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High Prevalence of Metabolic Syndrome among Female Vegetable Market Traders in Hargeisa, Somaliland: Risk Factors and Implications

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SUMMARY

Background: Metabolic syndrome, characterized by abdominal obesity and two or more of the following components (fasting blood glucose ≥100 mg/dL, low HDL-cholesterol, high triglycerides, and hypertension), is a common cause of morbidity and mortality. In Somaliland, female vegetable market vendors, who often sit for long hours, face an elevated risk.
Aims: This study aims to assess the prevalence and associated factors of metabolic syndrome in this population.
Methods: Conducted from December 2020 to April 2021 in Hargeisa's vegetable markets, this cross-sectional study recruited 291 women using stratified convenience random sampling. Structured questionnaires collected socio-demographic data, while fasting blood samples provided information on blood sugar, triglycerides, and high-density lipoprotein levels. Descriptive statistics and logistic regression were used for analysis.
Results: A total of 291 women, aged 21-80 years (mean age 45.3 (12.3) years, participated. The prevalence of metabolic syndrome was 71.8%, significantly higher than global averages. High waist circumference (87.9%, P = 0.00) was the most prevalent component, suggesting unique dietary or lifestyle factors. Notably, no significant association was found between marital status and metabolic syndrome (P = 0.41), contrasting with findings from other regions. Approximately 45% of participants had two components of metabolic syndrome, 40% had three components, and 15% had four components, respectively, indicating a distinct pattern of component distribution.
Conclusions: This study found a high prevalence of metabolic syndrome (71.8%) in this population. Key risk factors included older age, high BMI, and increased waist-to-hip ratio, highlighting the need for targeted health interventions and education for this specific occupational group.

Keywords: Metabolic syndrome; Abdominal obesity; Prevalence; Risk factors; Hargeisa, Somaliland.

ABBREVIATIONS

AACE	American Association of Clinical Endocrinology	**HDL**	High-Density Lipoprotein
BMI	Body Mass Index	**IDF**	International Diabetes Federation
CHD	Coronary heart disease	**MS**	Metabolic Syndrome
CI	Confidence Interval	**MTRH**	Moi Teaching and Referral Hospital
CVD	Cardio Vascular Disease	**NCEP-ATP III**	National Cholesterol Education Odds ratio Program Adult Treatment Panel III
EGIR	European Group for the study of Insulin Resistance	**OR**	Odds ratio
FBS	Fasting Blood Sugar	**WHO**	World Health Organization
		WHR	Waist to Hip Ration

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INTRODUCTION

Metabolic syndrome (MS) is a complex condition that has reached epidemic proportions globally, posing a significant public health challenge. It is characterized by the concurrent presence of at least three out of five cardiometabolic abnormalities: obesity, hyperglycemia, hypertriglyceridemia, reduced high-density lipoprotein (HDL) levels, and hypertension [1, 2]. These factors significantly elevate the risk of cardiovascular diseases and type 2 diabetes, underscoring the syndrome's public health relevance. The development of MS is influenced by various risk factors, including obesity, aging, and prolonged sedentary work [3].

Prompt detection of MS is vital for initiating lifestyle interventions that can mitigate the risk of related chronic conditions. Diagnostic criteria have been developed by numerous health organizations, such as the European Group for the Study of Insulin Resistance (EGIR), the National Cholesterol Education Program Adult Treatment Panel III (NCEP: ATP III), the World Health Organization (WHO), the American Association of Clinical Endocrinology (AACE), and the International Diabetes Federation (IDF) [4, 5]. Despite these differing standards, they all emphasize the necessity of managing MS to avert its severe health impacts.

Globally, the prevalence of MS varies from 12.5% to 31.4%, depending on the diagnostic criteria used [6]. Regional disparities are evident; for example, prevalence rates among women in Middle Eastern countries range from 11.7% in Kuwait to 41% in Saudi Arabia. In contrast, African nations report rates from 17.9% in Ethiopia to 40.2% among Kenyan women [7, 8]. In Central Africa, Bowo-Ngandji et al. (2023) [9], documented a similarly high prevalence of MS among women, particularly those exposed to urbanized environments and sedentary occupations. These findings underscore the urgent need for region-specific interventions tailored to the occupational and lifestyle factors prevalent in African settings.

Recent data from Africa suggest that MS is becoming increasingly prevalent. A comprehensive systematic review by Whelton et al. (2018) [10] found the overall prevalence of MS in African populations to be 32.4% (95% CI: 30.2–34.7), based on 297 studies from 29 African countries involving 156,464 participants. The prevalence was higher among women (36.9%) compared to men (26.7%) and was significantly elevated in adults over the age of 18 (33.1%) compared to children under 18 years (13.3%) [10]. Moreover, the prevalence of MS was particularly high among individuals with type 2 diabetes (66.9%) and those with cardiovascular diseases (48.3%). Despite these alarming statistics, Charles-Davies et al. (2023) [11] argue that existing diagnostic criteria may not fully account for the genetic and environmental factors unique to African populations, advocating for the development of African-specific diagnostic cut-offs to enhance the accuracy of diagnosis and management.

In Hargeisa, Somaliland, a substantial proportion of women work in vegetable markets. In the present study, five of the main markets in Hargeisa, with an approximate population of 1,000 female vegetable vendors, were sampled. These women face unique occupational challenges that may heighten their risk of MS. In particular, the market traders endure long hours of sedentary work, limited access to healthy dietary options, and exposure to stress, all of which are recognized risk factors for MS [3]. Understanding these occupational and lifestyle factors is essential for designing targeted interventions aimed at reducing the burden of MS in this vulnerable population.

While data on MS in Somaliland is limited, its prevalence is increasing across African nations, including neighboring countries [10]. Studies show that women are particularly affected, with MS rates ranging from 17.9% in Ethiopia to 40.2% in Kenya [7, 8]. However, there has been little research on MS among female vegetable market traders in Hargeisa. This study aims to address this gap by examining the prevalence and risk factors of MS in this population. The findings are essential for guiding public health strategies and interventions to mitigate MS's impact on women in Somaliland and similar contexts.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional study was conducted between December 2020 and April 2021 at vegetable markets in Hargeisa, the capital city of Somaliland, which covers an area of 78 km². Hargeisa has an estimated total female population of 500,000, of which approximately 300,000 to 325, 000 are women aged over 18 years [12].

The study employed stratified convenience random sampling by selecting five main vegetable markets in Hargeisa, which account for a significant portion of the overall market volume and sales. This approach enhances the representativeness of the vendor demographics. Additionally, we considered accessibility for data collection, diversity of offerings, and practical constraints such as time and resources.

All adult women (>18 years) working in the vegetable markets during the study period were eligible for enrollment, except those who were pregnant.

Sample size determination

The minimum sample size for the study was determined by the use of Fisher's formula for sample size calculation using the prevalence of 24% obtained from a study by Tran et al. [1], from neighboring Ethiopia.

n = Z2pq/d2

Where:

n = Desired sample size (population >10,000), population greater than 10,000

Z = the standard normal deviate usually set at 1.96 which corresponds to 95% confidence level.

p = Estimated characteristic of the study population 24.0% prevalence of metabolic syndrome among women in Ethiopia [1].

q = 1 – p

d = the minimum error/degree of accuracy desired, which is usually set at 5% or 0.05

Therefore:

(1.96)2 *0.24*0.76/0.0025

The initially determined sample size for the study was 280 participants. However, to account for potential non-responses and ensure sufficient statistical power, a total of 309 participants were selected proportionately across five markets. This adjustment was made to accommodate any non-responders and minimize the risk of an inadequate sample size. A total of 309 potential participants were initially interviewed, with 18 respondents not meeting eligibility criteria resulting in a final enrollment rate of 94.4%. Consequently, the final analysis is based on the responses from 291 participants.

Sampling Procedure

The sampling procedure for this study was designed to ensure proportional representation of vegetable sellers across five main markets in Hargeisa. A total of 1,000 vegetable sellers were estimated to be working in these markets, with a sample size of 309 sellers determined for the study [13]. The following steps were taken to distribute the sample across the markets:

Market 1: Out of 143 vegetable sellers, 45 were sampled, representing 14.5% of the total population.

Market 2: This market had the largest population of sellers, with 312 vendors. A sample of 96 sellers was taken, accounting for 30.1% of the total sample size.

Market 3: From the 255 vendors in this market, 78 sellers were included in the study, representing 25.2% of the total sample.

Market 4: In this market, 44 sellers were selected from a total of 140 vendors, which accounted for 14.2% of the total population.

Market 5: Lastly, 46 sellers were sampled from 150 total vendors, contributing 15% to the overall sample.

This stratified random sampling ensured proportional representation across the markets, with the total sample size of 309 sellers reflecting 30.9% of the total vegetable vendor population in the five main markets of Hargeisa.

Data Collection

Demographic Data

The questionnaire used for data collection was meticulously developed through a collaborative process involving experts in socio-economic and demographic research [14]. This ensured the inclusion of comprehensive and relevant questions tailored to the study's objectives. The structured questionnaire was designed to capture socio-economic and demographic information, including age (in years), marital status (e.g., single, married, divorced, widowed), education level (e.g., no formal education, primary, secondary, tertiary), duration of working at the vegetable market (in years), and family history of chronic illnesses (e.g., diabetes, hypertension).

On the first day of data collection, the interviewer-administered questionnaire was employed to gather the necessary information. For participants who faced challenges with reading and writing, the questionnaire was explained to ensure accurate and complete responses. To further enhance the validity of the data, the questionnaire was reviewed and revised with participants. All interviews were conducted in a secluded room to maintain privacy and confidentiality. Anthropometric measurements (weight, height, and abdominal circumference) were measured using standardized techniques and calibrated equipment, as outlined by Utkualp (2015) [15] and WHO, (2011) [16]. BMI was calculated by dividing weight by height squared (kg/m^2) and classified according to WHO criteria ($\geq 30\ kg/m^2$). Waist and hip circumferences were measured with participants standing, using a Roche circumference tape. The waist-to-hip ratio (WHR) was calculated by dividing waist circumference by hip circumference, both measured in centimeters. All measurements were taken by trained nurses to ensure accuracy and consistency.

Clinical and Laboratory Data

Blood pressure measurements were obtained using an Omron digital sphygmomanometer (Kyoto, Japan) after at least 10 minutes of rest following the 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults [10]. To ensure consistency in the fasting period, participants received standardized written instructions for a 12-hour overnight fast. Participants were organized into manageable groups with staggered fasting start times to facilitate efficient blood collection. Blood samples were drawn by qualified phlebotomists over several days, with 28 to 30 participants per day. Venous blood samples (5 ml) were collected via venipuncture and placed in red-topped tubes for biochemical analysis of fasting blood sugar (FBS) and lipid profiles. FBS was measured using a glucometer (Acon Diabetes Care, Pennsylvania, USA), while triglycerides and HDL levels were analyzed using an automated chemistry analyzer (Mindray BA-88A, India). This systematic approach, incorporating staggered fasting, scheduled blood draws, and qualified personnel, ensured both efficiency and accuracy across all participants.

Ensuring Quality and Reliability in Biochemical Measurements

The quality and reliability of biochemical measurements were maintained through several quality control measures. First, standardized equipment was used for all tests, including a glucometer (Acon Diabetes Care, Pennsylvania, USA) for fasting blood sugar (FBS) and an automated chemistry analyzer (Mindray BA-88A, India) for triglycerides and HDL levels. These devices were regularly calibrated according to manufacturer guidelines to ensure accuracy. Additionally, all blood samples were collected following a strict 12-hour fasting period, reducing variability in the test results. Laboratory personnel were trained to follow standard operating procedures (SOPs) for handling and analyzing samples, further ensuring consistency. Daily internal quality control tests were also conducted on the equipment to detect and correct any potential deviations before running participant samples.

Definition of Metabolic Syndrome

The International Diabetes Federation criteria for metabolic syndrome (MS) were used in this study [17]. The rationale for choosing the International Diabetes Federation (IDF) criteria over others was due to its global applicability, ease of use in clinical practice, and its emphasis on central obesity as a key factor in metabolic syndrome [18]. These criteria are widely accepted, particularly in regions with a high prevalence of central obesity and diabetes such as in many regions of Africa and Asia [19]. According to these criteria, an abdominal circumference greater than 80 cm is essential for diagnosing MS, along with any two of the following components:

a. Fasting glucose ≥100 mg/dL or ≥6.1 mmol/L
b. Triglycerides ≥150 mg/dL
c. High-density lipoprotein cholesterol ≤50 mg/dL
d. Hypertension ≥130 mmHg systolic or ≥85 mmHg diastolic

Statistical Analysis

The data in this study were analyzed using Epi Info software. Continuous variables were summarized using descriptive statistics, specifically the mean and standard deviation. Associations between metabolic syndrome and specific variables, including age, Body Mass Index (BMI), and waist-to-hip ratio, were identified by calculating Odds Ratios (OR) and p-values using logistic regression. A p-value of <0.05 was considered statistically significant for hypothesis testing. Incomplete records were omitted during final data analysis.

RESULTS

Socio demographic Characteristics of the Participants

A total of 291 women were studied. The mean age of the participants was 45.32 years, with the youngest being 21 and the oldest 80 (Table 1). The largest proportions of the participants, approximately 32.7%, were in the 31-40 age groups. The mean BMI was 27.14 (±6.67) kg/m^2, and about 31.6% of the women were classified as obese (Table 1). High waist-to-hip ratio (WHR) was observed in 69.8% of the participants (Table 1). A marked proportion of women had been working for more than 10 years. Regarding marital status, 63.9% of the women were married, and 18.6% were separated (Table 1).

Prevalence of Metabolic Syndrome

The prevalence of metabolic syndrome among women was 71.8% (Table 2). The prevalence for individual components of metabolic syndrome were as follows: high waist circumference (87.9%), low high-density lipoprotein cholesterol levels (78.3%), high blood pressure (56.1%), high fasting glucose levels (51.2%), and high triglyceride levels (42.6%) in the studied population (Table 2). Among the five metabolic syndrome components, high waist circumference (87.9%) and low HDL levels (78.3%) were the most prevalent. All components were highly associated with metabolic syndrome (p=0.000) except HDL (p=0.1667) (Table 2).

Table 1: Socio-demographic and Clinical Characteristics of the Participants

Variable	Frequency (%)	Mean (SD)
Age groups in years		45.32 (12.3)
21-30	32 (11.0)	
31-40	95 (32.6)	
41-50	84 (28.9)	
51-60	49 (16.8)	
61-70	27 (9.3)	
71-80	4 (1.4)	
Marital status		
Married	186 (63.9)	
Single	24 (8.3)	
Widow	27 (9.3)	
Separated	54 (18.6)	
Working duration		6.04 (5.55)
0-5 years	157 (54.9)	
6-10 years	97 (34.3)	
More than 10 years	37 (12.7)	
BMI		27.14 (6.67)
Obesity	92 (31.7)	
Overweight	92 (31.6)	
Normal weight	81 (27.8)	
Underweight	26 (8.9)	
WHR (Waist-to-Hip Ratio)		0.90 (0.11)
High WHR (>0.85)	203 (69.8)	
Normal WHR (0.81-0.85)	53 (18.2)	
Low WHR (<0.81)	35 (12.0)	

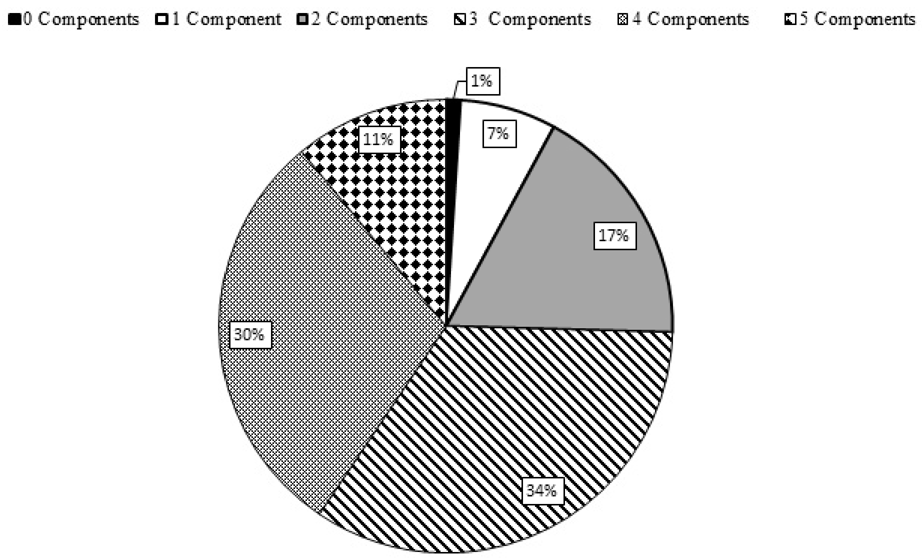
Table 2: Association between Metabolic Syndrome Components and Risk Factors with Odds Ratios

Variable (IDF)	Mean (SD)	Total Frequency (n, %)	With MS (%)	95% CI	Odds Ratio	p-value
Participants	-	291 (100)	71.8%	-	-	-
MS		209 (71.8%)	100%			
Normal		82 (28.2%)	0%			
Waist Circumference	97.91(15.30)			1.0474 - 1.0936	1.07	<0.001
Normal		35 (12.1%)	-			
High		256 (87.9%)	81.64%			
Triglycerides	151.53 (94.62)			1.0101 - 1.0206	1.02	<0.001
Normal		167 (57.4%)	-			
High		124 (42.6%)	91.94%			
HDL Cholesterol	34.55 (27.30)			0.9851 - 1.0026	0.99	0.167
Normal		63 (21.7%)	-			
Low		228 (78.3%)	76.75%			
Fasting Blood Sugar	6.30 (2.97)			1.3674 - 2.5540	1.87	<0.001

Normal		142 (48.8%)	-			
High		149 (51.2%)	91.28%			
Blood Pressure	Sys 133.7(23.3) Dis 80.8(14.8)			3.465 - 10.936	6.16	<0.001
Normal		128 (43.9%)	-			
High		163 (56.1%)	87.12%			

As shown in Figure 1, the largest proportion of study participants (34%) had three metabolic syndrome components, followed by those with four (30%), two (17%), five (11%), and none (1%).

Figure 1: The prevalence rates MS individual components (high waist circumference, low high-density lipoprotein cholesterol levels, high blood pressure, high fasting glucose levels and high triglyceride level) among participants were determined by dividing the number of women with each specific MS component by the total number of participants in the study and multiplying by 100.



Factors Associated with Metabolic Syndrome

The prevalence of metabolic syndrome varied across different age groups: 59.4% in the 21-30 age group, 62.1% in the 31-40 age group, 79.7% in the 41-50 age group, 75.6% in the 51-60 age group, 85.2% in the 61-70 age group, and 100% in the 71-80 age group (Table 3). Approximately 74.3% of participants who had been working for 6-10 years had metabolic syndrome (Table 3). Among obese participants, 83.6% had metabolic syndrome, while 82.6% of overweight participants were diagnosed with metabolic syndrome. A summary of factors associated with metabolic syndrome among women working in the vegetable markets in Hargeisa is provided in Table 3.

Table 3: Factors Associated with Metabolic Syndrome among Women Working in the Vegetable Markets in Hargeisa

Variable	Diagnosed with MS Frequency (%)	Without MS Frequency (%)	p-Value
Age groups (years)			
21-30 (N = 32)	19 (59.4)	13 (40.6)	≤0.000c
31-40 (N = 95)	59 (62.1)	36 (37.9)	
41-50 (N = 84)	67 (79.7)	17 (20.3)	
51-60 (N = 49)	37 (75.6)	12 (24.4)	
61-70 (N = 27)	23 (85.2)	4 (14.8)	
71-80 (N = 4)	4 (100)	0	
Marital status			0.4151
Single (N = 24)	16 (66.7)	8 (33.3)	
Married (N = 186)	132 (70.9)	54 (29.1)	
Divorced (N = 54)	41 (75.9)	13 (24.1)	
Widow (N = 27)	20 (74.1)	7 (25.9)	
Working duration			0.3385
0-5 years (N = 157)	109 (69.4)	48 (30.6)	
6-10 years (N = 97)	72 (74.3)	25 (25.7)	
More than 10 years (N = 37)	28 (75.6)	9 (24.4)	
BMI categories			≤0.000c
Obesity (> 30 kg/m²)	77 (83.6)	15 (16.4)	
Overweight (25.0-29.9 kg/m²)	76 (82.6)	16 (17.4)	
Normal weight (18.5-24.9 kg/m²)	0	81 (100)	
Underweight (< 18.0 kg/m²)	0	26 (100)	
WHR categories			≤0.000c
High WHR (> 0.85 cm)	159 (78.3)	44 (21.7)	
Normal WHR 0.18-0.85 cm		57(100)	
Low WHR < 0.80 cm		31(100)	

WHR: Waist to hip ration; BMI: body mass index; c: Refers to values that are highly significant (p ≤ 0.001).

DISCUSSION

Our study investigated the prevalence and contributing factors of metabolic syndrome (MS) among female vendors at vegetable markets in Hargeisa, Somaliland. With a prevalence rate of 71.8%, this study highlights a serious public health concern in this population. Although the vegetable selling profession involves prolonged periods of sitting, we acknowledge that directly linking this sedentary work to MS warrants further investigation. Nonetheless, this finding raises concerns about potential health risks associated with prolonged sedentary behavior, which has been noted in other studies to increase cardio-metabolic risk [20].

The sociodemographic characteristics of the participants revealed that most were middle-aged, with a mean age of 45.32 years, a factor known to be associated with an increased risk of MS [21]. Moreover, the participants exhibited an average BMI of 27.14 kg/m², with 31.7% classified as obese, reinforcing the global trend that links higher BMI with MS [22]. The study also found that high waist circumference and low HDL-cholesterol levels were prevalent among participants, aligning with findings in other populations where abdominal obesity and low HDL are closely linked to MS, particularly in women [23, 24].

In our analysis, we considered dietary habits and lifestyle factors as potential contributors to the high MS prevalence. While dietary data were not directly assessed, existing literature suggests that diets high in refined carbohydrates and unhealthy fats may contribute to the development of MS [25]. Future studies should prioritize dietary and lifestyle assessments to better understand their role in this population.

Although prolonged sitting is a plausible risk factor for MS among vegetable vendors, this study did not directly measure lifestyle behaviors such as physical activity levels. Structural or social factors, such as the nature of their work environment and cultural expectations, may limit these women's ability to be physically active during or after work. This highlights the need for future research to investigate the specific environmental and social determinants that may contribute to sedentary behavior and MS in this population [26].

Our findings are consistent with studies conducted in other countries, such as Ethiopia, where a prevalence of 22% was reported among working adults [1]. The differences in prevalence between these regions may be attributable to variations in socioeconomic status, occupational structures, healthcare access, and cultural factors, all of which require further exploration to contextualize these disparities. In South Africa, for instance, occupational diversity and differences in health system accessibility might partly explain why our findings in Somaliland present a higher prevalence rate of MS [4, 5]. Although the cross-sectional nature of our study precludes causal inferences, the high prevalence of MS observed in this population underscores the need for targeted interventions. These interventions should focus on promoting physical activity and dietary improvements while addressing the specific challenges faced by this occupational group. Future research should focus on longitudinal studies to assess the progression of MS, as well as qualitative studies to understand the barriers to adopting healthier lifestyles.

CONCLUSION

This study revealed a high prevalence of metabolic syndrome (71.8%) among female vegetable market traders in Hargeisa, Somaliland. Key factors associated with this condition included older age, elevated BMI, and increased waist-to-hip ratio, raising concerns about potential health risks related to sedentary behavior. While this study does not establish causality, the findings suggest the need for targeted interventions and health education tailored to this population. Future research should further explore the occupational and lifestyle factors contributing to metabolic syndrome in this group to guide the development of effective strategies for improving their health outcomes.

AUTHOR CONTRIBUTIONS

FAM, AK, CN, and GKM did conception and planning of the study. FAM ran the laboratory assays and abstracted patient demographic and clinical data. FAM did data entry and cleaning. FAM and CN conducted the data analysis. FAM and GKM did the drafting of the manuscript. FAM, AK, WEI, CN and GKM reviewed the manuscript for philosophical insights. All the authors reviewed the final manuscript and approved it for submission.

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ETHICAL APPROVAL

Verbal informed consent was obtained from all participants. The study was approved by the Institutional Research and Ethics Commission at Moi University/MTRH (REF IREC/2017/148) and the Directorate of Health Services and Hospitals, Ministry of Health Development in Somaliland.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, [G.K.M], upon reasonable request.

CONFLICT OF INTERESTS

The authors declared that they have no conflict of interest.

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