Medical and Research Publications
International Open Access

Research Article **Journal of MAR Gastroenterology (Volume 3 Issue 1)**

Association of Small Intestinal Bacterial Overgrowth (SIBO) in Obese Patients

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Received Date: May 17, 2023

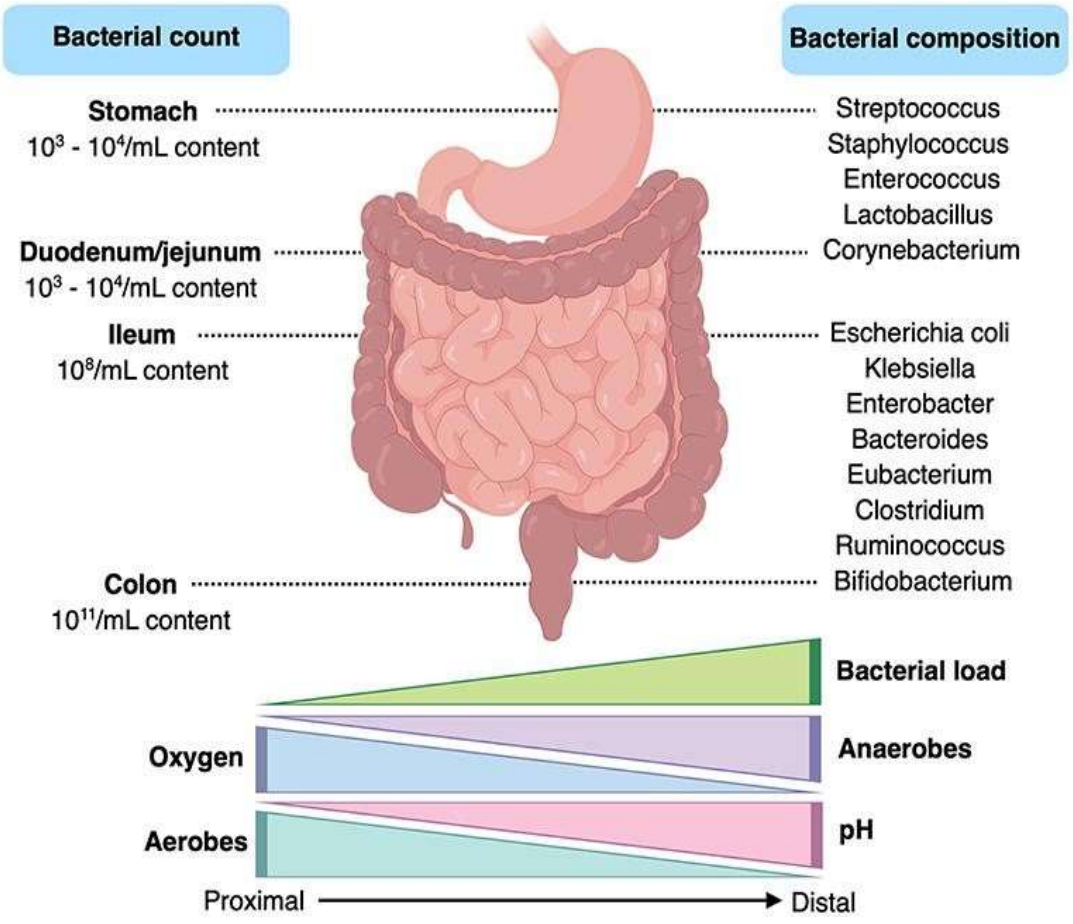
Published Date: June 01, 2023

DOI: 10.1027/margs.2023.0140

Introduction

The UAE has one of the highest prevalence of obesity worldwide, with the number of obese patients having doubled in the last 30 years [1]. This dramatic increase in obesity is primarily attributed to significant lifestyle changes, rapid urbanization, overeating, and a decrease in physical exercise.

The prevalence of Small Intestinal Bacterial Overgrowth (SIBO) in obese patients is largely under-reported due to nonspecific symptoms. Clinical diagnosis of this condition remains a significant challenge [2].

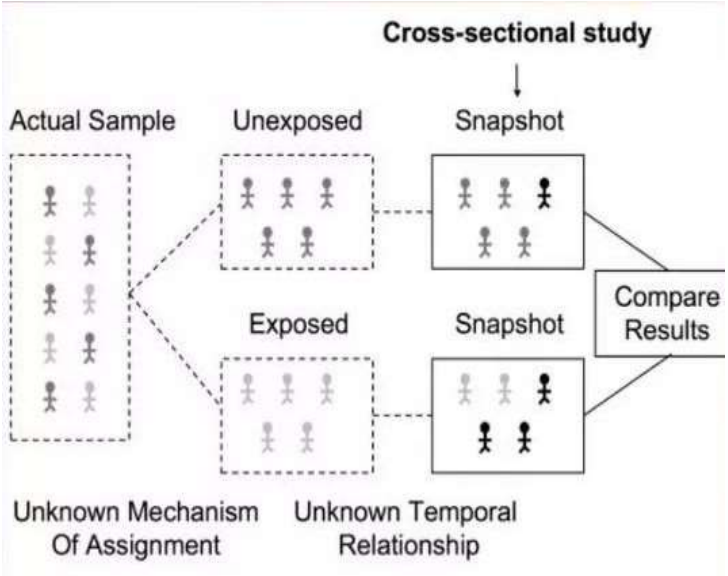


Introduction - Research Aims

The primary objective of this study is to explore the risk of small intestinal bacterial overgrowth (SIBO) in obese and overweight patients. The secondary objective is to understand the association between SIBO and comorbidity, presenting symptoms, medications, and procedures involved.

Methods - Sample Population

This is a cross-sectional association study. It encompasses patients who were suspected of having SIBO and had undergone lactulose breath tests for SIBO within the previous three months (from February 2023 to November 2022). The study includes retrospective data from 112 individuals (64 men and 48 women), with information related to their presenting symptoms, comorbidity, medications, and test-related procedures.



Methods - Dataset

This study is a cross-sectional prevalence and associations study. It comprises patients who were suspected of having SIBO and underwent lactulose breath tests for SIBO within the previous three months (from February 2023 to November 2022).

The data includes 112 patients (64 males and 48 females) aged between 15 and 75, all of whom had undergone the lactulose test due to suspicion of small intestinal bacterial overgrowth (SIBO). For the purpose of this study, a Body Mass Index (BMI) greater than 25 is considered indicative of obesity.

Age	Gender	Test-result	Nationality	BMI	Smoking	Alcohol
45	Male	10-01-2023	Sir langa	22.89	Yes	Yes
37	Male	05-01-2023	Pakistan	30,37	EX	No
46	Male	06-01-2023	UK	29,02	No	No
49	Female	08-01-2023	India	35,07	No	No
51	Male	07-01-2023	Sir langa	26,73	No	No
27	Male	05-01-2023	UAE	26,73	No	No
35	Female	09-01-2023	UK	30,12	No	Yes
27	Female	15-01-2023	UAE	25,12	No	No
27	Female	15-01-2023	UAE	27,3	No	No
29	Female	16-01-2023	Brazile	24,58	Yes	No
32	Female	18-01-2023	Sir langa	23,01	No	No
21	Female	22-01-2023	UAE	18,99	No	No
33	Male	20-01-203	Italy	20,28	Yes	Yes
66	Male	28-01-2023	Mauritanian	22,01	No	No
73	Male	03–01-2023	UK	24,51	Yes	Yes
38	Female	03–01-2023	UAE	3359	No	No
37	Female	04-01-2023	Ghanaian	30.56	No	No
43	Male	20-01-203	Bangladeshi	24.24	No	No
34	Male	16-01-2023	Pakistani	34.56	Yes	No
40	Female	22-01-2023	South African	34.95	No	No
45	Male	17-01-2023	Egyptian	17,1	Yes	Yes

ics | Presenting Symptoms | Comorbidites | Medications | SurgicalHx

Methods – Sample size calculations

Sample size for cross-sectional study design two proportion independent groups

P1 = 0.27

P2 = 0.32

Q1 = 0.73

Q2 = 0.68

P = 0.43

Q = 0.57

For 80% power and 95% confidence, the sample size calculated is – n1 = n2 = 591

Sample size calculation

$$n1 = n2 = \frac{\left(Z_\alpha\sqrt{2PQ} + Z_\beta\sqrt{P1\ Q1 + P2\ Q2}\right)^2}{(P1-P2)^2}$$

n = Sample size
$\alpha = 0{,}05$; $Z_\alpha = 1{,}96$
$\beta = 0{,}80$; $Z_\beta = 0{,}842$
P_1 = proportion of standard effect (literature)
P_2 = proportion of research effect (by author)
$P = \frac{1}{2}(P_1 + P_2)$
$Q = 1 - P$; $Q_1 = 1\text{-}P_1$
$Q_2 = 1\text{-}P_2$

Methods - Statistical Analyses

Data Reprocessing:

1) Categorical "text" data has been converted into binary format (0 and 1).

2) Multiple records of symptoms, comorbidity, medications, and surgical procedures have been merged into a single record for each patient.

3) Each patient has been classified as 0 or 1, where 0 represents "no symptom" and 1 represents "symptom". The same binary classification has been implemented for comorbidity, medications, and procedures.

Bivariate and Multivariate Analyses:

1) Bivariate analysis was conducted using the Chi-square test to examine the relationship between two variables.

2) Multivariate analysis was performed using logistic regression to control for potential confounding variables and to understand the relationship between multiple variables and the dependent variable (SIBO presence).

Results – Baseline characteristics

Demographics	Female (n = 48)	Male (n = 64)	Total (n = 112)	p value
Age (in years)				0.0025
Mean +- SD	34.52+-11.33	41.96+-13.49	38.77+-13.09	
Min/Max	18/71	15/75	15/75	
BMI (% of group)				
Underweight	1 (2.04%)	5 (7.81%)	6 (5.03%)	
Healthy	12 (24.48%)	15 (23.43%)	27 (24.10%)	
Overweight	12 (24.48%)	16 (25.00%)	28 (25.00%)	
Obese	23 (47.91%)	28 (43.75%)	51 (45.53%)	
Smoking (% of group)	6.12	40.62	25.89	
Alcohol (% of group)	4.16	26.56	17.85	
Symptoms (% of group)				
Abdominal pain	70.83	70.31	70.53	
Bloating	70.83	57.81	63.39	
Diarrhea	18.75	25	22.32	
Nausea/ Vomiting	29.16	15.62	21.42	
Comorbidities (% of group)				
GERD	6.25	9.37	8.03	
Hypertension	6.25	7.81	7.14	
Anemia	10.41	1.56	5.35	
Irritable Bowel Syndrome	12.5	7.81	9.82	
Liver Disease	2.08	4.68	3.57	
Medications (% of patients who received medicine)				
Rifaximin	41.66	37.5	39.28	
Esomeprazole	22.91	14.06	17.85	
Simethiclone	27.08	14.06	19.64	
SIBO (% of group)				
Positive	62.5	57.81	59.82	
Negative	37.5	42.18	40.17	

Table 1 - Demographics

Results - Proportion of SIBO and Obesity/Overweight

Overweight	no	yes
Positive_SIBO		
no	0.266667	0.733333
yes	0.462687	0.537313

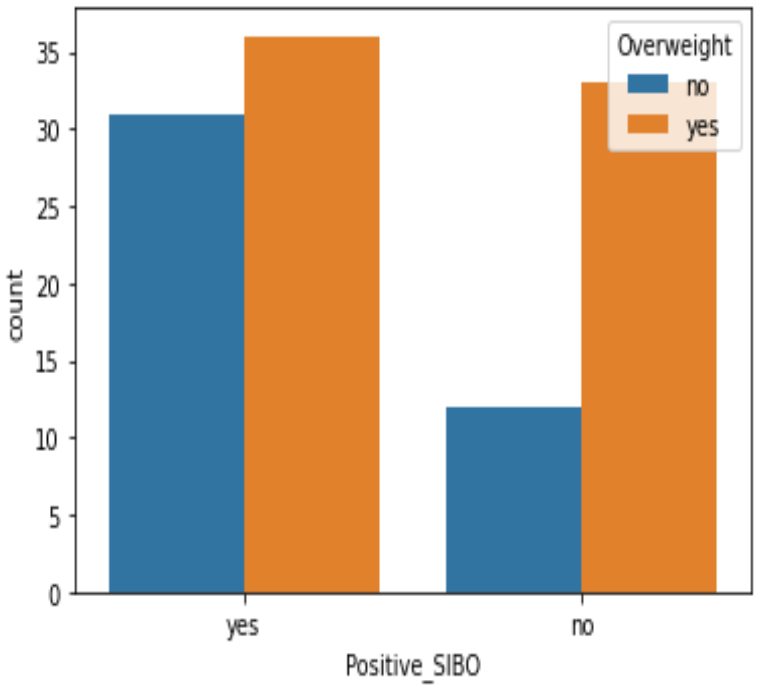
Overweight	no	yes	All
Positive_SIBO			
no	12	33	45
yes	31	36	67
All	43	69	112

Overweight	All		no		yes	
	n	%	n	%	n	%
Positive_SIBO						
no	45	0.401786	12	0.107143	33	0.294643
yes	67	0.598214	31	0.276786	36	0.321429
All	112	1.000000	43	0.383929	69	0.616071

	Overweight	no	yes	All
Positive_SIBO	Gender			
no	Female	4	14	18
	Male	8	19	27
yes	Female	14	16	30
	Male	17	20	37
All		43	69	112

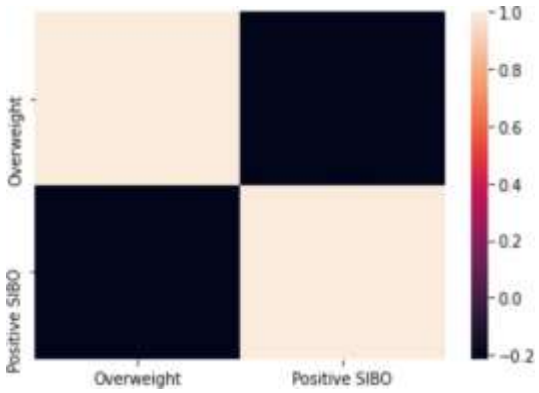
Results- Bivariate Analysis Association between OBESITY and SIBO

Bivariate analysis showed no significant association between SIBO and Obesity (p = 0.114)



1	**Table Analyzed**	Data 2		
2				
3	**P value and statistical significance**			
4	Test	Chi-square		
5	Chi-square, df	2.487, 1		
6	z	1.577		
7	P value	0.1148		
8	P value summary	ns		
9	One- or two-sided	Two-sided		
10	Statistically significant (P < 0.05)?	No		
11				
12	**Data analyzed**	**Obesity_No**	**Obesity_Yes**	**Total**
13	SIBO_No	32	13	45
14	SIBO_Yes	56	11	67
15	Total	88	24	112
16				
17	**Percentage of row total**	**Obesity_No**	**Obesity_Yes**	
18	SIBO_No	71.11%	28.89%	
19	SIBO_Yes	83.58%	16.42%	
20				
21	**Percentage of column total**	**Obesity_No**	**Obesity_Yes**	
22	SIBO_No	36.36%	54.17%	
23	SIBO_Yes	63.64%	45.83%	
24				
25	**Percentage of grand total**	**Obesity_No**	**Obesity_Yes**	
26	SIBO_No	28.57%	11.61%	
27	SIBO_Yes	50.00%	9.82%	

	Overweight	Positive SIBO
Overweight	1.000000	-0.197599
Positive SIBO	-0.197599	1.000000



Results- Bivariate Analysis Association between OBESITY and SIBO

OLS Regression Results

Dep. Variable:	Positive SIBO	R-squared:	0.039
Model:	OLS	Adj. R-squared:	0.030
Method:	Least Squares	F-statistic:	4.470
Date:	Tue, 21 Mar 2023	Prob (F-statistic):	0.0368
Time:	02:18:51	Log-Likelihood:	-76.855
No. Observations:	112	AIC:	157.7
Df Residuals:	110	BIC:	163.1
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.7209	0.074	9.748	0.000	0.574	0.867
Overweight	-0.1992	0.094	-2.114	0.037	-0.386	-0.012

Omnibus:	1461.507	Durbin-Watson:	1.405
Prob(Omnibus):	0.000	Jarque-Bera (JB):	16.034
Skew:	-0.368	Prob(JB):	0.000330
Kurtosis:	1.299	Cond. No.	2.99

Results – Bivariate Analysis Association between Comorbidities and Obesity

OLS Regression Results

Dep. Variable:	Comorbidites	R-squared:	0.014
Model:	OLS	Adj. R-squared:	0.005
Method:	Least Squares	F-statistic:	1.567
Date:	Tue, 21 Mar 2023	Prob (F-statistic):	0.213
Time:	02:45:19	Log-Likelihood:	-76.882
No. Observations:	112	AIC:	157.8
Df Residuals:	110	BIC:	163.2
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.3023	0.074	4.087	0.000	0.156	0.449
Overweight	0.1180	0.094	1.252	0.213	-0.069	0.305

Omnibus:	1564.152	Durbin-Watson:	1.313
Prob(Omnibus):	0.000	Jarque-Bera (JB):	18.012
Skew:	0.504	Prob(JB):	0.000123
Kurtosis:	1.313	Cond. No.	2.99

Results – Multivariate Analysis: Association between SIBO and Obesity

A multivariate analysis was performed by selecting dependent and independent variables. For this analysis, we selected 10 dependent variables and one target variable.

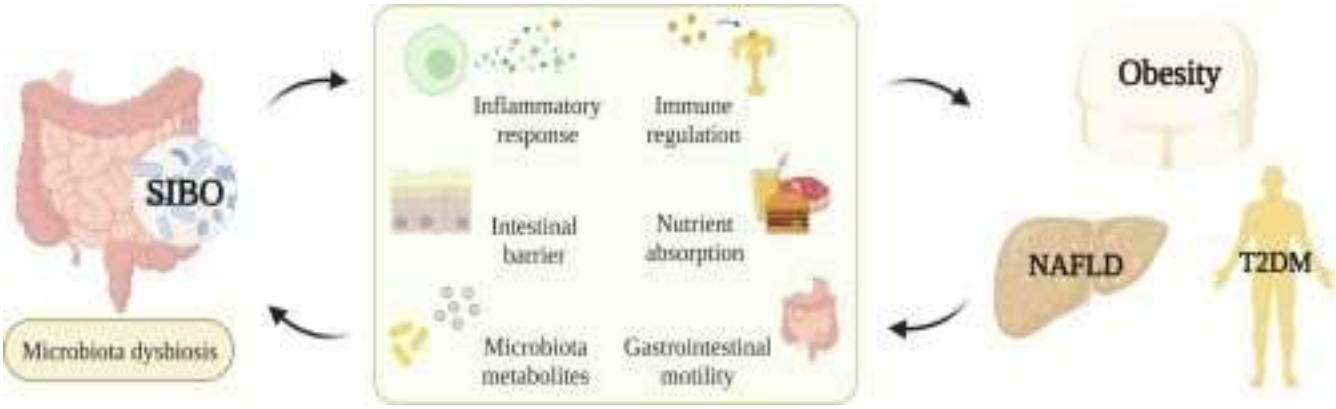
The logistic regression algorithm was used as the base model to predict the categorical outcome: obese or non-obese.

Evaluation

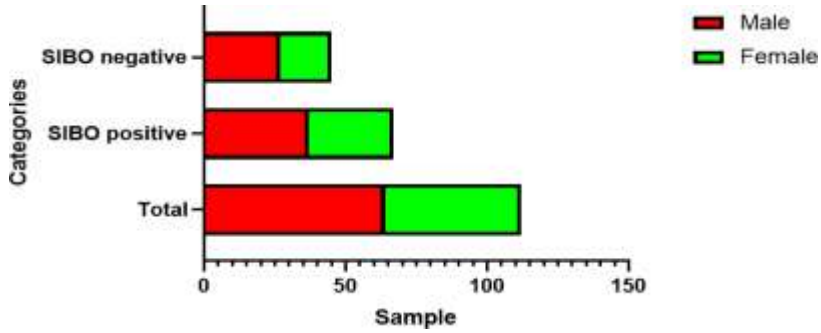
	precision	recall	f1-score	support
0	0.75	0.46	0.57	13
1	0.73	0.90	0.81	21
accuracy			0.74	34
macro avg	0.74	0.68	0.69	34
weighted avg	0.74	0.74	0.72	34

Results – Multivariate Analysis Association between SIBO and Obesity

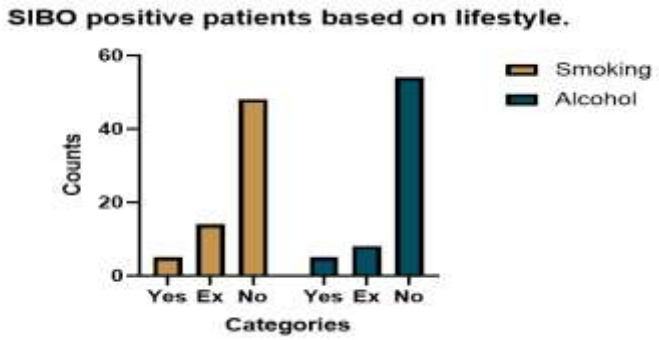
Model_Name	Precision	Recall	Train_Accuracy	Test_Accuracy	F1_Score	AUC
DecisionTreeClassifier	0.61	0.52	1.00	0.50	0.56	0.492674
RandomForestClassifier	0.68	0.62	1.00	0.59	0.65	0.578755
LogisticRegression	0.73	0.90	0.69	0.74	0.81	0.683150
AdaBoostClassifier	0.75	0.86	0.90	0.74	0.80	0.697802
BaggingClassifier	0.64	0.76	0.96	0.59	0.70	0.534799
GradientBoostingClassifier	0.72	0.86	1.00	0.71	0.78	0.659341
SVC	0.62	1.00	0.62	0.62	0.76	0.500000
XGBClassifier	0.67	0.76	1.00	0.62	0.71	0.573260
SVC	0.62	1.00	0.62	0.62	0.76	0.500000
KNeighborsClassifier	0.67	0.86	0.72	0.65	0.75	0.582418
GaussianNB	0.66	0.90	0.67	0.65	0.76	0.567766



Results – SIBO and Smoking/Alcohol

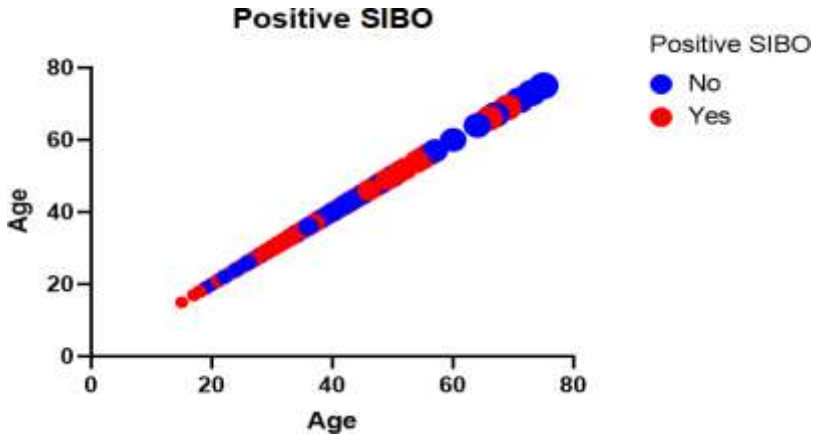


The above graph represents the ratio of patients with test results categorized as positive or negative, and it also displays the division according to gender.



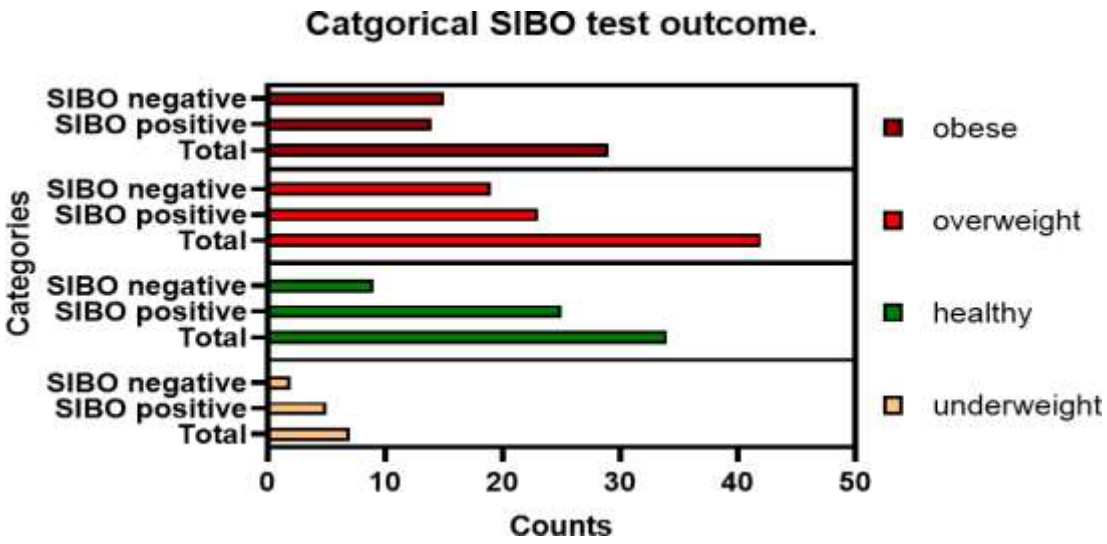
The above graph represents the ratio of patients undergoing tests.

Results – Positive SIBO and Visits



The age groups between 30-35 and 45-55 have a high rate of positive SIBO tests.

Results – SIBO and Obesity



Discussion

Small Intestinal Bacterial Overgrowth (SIBO) is a clinical condition characterized by malabsorption syndrome due to an increase in microorganisms to a level exceeding 105 bacteria/mL of jejunal juice. The cornerstone of the treatment of SIBO is antibiotic therapy. Rifaximin was approved for treatment of SIBO in 2015, and recent reports have upheld its efficacy. An excess of bacteria in the small intestine is rare, typically not exceeding 1000 org/mL. This can be attributed to gastric acid secretion and intestinal motility that limit the overgrowth of bacteria in the small intestine.

Conclusion

After eradicating unwanted intestinal bacteria, symptoms of Irritable Bowel Syndrome (IBS), such as bloating, abdominal pain, and diarrhea, improved. However, SIBO isn't exclusive to individuals with IBS-like symptoms. Non-digestive symptoms, such as fatigue, may be the primary concern. Some alternative medicine practitioners suggest that SIBO may play a role in Chronic Fatigue Syndrome, Irritable Bowel Disease (IBD), Fibromyalgia, allergies, arthritis, lupus, and other autoimmune diseases. Small intestinal bacterial overgrowth is a condition that may be present for years without causing obvious symptoms.

This study focuses on the association of SIBO with obesity, a global health concern, particularly in Gulf countries. The involvement of gut microbiota brings additional complexity to the occurrence and development of obesity.

SIBO is associated with chronic digestive problems such as gas, bloating, diarrhea, and/or constipation and is often misdiagnosed as IBS. Our NMC Royal Abu Dhabi examined 112 obese patients (64 males and 48 females, aged 15 to 75), all of whom had undergone the lactulose hydrogen test due to suspicion of SIBO. Obesity was defined as having a BMI > 25.

We found that 69 112 patients (65%) had bacterial overgrowth. The primary cause of obesity was identified as a sedentary lifestyle, with less association with alcohol and smoking in comparison to Western countries. This study provides further insight into the role of SIBO in obesity and other related chronic diseases.

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