosity associated with the complexity of its pathophysiology [2].

The Joint Interim Statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity defined metabolic syndrome as elevated waist circumference and any of the following; elevated triglycerides, reduced High Density Lipoproteins (HDL), elevated blood pressure and elevated fasting blood glucose [3]. Primary preventive methods such as lifestyle changes are highly effective in improvement and preservation of cardiovascular health [4].

Substance use has a significant impact on the quality of life of families and children, and on nations and health systems [5]. The 2016 report on the United States National Survey of Drug Use and Health (NSDUH) estimated that 19 million adults above 18 years had a substance use disorder during the past year and 8.2 million had a substance use disorder and mental illness. In general, the numbers of adults initiating cocaine, cannabis and heroin increased in 2018 [6]. Substance use has shown increment in the risk of metabolic syndrome and diabetes in part due to increased cell damage and lowered cellular antioxidant potential [7]. Patients with metabolic syndrome have a higher occurrence of psychiatric comorbidity with psychotropics leading to development of metabolic syndrome [8]. Global estimates of the use of opioids is 28.6 million-38 million with a global prevalence of 0.7% [7, 9]. Increasing evidence indicates that opioids play a critical role in regulation of food intake and the reward basis based on ingestion [7].

Substance use prevention has a strong association to the constructs of social cognitive theory, the theoretical basis for explaining substance use [4]. Mattoo et al. [10] found a significant correlation of Body Mass Index (BMI) with presence of metabolic syndrome. The critical role of anthropometric measurements such as weight, waist circumference and BMI is emphasized by Mattoo et al. [11] and Grover et al. [12] who reported higher levels of BMI and obesity as significant predictors of metabolic syndrome. This is reinforced by findings from Gardner-Sood et al. [13] which emphasize the need for routine monitoring of waist circumference in psychosis and assertive management for cardiovascular risk in people with psychosis.

Understanding the causality and relationship of substance use and metabolic syndrome is critical towards development of definitive management and preventive measures among substance dependent persons. Metabolic syndrome and its defining elements in substance dependence remains an understudied research area in Kenya and Sub Saharan Africa despite the associated cardiovascular complications that manifest in these patients. The findings reported here are part of the project findings titled Gene-environment interactions in the genesis of substance dependence, psychosis and relapse in Kenya.

## Methods

### Study sites and Design

This was a cross-sectional study in 3 counties in Kenya; Mombasa, Muranga and Uasin Gishu. This was designed to sample a representative population of the country into the study due to the diversity in distribution of clients admitted in these rehabilitation centers. The study sites were six rehabilitation centers located in the three counties, two in each county. Community sensitization within counties hosting the study sites was done to encourage persons dependent on alcohol, cannabis and cocaine to visit the selected study rehabilitation centers. Samples were collected from consenting persons attending health facilities, admitted in rehabilitation centers and those sampled out from the community in the

county who accepted to visit community sampling centers that were established in various parts of the country during the project.

Blood samples were collected from consenting individuals diagnosed as dependent to a substance or those who confess to be users and willingly visited the community sampling centers.

## **Sampling**

A convenient sample of 166 substance patients was used in the study selected from 6 participating rehabilitation centers and the surrounding community sampling centers. Purposive sampling was used to select the 6 rehabilitation sites. Severe cases were referred to selected rehabilitation facilities for further management. Intervention mechanisms were also put in place to provide treatment and counselling collaboratively with selected rehabilitation centers as per the current standard of care.

## **Anthropometric measurements**

Height, weight, waist circumference and blood pressure measurements were taken during a private physical examination by a qualified nurse. The height was measured using a Seca Rod 220 stadiometer (Seca, Hamburg, Germany), a TANITA (TANITA, Arlington Heights, Illinois) weighing scale to measure the weight and a Gulick tape measure to measure the waist circumference. All anthropometric measurements were taken without shoes and wearing light clothing. Waist circumference was measured at the iliac crest upon exhalation. Blood pressure was taken after a five minutes rest using an Omron automated monitor (Omron, Kyoto, Japan). The WHO guidance on body mass index classification was employed.

## **Biochemical measurements**

SD Cholesterol/Lipid desktop analyzer was used to measure the biochemical measures for triglycerides, High Density Lipoproteins, and fasting glucose. Blood samples were acquired from a finger prick using a lancet and collected using a pipette. 12 hour fasting blood samples were assayed by standard methods for blood glucose, HDL-cholesterol and triglycerides in three minutes. A copy of the results was availed to each participant. If the results were outside normal parameters, the participant was referred for follow up and continued management with a health provider.

## **Metabolic and its elements' defining criteria**

The defining criteria stipulated in the Harmonized Joint Scientific Statement (HJSS) [3] on metabolic syndrome was used. This requires central obesity or an elevated waist circumference and at least two other components. Precisely, the criteria is as follows: Waist circumference: >94 cm (male) >80 cm (female), Blood pressure- > 130/85 mmHg. (Hypertension), Impaired glucose handling-PG >200 mg/dL

(11.1 mmol/L), raised fasting plasma glucose >100 mg/dL (>5.6 mmol/L), Body mass index  $\geq 30 \text{ kg/m}^2$ , Dyslipidemia: triglycerides (TG):  $\geq 1.7 \text{ mmol/L}$  /150 mg/dL and high-density lipoprotein cholesterol (HDL-C)  $\leq 1.0 \text{ mmol/L}$ /40 mg/dL (male),  $\leq 1.3 \text{ mmol/L}$  /50 mg/dL (female).

## Results

### Demographic characteristics

The findings indicate that out of 166 rehabilitated patients participating in the study, majority of the respondents were male with 93.4% (155) and 6.6% (11) were female. Most of the findings reported herein will be inclined towards the male gender. The mean age was 35.5 years ( $SD = 10.68$ ) It was further established that 6.6% were aged 18–20 years, 31.3% aged 21–30 years, 31.3% aged 31–40 years, 20.5% aged 41–50 years and 6.6% above 50 years. 3.6% had missing information on the age. Regarding the level of academic achievement, 12.7% got to primary/elementary school level, 25.3% in high school, 1.2% in certificate level, and 22.3% in Diploma, 23.5% reached the degree level while 2.4% had masters. This indicates that majority of the substance abuse clients had attained at least high school completion.

### Anthropometric, clinical, and biochemical description of the participants

The mean height and weight were 1.72 meters ( $SD = 0.078$ ) and 69.5 kg ( $SD = 12.63$ ) respectively. The mean Body Mass Index was borderline normal at  $23.46 \text{ kg/m}^2$  ( $SD = 4.05$ ) with 24.7% reported as overweight and 6% as obese (Table 1). The mean waist circumference was 90.1 cm with 28.8% having central obesity. The study established a mildly elevated mean systolic blood pressure of 129.18 ( $SD = 16.240$ ) mmHg. As for the diastolic blood pressure, they recorded a mean of 82.86 ( $SD = 11.415$ ). An elevated mean of 6.83 mmol/L ( $SD = 6.205$ ) was recorded in fasting blood glucose with the standard deviation indicating a vast population spread and variability with 62% of the sampled population had elevated fasting blood glucose. This is an indication of the presence of prediabetes in majority of the population prone to substance abuse. Triglycerides revealed the most significant variability with a mean of 216.95 mg/dl and a standard deviation of 151.107. The recorded mean of high-density lipoproteins was 54.20 ( $SD = 39.862$ ) mg/dl and a mean of 77.008 ( $SD = 41.1888$ ) mg/dl for low-density lipoprotein cholesterol. Non-high density lipoprotein cholesterol registered a mean of 115.23 ( $SD = 43.449$ ) mg/dl.

### Prevalence of Metabolic syndrome and each of the defining elements

The prevalence rate of metabolic syndrome among substance abuse clients in rehabilitation in Kenya is 4.8% (8) out of a sampled population of 166 respondents. Most respondents with metabolic syndrome were between the ages of 31–40 with 62.5% (5) with the males accounting for 75% (6) and females 25%

(2). In relation to substance abuse and diagnosed metabolic syndrome, 75% (6) used alcohol, 62.5% (5) used cannabis while 25% (2) used heroin.

Of the 166 valid responses from the patients undergoing rehabilitation, 87.34% had at least 1 component of the metabolic syndrome markers in all the 3 counties. The study established that 62.0% had impaired fasting glucose 42.2% had high systolic blood pressure, 37.3% had high diastolic blood pressure and 32.5% had elevated triglycerides. Hence, impaired fasting glucose was the most prevalent defining criteria for metabolic syndrome, followed by high blood pressure as indicated in Table 1.

Table 1  
Prevalence of metabolic syndrome elements

Anthropometric/biochemical indices	% of the population sampled		
	Normal	Elevated/Decreased	No recording
Waist Circumference	69.9	28.9	1.2
BMI	60.2	Overweight-24.7, Obese-6  Underweight-7.8	1.2
Systolic Blood Pressure	56	42.2	1.8
Diastolic Blood Pressure	60.8	37.3	1.8
Fasting Blood Glucose	34.9	62	3
Triglycerides	33.7	32.7	33.7*
HDL-C	53.6	12 (low)	34.3*

\*The high percentage of respondents without readings as a result of refusal to have blood drawn for the lipid profiling.

It was further established that 28.9% of the participants had a high waist circumference and 6.0% were obese. These results indicate that high waist circumference and obesity were the least prevalent defining criteria for cardiometabolic syndrome respectively.

Alcohol was the most prevalent substance of addiction at 86.2%. The study sought to examine use of alcohol regarding the number of defining criteria using chi square test. The difference in fasting blood glucose levels and Triglycerides due to alcohol consumption was statistically significant ( $P < 0.05$ ) with 67.41% and 54.74% of alcohol users showing elevated levels of these metabolic syndrome elements respectively. The conclusion drawn is that alcohol consumption mostly likely affected the levels of fasting blood glucose and triglycerides for the users.

Table 2  
Alcohol differences in regard to elevated metabolic syndrome elements

MetS Criteria	% that reported alcohol abuse	$\chi^2$
		P Value
BMI	5.1%	$\chi^2 = 2.512^a$ P = 0.473 df = 3
Waist circumference	29.2%	$\chi^2 = 0.709^a$ P = 0.400 df = 1
Fasting blood glucose	67.41%	$\chi^2 = 4.880^a$ P = 0.027 df = 1
Triglycerides	54.74%	$\chi^2 = 9.177^a$ P = 0.002 df = 1
HDL-C	82.8%	$\chi^2 = 1.371^a$ P = 0.242 df = 1
$\chi^2$ -Chi square, Df-Degree of freedom		

Comparing this with two of the substances with higher prevalence rates, cannabis and cocaine, none of the metabolic syndrome elements were statistically significant as the p-value was more than 0.05. Hence, there was no significant association between the use of cannabis and cocaine; and any of the metabolic syndrome elements.

Table 3  
Cannabis and cocaine differences in regard to elevated metabolic syndrome elements

MetS Criteria	% abusing Cannabis	% abusing cocaine	$\chi^2$	$\chi^2$
			Cannabis	Cocaine
BMI	7.23%	0	$\chi^2 = 3.300^a$ P = 0.348 df = 3	$\chi^2 = 1.122^a$ P = 0.772 df = 3
Waist circumference	24.10%	40%	$\chi^2 = 1.099^a$ P = 0.294 df = 1	$\chi^2 = .343^a$ P = 0.558 df = 1
Fasting blood glucose	60.98%	60%	$\chi^2 = 146^a$ P = 0.703 df = 1	$\chi^2 = 026^a$ P = 0.873 df = 1
Triglycerides	50.0%	66.67%	$\chi^2 = 0.877^a$ P = 0.349 df = 1	$\chi^2 = 0.343^a$ P = 0.558 df = 1
HDL-C	80%	100%	$\chi^2 = .014^a$ P = 0.907 df = 1	$\chi^2 = .763^a$ P = 0.382 df = 1
$\chi^2$ -Chi square, Df-Degree of freedom				

## Discussion

There exists a gap in cardiovascular and mental health research in Africa into the relationship between substance abuse and occurrence of metabolic syndrome and its elements. Substance abuse is a growing societal and health systems problem that requires urgent intervention. Part of the overall net effect in substance dependent individuals is a cascade of cardiovascular related risk factors denoting metabolic syndrome. Substance abuse patients have poorer diabetes and cardiovascular outcomes that include poor follow up, sub-optimal self-management skills and limited access to care [14, 15].

The prevalence rate of 4.8% observed in this project falls near the global range of 5%-31% in other studies of patients with alcohol abuse [11, 16–19]. The prevalence of metabolic syndrome in psychiatric patients was significantly higher in Brazil at 29.4% [20]. The most prevalent metabolic syndrome element was

impairment of fasting glucose. This is different from observation by Mattoo et al. [11] and Yoon et al. [18] who identified elevated triglycerides as the most prevalent metabolic syndrome element.

A significant statistical difference is highlighted in the differences in triglyceride and fasting blood glucose levels resultant from alcohol consumption. This correlates with findings from Ojo et al., [21] who reported that the effect of substance abuse on fasting blood glucose was significant. Approximately a third of the sampled population had increased waist circumference with 12% having low HDL. These findings correlate with those of Shah et al. [22] who showed that history of ever use of any drug was associated with increased odds of elevated waist circumference and decreased odds of having low HDL.

Cannabis and cocaine users did not show any statistical difference in the elevated metabolic syndrome elements. Existing literature indicates that cannabis users have better metabolic profiles, 77% less likely to have metabolic syndrome according to Yankey et al. [2]. Cannabis use has also been associated with lower levels of waist circumference and fasting insulin [23, 24]. However, Yankey et al. [2] also reported that regular cannabis users had an average higher waist circumference than normal metabolic syndrome clients who did not use cannabis with significant associations between duration of cannabis use and metabolic syndrome and its elements. Each year of continued cannabis use was associated with a significant 5% increase in the odds of having metabolic syndrome and 4% increase in odds of having hypertension. Muniyappa et al. [25] opined that chronic use of cannabis was associated with visceral adiposity and adipose insulin resistance but it was not associated with insulin insensitivity, glucose intolerance and hepatic steatosis.

The most prevalent substance abused identified was alcohol. Its harmful effects can-not be over-emphasized. Globally, alcohol dependence was the most prevalent of the substance use disorders, with 100·4 million estimated cases in 2016 (age-standardized prevalence 1320·8 cases per 100 000 people, 95% uncertainty interval. The Disability Adjusted Life Years in Eastern sub-Saharan Africa attributed to alcohol showed the major cause as unintentional injuries and for drug use as drug use related disorders in 2016 [26]. The harmful impact of excessive alcohol consumption primarily manifests in the presence of metabolic syndrome at half the amount that the same harmful impact would manifest in individuals absent of metabolic syndrome [27]. Binge drinking is associated with mortality with adjustment for average daily consumption. The overall mortality in individuals with fatty liver disease and metabolic syndrome with excessive alcohol intake was 32.2% compared to 22.2% in individuals with non-excessive alcohol intake [27].

## Conclusion

This is one of the few studies, and the first one in Kenya, seeking to understand the relationship between substance use and occurrence of metabolic syndrome. The correlation indicated herein and in literature on metabolic syndrome, its elements and substance use is a critical knowledge source in the successful design and implementation of an integrated, multidisciplinary approaches in the management of

metabolic syndrome and substance dependency such as physical activity measures, dietary modifications, behavior change communication and psychotherapeutic approaches [28].

## Abbreviations

**BMI**- Body Mass Index

**HDL**- High Density Lipoprotein

## Declarations

### Ethics approval and consent to participate

Ethical approval was sought from Mount Kenya University Institutional Research Ethics Committee. The research permit was received from the National Commission for Science, Technology and Innovation (NACOSTI). The researchers explained and sought informed consent from study participants with assurance of privacy and confidentiality.

### Consent for Publication

Not applicable

### Availability of data Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no competing interests.

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This work was made possible through a financial grant from the National Research Fund, Kenya.

### Authors' Contributions

All authors were instrumental in conception, research design and data collection. SM conceptualized the idea, CM, PK, EM, FM, MN, JG, BM was instrumental in manuscript review and revision. All authors

approved the final manuscript for submission and publication.

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