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Trends in blood sugar, glycated hemoglobin, lipid profile, Vitamin B12, and Vitamin D in Alavi Bohra women – A micro minority Muslim community cohort study

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ABSTRACT

Background and Aim: Community cohort studies play an essential role in gaining knowledge about diseases and reducing their associated burden on women. The present study aimed to assess the trends of blood sugar, glycated hemoglobin, lipid profile, Vitamin B12, and Vitamin D in women of reproductive age from varying socioeconomic status from the micro minority Muslim Alavi Bohra community residing in Vadodara city.
Materials and Methods: A cross-sectional community cohort study wherein all women of the Alavi Bohra community from Vadodara city (19-45 years) (n=95), were purposively selected. Data were elicited on socio-economic status (SES) and biochemical profile. Fasting blood sugar, glycated hemoglobin, vitamin B12, and vitamin D using standard protocols and data were segregated based on two classes of socioeconomic status (Lower SES and Upper SES) as per the modified Kuppuswamy socio-economic scale (2021). Data were analyzed using JASP software for statistical analysis.
Result and Discussion: The Alavi Bohra are immigrants from Egypt and Yemen and follow a distinct Muslim culture and lifestyle. The mean age of the women was 33 years (range 21-42 years), and the average income was Rs. 20669 vs Rs. 77162 for low and high-income groups, respectively. Biochemical indices revealed that 83% of women had prediabetes as per International Diabetes Federation guidelines (2015), mean FBS of 117 mg/dl with mean HbA1c of 5.7 and vitamin D of 14.36 ng/ml, and mean vitamin B12 of 489.62 pg/ml, and mean total cholesterol of 166 mg/dl, however, women of both groups suffered from metabolic imbalances.
Conclusion: There was no significant difference between the lower and upper socioeconomic groups regarding most of the parameters investigated. However, a high risk of diabetes, dyslipidemia, and vitamin D deficiency was reported irrespective of socioeconomic class. More in-depth studies of marginalized populations such as those investigated in the present study are needed for improving the health of women.

Key words: *Alavi Bohra, prediabetes, diabetes, food anthropology, women's health, socio-economic status, community short study*

Introduction

The emerging burden of non-communicable diseases (NCDs), particularly cardiovascular disease (CVD) and diabetes impends the gains in life expectancy made by combating infectious diseases **(IDF, 2015).** Food, culture, and socioeconomic status may be independently related to the overall health conditions of a community and therefore ethnographic approaches are used to assess the epidemiology of many diseases including non-communicable diseases **(Nambiar 2021 a & b).**

India is a vast country with over 7 major religions and several sub-sects with specific cultural beliefs, with a typical food pattern that may change with socioeconomic

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status. Specific factors linked to the development of diabetes include a family history of diabetes, race, age, obesity, physical activities, and diet. Environmental factors, as well as genetic factors, are known to influence the development of diabetes. Socioeconomic status (SES) has also been shown to account for increases in the prevalence of diabetes **(Kim et al., 2015).** Gender, age, education, and level of income explain the association of diabetes with subjective health **(Assari et al., 2014).** Socioeconomic status (SES) measures the social standing of an individual or a family in society and has important implications for all aspects of life. It is known to influence accessibility, affordability, acceptability, and utilization of available health facilities. Indian foods and eating habits are influenced by caste, class, family, kinship, tribe affiliation, lineage, religiosity, ethnicity, and increasingly, secular group identification **(Srinivas, 2011).**

Changing demographics, urbanization, and dietary and lifestyle behavior are contributing to the rising prevalence of non-communicable diseases (NCDs), diabetes, and high blood pressure. To make informed policy decisions to address the factors that aggravate the situation, it is necessary to have country-level information on the burden of the diseases. While the behavioral components of individual socioeconomic status may be hard to address, efficient dissemination of health knowledge regarding the risk factors for NCDs through mass media can have promising outcomes **(Yaya S et al., 2021).**

The nutrition transition is predicted to lead to changing relationships between SES and CVD risk. The nutrition transition is defined as changes in dietary intake patterns because of the adoption of 'modern' lifestyles due to social and economic development. As a consequence, disease patterns initially shift towards nutrition-related chronic diseases like CVD. In the early stages of such a transition, risk factors tend to be concentrated among the high SES groups and urban dwellers, who have earlier access to these 'modern' lifestyles **(Samuel et al., 2012).**

Therefore, the health and nutritional status of marginalized and the least-studied population is usually not well-reported. As Alavi Bohra, is a distinct Muslim community, is an integral part of the Indian population and their nutritional health is equally important to be known for designing future health policies and national strategies. Hence the current study aimed to assess the prevalence of diabetes, dyslipidemia, and vitamin B12 and Vitamin D deficiency in women of reproductive age from varying socioeconomic status from the micro minority Alavi Bohra Muslim community residing in Vadodara city.

Materials and Methods

Study design/subjects/study area: This was a cross-sectional community cohort study design. The study was conducted in Vadodara City, Gujarat, India. Women of the Alavi Bohra community from Vadodara city were selected as the subjects. Data was collected over a period of three months i.e. January to March 2022.

Sample Size and Sampling Procedure

Based on the consent a sample of 95 women of the Alavi Bohra Community were selected using a purposive sampling technique. Ethical clearance was obtained for the study by Institutional Ethics Committee (IECHR/FCSc/PhD/2021/124).

Tools and techniques: For the present study, a new scale was developed by modifications in Kuppuswamy's socioeconomic scale (Saleem, 2021) and standard of living index (table 1a and 1b). Socioeconomic status may be defined as "a position attained by any individual within a system of hierarchical social structure". A semi-structured questionnaire was designed to assess the socio-economic status (SES) of women of reproductive age (n=95) based on consent. SES was analyzed based on the modified Kuppuswamy socio-economic scale (Saleem, 2021) that majorly focuses on 3 components education, occupation, and income. It is the most widely used and popular scale for SES in urban areas. Whereas the standard of living index (SLI) comprised of house type, toilet facility in house, electrification, fuel used for cooking, source of drinking water, separate space for cooking, ownership of the house, automobiles, and durable goods.

Biochemical profile: The blood sample was collected by trained phlebotomists of NABL accredited laboratory as per standard protocols. Total of 5 ml blood sample was collected of which 3 ml in plain tube and 2 ml in EDTA tube. Glycemic parameters: glycated hemoglobin (HbA1c) using high-performance liquid chromatography (HPLC), and lipid parameters: triglycerides (TG), total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL) were analyzed by photometry methods, vitamin D and vitamin B12 were estimated by chemiluminescent immunoassay (CLIA).

Dietary Data: Diet-related data was collected using one day 24 hour dietary recall on a random day. The complete analysis of which is not included in the study.

Data analysis: Data analysis was done using Microsoft Excel 2021 (Version 2303 Build 16.0.16227.20202), and

Table 1a: Kuppuswamy's socioeconomic status and Standard of living index score used in the present study

S.no.	Parameter	Score
1.	**Education**	
	(a) Postgraduate (b) Graduate (c) HSC+ diploma (d) HSC (e) SSC (f) <SSC	7,6,5,4,3,2
2.	**Income**	
	(a)≥123,322 (b) 61,663-123,321 (c) 46129-61,662 (d) 30,831-46,128 (e) 18,497-30,830 (f) 6,175-18,496 (g) ≤ 6174 *	12, 10, 6, 4, 3, 2, 1
3.	**Occupation**	
	(a)Profession (b) Semi Profession (c) Clerical (d) Skilled worker (e) Semi-skilled worker (f) Unskilled worker (g) Unemployed	10,6,5,4,3,2,1
4.	**House type**	
	(a) Pucca (b) Semi pucca (c) Kachha	4,2,0
6.	**Toilet facility**	
	(a) Own flush toilet (b) Public or shared flush toilet/ own pit toilet (c) Shared or public pit toilet (d) No facility	4,2,1,0
7.	**Source of lighting**	
	(a) Electricity (b) Kerosene, gas or oil (c) Other sources of lighting	2,1,0
8.	**The main fuel for cooking**	
	(a) Electricity, Liquid petroleum gas or biogas (b) Coal, charcoal or kerosene (c) Other fuel	2,1,0
9.	**Source of drinking water**	
	(a) Pipe, hand pump, or well in residence/ yard/ plot (b) Public tap, hand pump, or well (c) Other water sources	2,1,0
10.	**Separate room for cooking**	
	(a) Yes (b) No	1,0
11.	**Ownership of house**	
	(a) Yes (b) No	1,0
12.	**Ownership of Electrical Appliances**	
	(a) Fan (b) Refrigerator (c) Television (d) Oven (e) Air-conditioner	2,3,3,3,4
13.	**Ownership of transport vehicles**	
	(a) Bicycle (b) Two-wheeler (c) Car	2,3,4
	Maximum Possible score	**69**

*as updated by Saleem, (2021) (HSC- higher secondary certificate), (SSC- senior secondary certificate)

Table 1b: Categorization SES based on the overall score in the present study

Classification of Socioeconomic Status	Score
Lower socioeconomic status	<34
Upper socioeconomic status	34-69

further in JASP software (Version 0.17.1; JASP Team 2023). The data was compiled using Microsoft Excel into a spreadsheet which was imported into JASP software for further analysis.

Results and Discussion

***Background information*:** Among Muslims, there are two main divisions- *Sunni* and *Shia* based on the school of *mazhab* that they follow, of which *Sunni* are divided into 4 sub-sect and Shia are further divided into 3 sub-sects: *Dawoodi Bohra*, *Alavi Bohra,* and *Suleimani Bohra*. *Alavi Bohra* is a Nano Minority Community sub-divided from *Ismaili Shia* Muslims. The Alavi Bohra have their roots in Egypt and Yemen and the community follows a distinct culture, food, and lifestyle. Food (*Thaal Jaman*) is eaten from a single plate called *thaal* by a group of 7-8 people sitting on the floor, beginning by tasting a pinch of salt.

The background information on the households of the women (n=95) from the micro minority Muslim community cohorts of Alavi Bohra revealed that all the households had an electricity connection, water supply, private toilets with flush mechanisms, and a separate space for cooking.

The mean age of the women was 33 years (range 21-42 years), the average family income was Rs. 40274, and the average family size was 6 members. The average income

of lower SES families was Rs. 20669 and an average family size of 5 with a per capita income of Rs. 4290. Similarly, the average income for higher SES was Rs. 77162, and an average family size of 6 with per capita income of Rs. 11082, which is more than double of lower SES. The disparity in education level between the two SES groups is presented in Table 3.

Biochemical indices: The two categories of women showed varied trends in the biochemical indicators, with major differences observed in the case of fasting blood sugar and total cholesterol, wherein the upper socio-economic group was at higher risk of diabetes, and borderline high cholesterol (Table 4-5). The prevalence of prediabetes was 83% in the community cohort with a mean ± standard deviation of fasting blood sugar of 117.0 ± 22 mg/dl and 117.4 ± 11mg/dl, with mean HbA1c of 5.7 and 5.7 for lower and upper SES respectively. The mean ± standard deviation of vitamin D was 15.07 ± 7.5 ng/ml and 13.78 ±6.4 ng/ml for lower and upper SES respectively. The mean ± standard deviation of vitamin B12 was 540 ± 196 pg/ml and 449 ± 169 pg/ml for lower and upper SES respectively. Similarly, the mean ± standard deviation of total cholesterol was 158 ± 24 mg/dl and 172 ± 26 mg/dl for lower and upper SES respectively.

Table 3: Characteristics of women from the two SES groups

Parameter	Socio-economic Status		
AGE	Lower (n=42)	Upper (n=53)	Overall (N=95)
21-25	4 (4.21)	7 (7.37)	11 (11.58)
26-30	23 (24.21)	13 (13.68)	36 (37.89)
31-35	13 (13.68)	28 (29.47)	41 (43.16)
36-42	2 (2.11)	5 (5.26)	7 (7.37)
EDUCATION QUALIFICATION	Lower (n=42)	Upper (n=53)	Overall (N=95)
< SSC	5(11.9)	1 (1.89)	6 (6.3)
SSC	3 (7.14)	3 (5.56)	6 (6.3)
HSC	9 (21.43)	7 (13.21)	16(16.8)
HSC + Diploma	1 (2.38)	4 (7.55)	5 (5.3)
Graduate	17 (40.48)	23 (43.40)	40 (42.1)
Postgraduate	7 (16.67)	15 (28.30)	22 (23.2)

SES was analyzed based on the modified Kuppuswamy socio-economic scale (2021) that majorly focuses on 3 components education, occupation, and income.

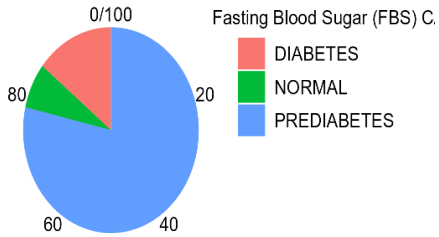
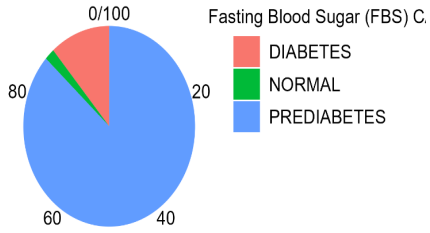
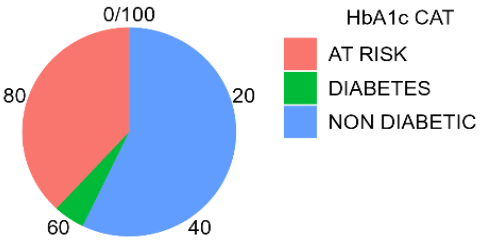
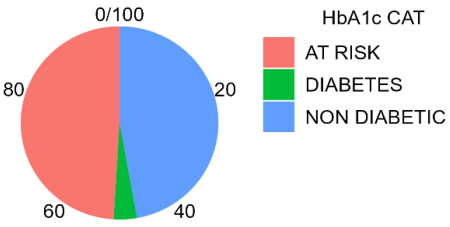
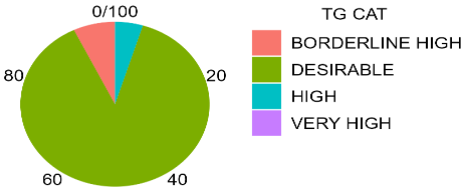
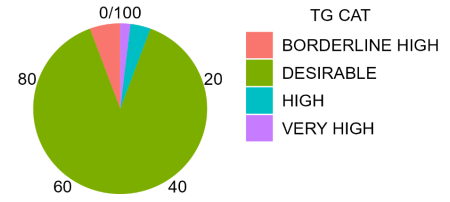
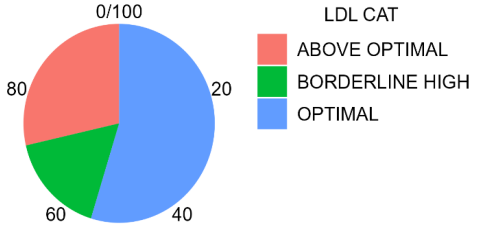
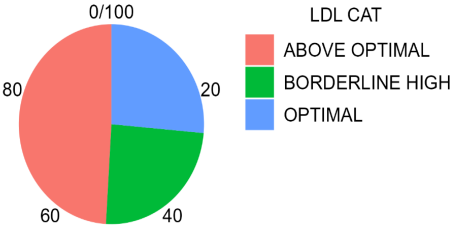
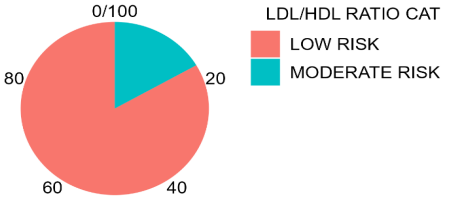
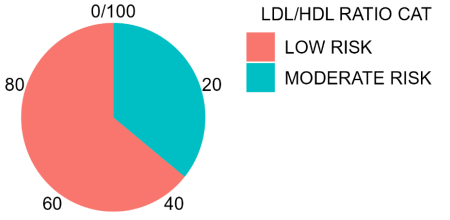
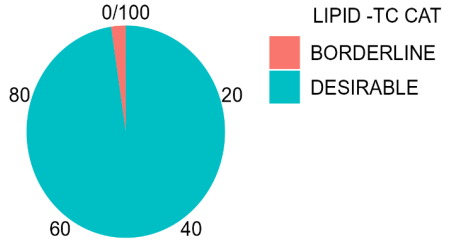
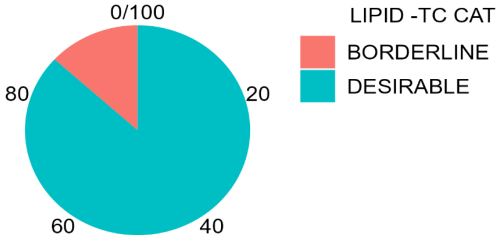
Table 4: Biochemical Profile of Alavi Bohra women of reproductive age of varying SES

Parameters	**Lower (n=42)**	**Upper (n=53)**	**Overall (N=95)**	**Difference**
Fasting blood sugar (FBS) (mg/dl)				
Mean ± Std. Deviation	117.4 ± 22.08	117.0 ± 11.44	117.19 ±16.88	0.4 ^{NS}
Range	88 – 223	97 – 160	88 – 223	
Diabetes (>125mg/dl)	6 (14.29)	6 (11.32)	12 (12.63)	
Normal (<100 mg/dl)	3 (7.14)	1 (1.89)	4 (4.21)	
Prediabetes (100-125 mg/dl)	33 (78.57)	46 (86.79)	79 (83.16)	
HbA1c				
Mean ± Std. Deviation	5.7 ± 0.77	5.7 ± 0.40	5.71 ± 0.59	0 ^{NS}
Range	4.7 – 9.4	5 – 7.2	4.7 – 9.4	
At risk (5.7-6.4)	16 (38.10)	26 (49.06)	42 (44.21)	
Diabetes (>6.4)	2 (4.76)	2 (3.77)	4 (4.21)	
Non diabetic (<5.7)	24 (57.14)	25 (47.17)	49 (51.58)	
Total cholesterol (mg/dl)				
Mean ± Std. Deviation (mg/dl)	158.6 ± 24.93	172.1 ± 26.68	166 ± 26.66	13.5 ^{NS}
Range	115 – 211	110 – 227	110 – 227	

Borderline (200-239 mg/dl)	1 (2.38)	7 (13.21)	8 (8.42)	
Desirable (<200 mg/dl)	41 (97.62)	46 (86.79)	87 (91.58)	
Triglycerides (mg/dl)				
Mean ± Std. Deviation (mg/dl)	89.2 ± 49.11	105.2 ± 77.98	98.18 ± 66.93	16 ^{NS}
Range	25 – 245	35 – 530	25 – 530	
Desirable (< 150 mg/dl)	37 (88.10)	47 (88.68)	84 (88.42)	
Borderline high (150 – 199 mg/dl)	3 (7.14)	3 (5.66)	6 (6.32)	
High (200 – 499 mg/dl)	2 (4.76)	2 (3.77)	4 (4.21)	
Very high (>500 mg/dl)	0	1 (1.89)	1 (1.05)	
HDL cholesterol – direct (mg/dl)				
Mean ± Std. Deviation	42.0 ± 7.30	42.2 ± 7.80	42.18 ± 7.55	0.2 ^{NS}
Range	26 – 55	26 – 65	26 – 65	
Desirable (40-60 mg/dl)	28 (66.67)	30 (56.60)	58 (61.05)	
High (>60mg/dl)	0	1 (1.89)	1 (1.05)	
Low (<40 mg/dl)	14(33.33)	22 (41.51)	36 (37.89)	
LDL cholesterol – direct (mg/dl)				
Mean ± Std. Deviation	101.6 ± 24.18	113.6 ± 22.13	108.36 ± 23.7	12 ^{NS}
Range	55 – 149	67 – 153	55 – 153	
Above optimal (100-130 mg/dl)	12 (28.57)	26 (49.06)	38(40)	
Borderline high (>130mg/dl)	7 (16.67)	13 (24.53)	20 (21.05)	
Optimal (<100 mg/dl)	23 (24.21)	14 (26.42)	37 (38.95)	
LDL / HDL ratio				
Mean ± Std. Deviation	2.5 ± 0.92	2.7 ± 0.65	2.66 ± 0.79	0.2 ^{NS}
Range	– 5.7	1.2 – 4.3	1.1 – 5.7	
Low risk (0.5-3)	35 (83.33)	34 (64.15)	69 (72.63)	
Moderate risk (>3)	7 (16.67)	19 (35.85)	26 (27.37)	
VLDL cholesterol (mg/dl)				
Mean ± Std. Deviation	17.84 ± 9.84	21.02 ± 15.58	19.62 ± 13.39	3.18 ^{NS}
Range	5.02 – 49.06	6.92 – 105.94	5.05 – 105.94	
Normal (5-40 mg/dl)	40 (95.24)	50 (94.34)	90 (94.74)	
High (>40 mg/dl)	2 (4.76)	3 (5.66)	5 (5.26)	
Vitamin D (ng/ml)				
Mean ± Std. Deviation	15.0 ± 7.57	13.7 ± 6.41	14.36 ± 6.94	1.3 ^{NS}
Range	7.37 – 42.11	6.9 – 40.02	6.9 – 42.11	
Deficiency (<20 ng/ml)	35 (83.33)	47 (88.68)	82 (86.3)	
Insufficiency (20-30ng/ml)	4 (9.52)	4 (7.55)	8 (8.4)	
Sufficiency (30-100 ng/ml)	3 (7.14)	2 (3.77)	5 (5.2)	
Vitamin B 12 (pg/ml)				
Mean ± Std. Deviation	540.0 ± 196.44	449.6 ± 169.07	489.62 ± 186.23	90.4 ^{NS}
Range	250 – 1132	153 – 1080	153 – 1132	
Deficient (<200 pg/ml)	0	1 (1.89)	1 (1.05)	
Sufficient (200-900 pg/ml)	41 (97.62)	51 (96.23)	92 (96.84)	
Toxicity (>900 pg/ml)	1 (2.38)	1 (1.89)	2 (2.11)	

Note: Percentages in parenthesis, ^{NS} – Non-significant, Cut-off value by American Heart Association (AHA), Center for Disease Control and Prevention (CDC); and National Cholesterol Education Programme -Adult Treatment Panel-III Guidelines (NCEP-ATP-III)

Table 5: Difference in the biochemical parameters between low and high SES groups of women of Alavi Bohra Community

Lower SES group	Upper SES group
	
	
	
	
	
	

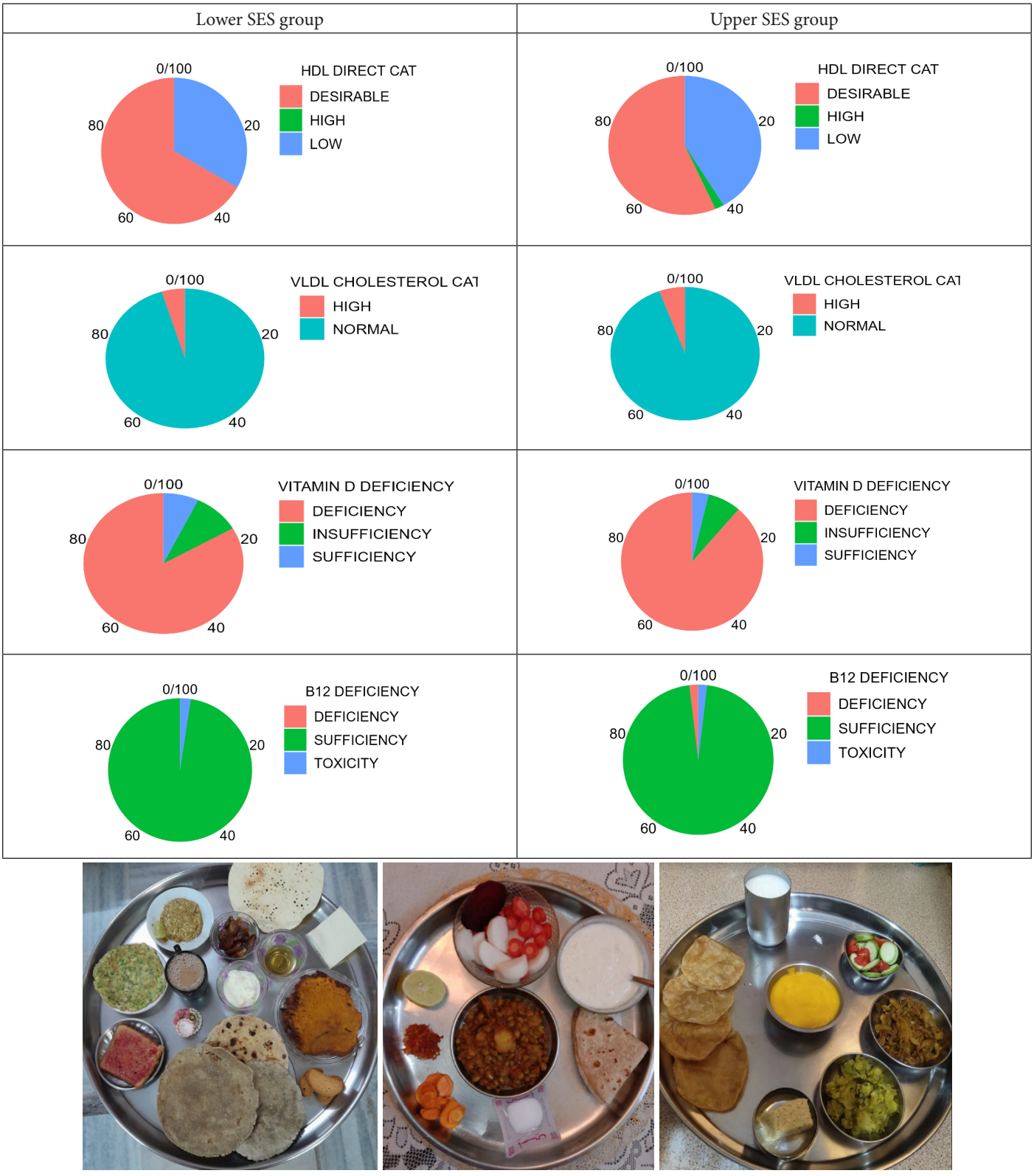


Fig. 1: Day-to-day routine meals of the day - Breakfast, Lunch, and Dinner

Dietary patterns: The actual dietary intakes of the women have not been included in the study but the sample thaal (plate) of breakfast, lunch, and dinner are presented. (Figure 1). Overall, the composition of the three meals as compared to my plate (ICMR-NIN, 2017) lacks fruits and excess use of carbohydrates, fats, and sugar is observed.

Discussion

The present study is a documentation work from one of the nano-micro communities of Islam, (the second-largest religion in India, which entered in the 7th century), which has a distinctive culture, festivals, and eating patterns. Even among the two major sects of Muslims- Sunni, and Shia, the Bohra Shias were established in Gujarat in the second half ofthe 11th century. The Bohra Indian community's belief system originates in Yemen and has three intra- sects which have distinct belief systems namely - Dawoodi, Alavi, and Suleimani. The current study highlighted the deranged biochemical profile of Alavi Bohra women of reproductive age, irrespective of their socio-economic status.

The risk of type 2 diabetes for African-American women is influenced not only by their characteristics but also by the characteristics of the neighborhoods in which they live. Even women with the highest levels of education appeared to be affected by their neighborhood environment **(Krishnan S et al., 2010).**

Household income and education level were inversely associated with the prevalence of diabetes among individuals aged 30 years or older. These associations were more prominent in females aged 30–64 years. According to household income, the odds ratio (OR) [95% confidence interval (CI)] for the lowest quartile group versus the highest quartile group was 4.96 (2.87–8.58) **(Kim Y et al., 2015).**

In a community-based cross-sectional survey from Dhaka, Bangladesh on 615 women, the mean value of total cholesterol and HDL cholesterol was 174 mg/dl and 38 mg/dL respectively. The prevalence of raised total cholesterol (≥190 mg/d L) was 34.0% in women. High level triglyceride (≥200 mg/dL) was 22.4% in women **(Khalequzzaman et al., 2017).**

Similarly**,** hypertriglyceridemia, and raised very low-density lipoprotein are the most frequent abnormal lipid levels during hyperglycemia-induced dyslipidemia. Individuals with poor glycemic control are more likely to have dyslipidemia, which may be a major factor in the development of cardiovascular disease in diabetic patients **(Kumar et al., 2022).**

Vitamin D deficiency is associated with several chronic diseases, which include cardiovascular, autoimmune diseases, and cancer. Several factors such as exposure to sunlight, skin color, dietary habits, and cultural factors affect serum vitamin D levels. Despite abundant sunshine, Vitamin D deficiency is prevalent in urban India. However, reports on analyzing the Vitamin D status of the rural Indian population are scanty **(Buyukuslu et al., 2014).**

Hindu women had a higher prevalence of low vitamin B-12 concentrations [50.5%, median (interquartile range) 149 (117, 209) p mol/L] than Muslims [30.2%, 180 (135, 224)] and Christians [37.8%, 186 (134, 229)] **(Veena et al., 2010).**

The Hindu community of Maharashtra and the Hindu community of the rest of the states showed around 20% deficiency. The comparative percentage was lower in Hindus of Maharashtra and other states because the number of people consuming a nonvegetarian diet was more as compared to people taking a vegetarian diet amongst these Hindus. The deficiency was found to be the lowest among Muslims as almost all of them were non-vegetarians **(Kankonkar, 2014).**

Greater material and financial wealth enable the purchase of healthier food and access to better quality health care, but it may also be associated with unhealthy lifestyle choices. Economic development combined with modernization can lead to an increase in the consumption of processed foods, and animal fats and a shift to a more sedentary lifestyle. Previous studies have shown that higher wealth and income are associated with diets rich in animal fats, and there is evidence of this in India **(Popkin et al., 2001).**

Conclusion

Socioeconomic status did not have any significant influence on the biochemical parameters of the women from the Alavi Bohra community. A high risk of diabetes, dyslipidemia, and vitamin D deficiency was recorded indicating that though they have a very traditional dietary pattern they do suffer from metabolic imbalances which need immediate attention.

Declaration

There is no conflict of Interest/Competing Interests among authors.

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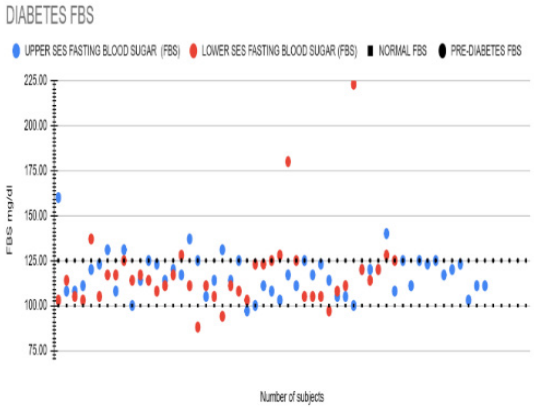
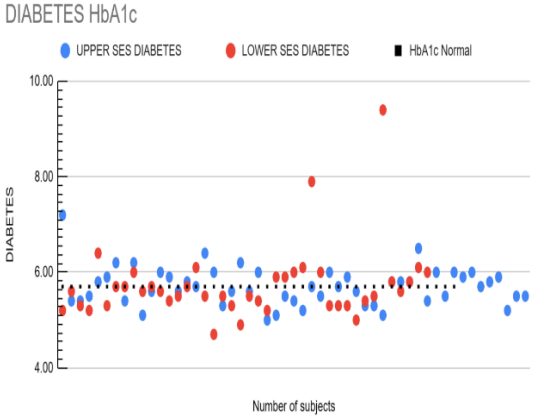
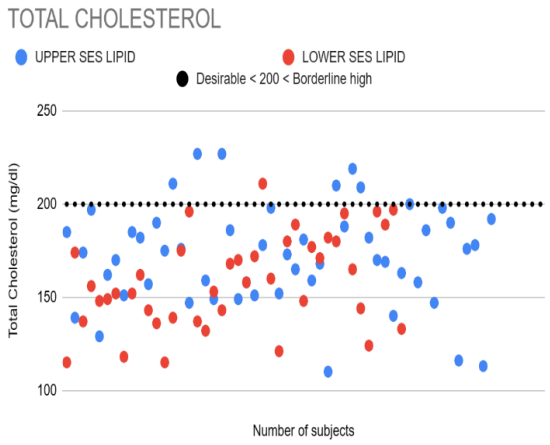
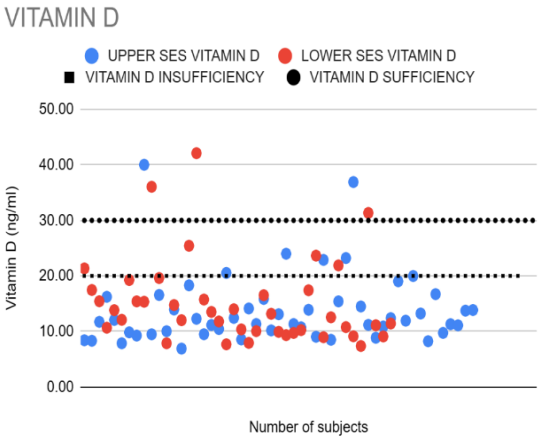
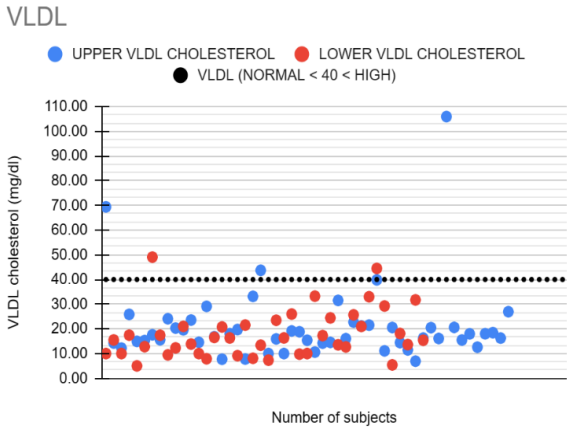
Supplementary Figures

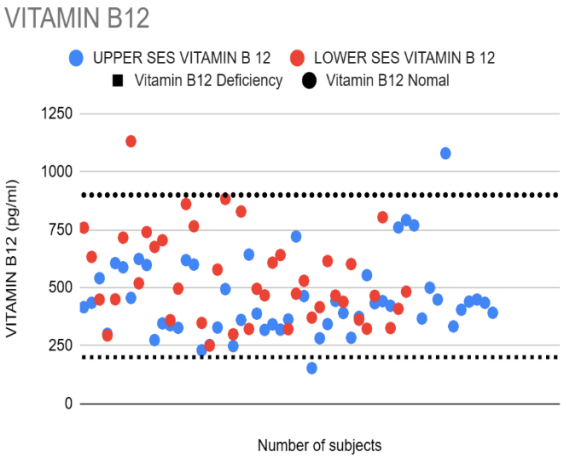





TOTAL CHOLESTEROL
UPPER SES LIPID
LOWER SES LIPID
Desirable < 200 < Borderline high
250
200
150
100
Total Cholesterol (mg/dl)
Number of subjects


VITAMIN D
UPPER SES VITAMIN D
LOWER SES VITAMIN D
VITAMIN D INSUFFICIENCY
VITAMIN D SUFFICIENCY
50.00
40.00
30.00
20.00
10.00
0.00
Vitamin D (ng/ml)
Number of subjects


VLDL
UPPER VLDL CHOLESTEROL
LOWER VLDL CHOLESTEROL
VLDL (NORMAL < 40 < HIGH)
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
VLDL cholesterol (mg/dl)
Number of subjects


VITAMIN B12
UPPER SES VITAMIN B 12
LOWER SES VITAMIN B 12
Vitamin B12 Deficiency
Vitamin B12 Nomal
1250
1000
750
500
250
0
VITAMIN B12 (pg/ml)
Number of subjects