4. RESULTS AND DISCUSSION

The results of the present study entitled "**Impact of Nutrition Intervention and Dress Code on Vitamin D Nutriture of Muslim Women",** is presented under the following headings:

4.1 Factors Influencing Vitamin D Nutriture among Muslim Women

4.1.1 Socio-economic background among the Muslim families

4.1.2 Demographic profile of the Muslim women

4.1.3 Health status of the Muslim women

4.1.4 Dietary pattern of the Muslim women

4.1.5 Lifestyle pattern of Muslim women

4.1.5.1 Dress code practices

4.1.5.2 Sunlight exposure

4.1.5.3 Physical activity pattern

4.1.6 Knowledge and attitude on Vitamin D

4.1.7 Influence of dress code and Knowledge on Vitamin D

4.2 Health and Nutritional Status of Muslim

4.2.1 Anthropometric measurements

4.2.2 Clinical examination

4.2.3 Diet survey

4.2.4 Serum Calcium and Vitamin D status of selected Muslim women

4.3 Identification and Analysis of Vitamin D Fortified Foods

4.3.1 Market survey

4.3.2 Calcium and Vitamin D content of fortified egg and milk

4.4 Impact Evaluation

4.4.1 Impact of digital health intervention and telephonic counseling on knowledge, attitude and practice

4.4.2 Impact of digital health intervention and dietary modification on food and nutrient intake of the Muslim women

4.1 Factors Influencing Vitamin D Nutriture among Muslim Women

A total of 566 Muslim women among the urban population in Coimbatore city were studied to identify the various factors which might influence their Vitamin D nutriture. Age, socioeconomic background, family type and size, acute and chronic health conditions, dietary pattern, cultural practices concerning Islamic dress code, physical activity pattern and knowledge and attitude on Vitamin D among the Muslim women are discussed as follows

4.1.1 Socio-economic Background among the Muslim Families

Literature ascertains socio economic status which is marked by the social and economic condition of the family members, evidence of unfavourable socioeconomic status leading to poverty, poor health and nutritional practices and low educational levels remark its significant influence on the family background of an individual or population (Reardon *et al*., 2013; Alkerwi *et al*., 2015).

Background of the Muslim families

Table IV depicts the background of the Muslim families such as family type, size, education and occupation of the family head, income and household amenities.

Table IV

Background of the Muslim Families

(N = 566)

Background details		Number	Percentage (%)
Family Type	Joint	146	25.8
	Nuclear	420	74.2
	Total	566	100
Family size(in number)	≤ 3	166	29.3
	4 – 6	387	68.4
	7 – 9	9	1.6
	≥ 10	4	0.7
Educational qualification of the family head*	Professional Degree	99	17.5
	Post Graduate	12	2.1
	Graduates	196	34.6
	Diploma	18	3.2
	High school	215	38
	Middle school	25	4.4
	Primary school	1	0.2
	Illiterate	0	0
Occupation of the family head*	Professional	50	8.8
	Semi professional	24	4.3
	Business	273	48.2
	Skilled worker	120	21.2
	Semi skilled worker	58	10.2
	Unskilled worker	35	6.2
	Unemployed	6	1.1
Family Income (₹)*	≥ 52,734	43	7.6
	26,355 – 52,733	147	26
	19,759 – 26, 354	153	27
	13,161 – 19,758	109	19.3
	7,887 – 13,160	95	16.8
	2,641 – 7,886	19	3.3
	≤ 2641	0	0
Household amenities possessed (in number)	≤ 2	191	33.7
	3 – 5	370	65.4
	≥ 6	5	0.9

*Modified Kuppuswamy's socioeconomic scales (Wani,2019)

Family type and size

The above table revealed the family background of the Muslim women, in which 146(26%) of them were joint families and the remaining 420(74%) were nuclear families. This trend of a higher rate of the nuclear family was similar to the observation of Allendorf (2013) where there was an increase in Indian married

women living in nuclear families due to urbanisation. The family size revealed the majority of the families had four to six members (68 per cent) followed by one to three members (29 per cent), besides from Figure 5 comparing the type and size of the family, it is evident that a pattern of three to four family members was 68 per cent in nuclear families which was found to be on par with 71.4 per cent of families having three to four members as noticed in the study conducted in Coimbatore city (Anbukarasi and Dheivanai, 2017). Among the joint families, 58 per cent had a five to six member pattern, while in the nuclear family it was 21.4 per cent. Ten per cent of nuclear families had one to two members.

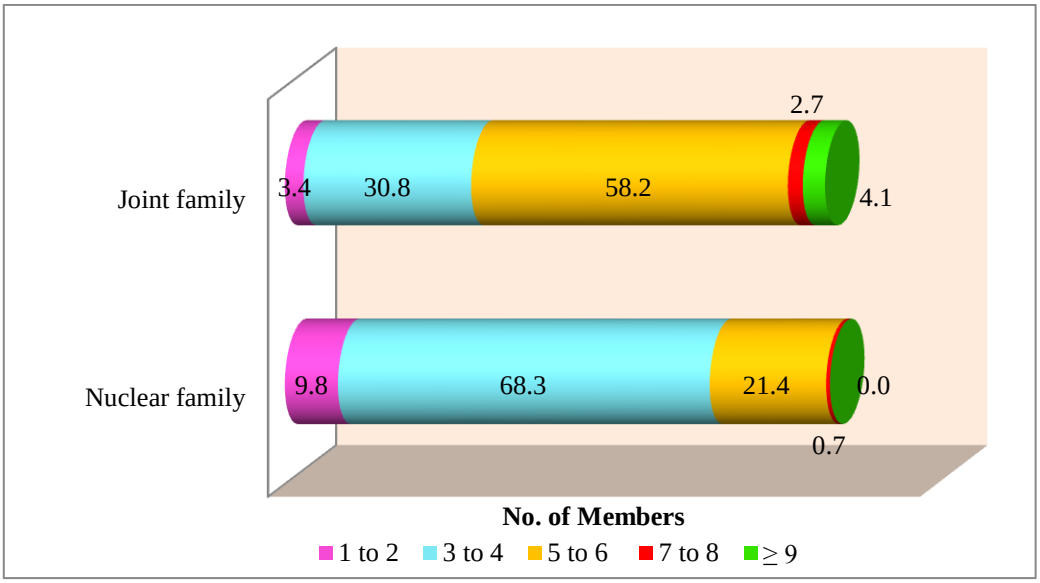


Figure 5: Type and Size of the Family

Educational qualification of the family head

A senior family member, a male is entitled as the head of the family and is responsible for various decisions and financial assistance for the family educational qualification of the head may directly influence the family (Mathur, 2015). In the present study, the educational qualification of the family head, occupation and family income are categorised based on modified kuppuswamy scales 2019 (Wani, 2019). Regarding the educational qualification of the family head, 35 per cent were graduates and 17.5 per cent had completed a professional degree. Thirty eight per cent had completed education upto high school levels. None of the family head was illiterate.

Occupation of the family head

Forty nine per cent of the families had business as their main occupation followed by skilled workers (21.2%) namely tailors, drivers, caterers and mechanics and

semiskilled workers (10.2%) such as auto drivers, salesmen and workshop workers. Nine per cent were in professional jobs like doctors, engineers, lawyers and accountants and4.3 per cent were semi skilled workers such as private teachers and medical technicians. The rate of unemployment was one per cent among the families studied.

Family income

Income may be defined as any payment, salary, rent, interest, profit or type of earnings obtained over a period that determines the purchasing capacity and thereby consumption and health of an individual (Case and Fair, 2007) Among the families studied only 7.6 per cent earned above₹ 53000, families earning between ₹ 26300 to 53000 and ₹ 19700 to 26300 were 26 and 27 per cent respectively, which was on par with a study conducted in urban Coimbatore showing 23.7 per cent of families earning between ₹ 16000 to 22000 (Nathania and Vasanthamani, 2011). None of the families earned below ₹ 2641.

Household amenities

Based on the household amenities owned television, washing machine, microwave oven, two wheelers and four wheelers a score out of seven was provided. Among the families studied, 65.4 per cent scored 3 to 5 while 33.7 per cent scored 1 to 2. Two wheelers and television were the two amenities predominantly present in the majority (99 %) of the households.

Monthly expenditure pattern among the Muslim families

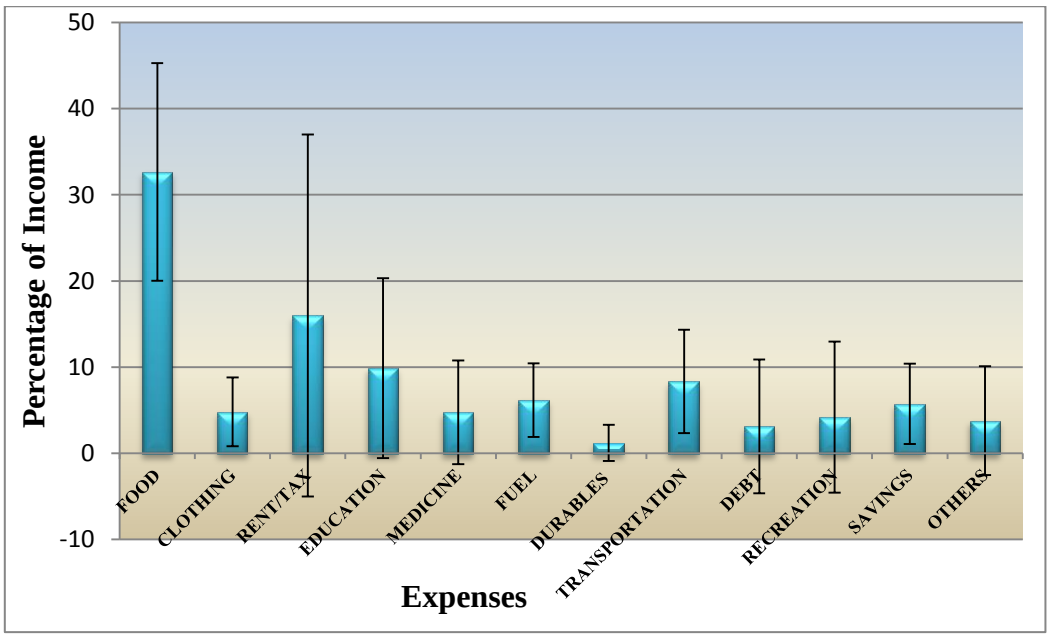


Figure 6: Monthly Expenditure Pattern among Muslim Families

The percentage of income expended on various family expenses was calculated and average monthly expenditure pattern and deviation was detected (Figure 6) discerned that majority of the families spent the highest per cent of their income on food (32.7 ± 12.6) followed by 16 ± 21.0 on rent and 9.9 ± 10.44 and 8.3 ± 6.0 on education and transportation.

Sathiyabamavathy and Sekhar (2020) found a similar monthly expenditure pattern of 33.2 per cent on food, conversely 28 per cent and 31.6 per cent expenditure on education and clothing in a research conducted in Coimbatore city, which was much higher when compared with the Muslim families concluding low expenses preferences for education and clothing expenses among the Muslim families in Coimbatore city. Greater values of standard deviation observed for education, rent, medicines, durable goods purchase, debt, recreation and others indicated diversity in expenditure among the families. Other expenses (3.8 ± 6.8) premium payments, charity and household repairs were covered.

Socio-economic status among the Muslim families

Table V shows the socio-economic status among Muslim families.

Table V
Socio-economic Status among the Muslim Families

Criteria*	Number (n = 566)	Percentage (%)	Variance	
			F value	p value
Upper	34	6.0	702.69	0.000**
Upper middle	256	45.2		
Lower middle	230	40.7		
Upper lower	46	8.1		
Lower	0	0		

*Modified Kuppuswamy's socio-economic scales (Wani,2019) **Significant at 1%

In accordance with Kuppuswamy's classification 2019, using income, education of the family head and occupation scores, the socioeconomic total grade scores were calculated. Using these scores, the families were classified as lower, lower middle, upper lower, upper and upper middle socioeconomic groups (Wani, 2019).

The socio-economic status of Muslim families was diverse with 45.4 per cent of families belonging to an upper middle class, 40.5 per cent of the families belonging to a lower middle class, and 54 per cent of lower middle class families was observed in a study conducted in Salem district of Tamilnadu (Balamurugan *et al*., 2014). None of the

Muslim families studied belonged to low income category. A difference in distribution within the group was observed indicating varied socioeconomic status among the Muslim families, which was statistically significant at one per cent level.

4.1.2 Demographic profile of the Muslim women

Details on the demographic profile of the Muslim women was elicited in terms of their age, Islamic category, marital status, education, occupation, autonomy and vital statistics and the results are presented as follows:

Age of the selected Muslim women

Figure 7 shows the age of the selected Muslim women.

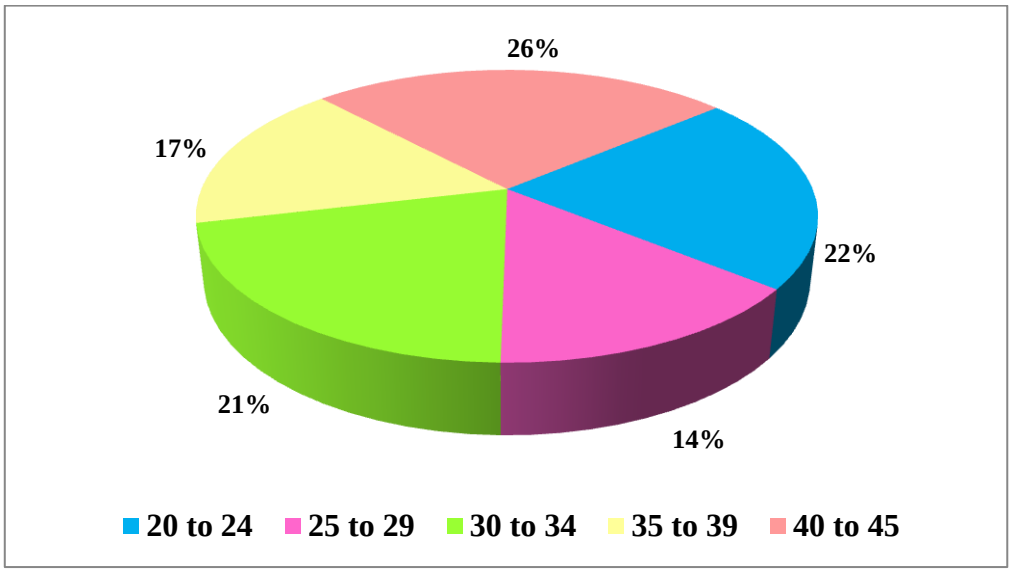


Figure 7:Age of the selected Muslim Women

From the 566 Muslim women included in the study based on the inclusion and exclusion criteria, 22 per cent were between 20 to 24 years, 14 per cent were between 25 to 29 years, 21 per cent were between 30 to 34 years, 17 per cent between 35 to 39 years and 26 per cent between 40 to 45 years as indicated in Figure 7. For the study, the Muslim women were divided into three age categories, women between 20 to 29 years, 30 to 39 years and 40 to 45 years. The mean age of the Muslim women included in the study was 32.5 ± 8.2, which coincided with the mean age of 32.5 years observed in another study by Khamechian*et al*. (2014).

Categorisationof the Muslim women

The Muslim women identified in the city werecategorised based on the languages spoken into five groups. In the age group of 40 to 45 years, 12 per cent spoke Malayalam, 36 per cent spoke Tamil and 52 per cent spoke Urdu. In the 30 to 39 years age group 19 per cent spoke Malayalam, 37 per cent spoke Tamil and 45 per cent spoke Urdu and one per cent spoke Kutchi and bora. Overall 99.6 per cent of the Muslim women studied were Sunni Muslim and the remaining 0.4 per cent were Shia Muslim, also alluding that a higher population of Sunni Muslims compared to Shia living in the city.

Marital status of the Muslim women

Table VI depicts the marital status of Muslim women.

Table VI
Marital Statusof the Muslim Women

(N =566)

Marital status	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)		Association with age	
	N	%	N	%	N	%	χ^2 value	P value
Married	119	57.7	206	96.7	137	93.2	173.24	0.000*
Unmarried	85	41.3	5	2.3	0	0		
Divorced	2	1	1	0.5	2	1.4		
Widow	0	0	1	0.5	8	5.4		

*Significant at 1%

Details on marital status among the Muslim women revealedninety three per cent of the Muslim women were married in 40 to 45 years age group and among the remaining one per cent were divorced and five per cent were widows. In the 30 to 39 years age group 96.7 per cent and two per cent were married andunmarried and among the age group of 20 to 29 years 57.7 per cent and 41.3 per centwere married and unmarried respectively. Jerinabi and Kanniammal (2009) found 80 per cent of Muslim women in Coimbatore city were married which was on par with the average per cent (82%) of married women observed in the present study. Further, there was a statistically significant association between age and marital status.

Vital statistics of the Muslim women

Table VII depicts the vital statistics of the Muslim women.

Table VII

Vital Statistics of the Muslim Women

N =566

Details	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Unmarried	85	41.3	5	2.3	0	0
Age at marriage (in years)						
≤ 20	75	36.4	116	54.5	92	62.6
21 – 24	42	20.4	56	26.3	38	25.8
25 – 28	4	1.9	34	16	15	10.2
≥ 29	0	0	2	0.9	2	1.4
Age at 1st pregnancy (in years)						
≤ 20	40	19.4	83	39	62	42.2
21 – 24	44	21.4	70	32.8	51	34.7
25 – 28	10	4.8	36	16.9	26	17.7
≥ 29	0	0	7	3.3	7	4.7
Not pregnancy	112	54.4	17	8	1	0.7
1st pregnancy - miscarried or stillbirth	5	2.4	1	0.5	1	0.7
Number of children						
1	50	24.3	32	15	15	10.2
2	34	16.5	119	55.9	85	57.8
3	4	1.9	37	17.4	39	26.5
>3	1	0.5	7	3.2	6	4.1
Number of miscarriages						
1	22	10.7	52	24.4	28	19.1
2	6	2.9	15	7.1	14	9.5
>2	1	0.5	6	2.8	3	2.0
Number of stillbirths						
1	0	0	7	3.3	5	3.4
2	0	0	1	0.5	0	0
>2	0	0	0	0	0	0

The study revealed that the age at marriage was less than 18 years in 23 per cent between 40 to 45 years, which reduced to 7.3 per cent in the age group of 20 to 29 years indicating a decrease in the trend of early marriage. Nearly 40 per cent of the women were married between the age of 18 to 20 years among Muslim women between 30 to 45 years of age. Among 20 to 29 years, 41.3 per cent were unmarried highlighting a change inclination among the younger Muslim women, besides 29.1 per cent in this age group were married between 18 to 20 years of age.

Table VIIhighlights 42 per cent of Muslim women in 40 to 45 years and 39 per cent in the age group of 30 to 39 years had a first child at or below the age of 20 followed by Muslim women from all three age groups at the range of 21 to 35 per cent had the first child between 21 to 24 years. This indicated a recent rise in the age of marriage, further, a pattern of decrease in pregnancy below 20 years of age from 42 per cent in 40 to 45 years age group to 19 per cent in 20 to 29 years was evident. Two per cent of the Muslim women experienced miscarriage or stillbirths during the first pregnancy (20 – 29 years) and thereafter did not conceive.

The measure of the number of children given birth by the women is said to be directly applicable to the availability of public health services and thereby affect on maternal mortality rate, it also affects the quality of life (Cleland, 2008). The number of children in 56 per cent (30 -39 years) and 58 per cent (40 – 45 years) of the Muslim women was two children, followed by three children in 17.4 per cent in 30 to 39 years and 26.5 per cent in 40 to 45 years age group. One child pattern was observed in 24 per cent of the Muslim women in 20 to 29 years age groupwhich was more than the other two age groups. This revealed the two child pattern to be dominant among the families. Twenty four per cent of miscarriages and 3.3 per cent of stillbirth incidences were reported among the Muslim women in 30 to 39 years and in 40 to 45 years 3.4 per cent still birth were obvious.

Educational qualification of the Muslim women

Table VIII shows the educational qualification of the Muslim women.

Table VIII
Educational Qualification of the Muslim Women

(N = 566)

Level of education	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)		Association with age	
	N	%	N	%	N	%	χ^2 value	P value
Primary	25	12.1	83	39	99	67.3	198.29	0.000*
Secondary	20	9.7	52	24.4	13	8.8		
Higher secondary	47	22.8	42	19.7	19	12.9		
Graduate	105	51	26	12.2	9	6.2		
Postgraduate	6	2.9	10	4.7	2	1.4		
Others	3	1.5	0	0	5	3.4		

*Significant at 1%

The above table depicted that 51 per cent of the Muslim women between 20 to 29 years were graduates and 22.8 per cent had completed education up to higher secondary levels. Among Muslim women in the age of 30 -39 years, 39 per cent had completed only primary education, followed by secondary education (24.4%) and higher secondary education (19.7%), while only 12.2 per cent were graduated this figure was marginally higher than(7.7%) observed in a study by Hussain *et al*, 2018 among the Indian Muslim women. These figures suggest a recent improvement in the educational qualification of young Muslim women (20 - 29 years) and an inverse relationship was evident.

Education pattern of the Muslim women

Table IX presents the education pattern of the Muslim women.

Table IX

Education Pattern of the Muslim Women

(N =566)

Details	**20 – 29 years (n = 206)**		**30 – 39 years (n = 213)**		**40 – 45 years (n = 147)**	
	N	**%**	**N**	**%**	**N**	**%**
Type of Institution						
Women's institution	115	55.8	105	49.3	75	51.0
Coeducational	89	43.2	105	49.3	68	46.3
Not applicable (home education)	2	1	3	1.4	4	2.7
Total	**206**	**100**	**213**	**100**	**147**	**100**
Dropout rate	45	21.8	135	63.3	112	76.2

Table IX suggested that 56 per cent of women in 20 to 29 years, 49 per cent in 30 to 39 years and 51 per cent in 40 to 45 years preferred women's institutions for education; this was supported by studies suggesting opening women's institutions with lady teacher for boosting Muslim women education (Hossain, 2013). Muslim women who did not pursue higher education were considered dropouts. From the above table, 76.2 per cent and 63.3 per cent in the age of 40 to 45 years and 30 to 39 years were dropouts. The reason for dropping out from school was due to lack of interest (17.3%),

early marriage (14.1%), family circumstances (18.1%), not being permitted (12.1%) and pursuing Islamic education (4.9%) among the Muslim women.

Among Muslim women in the age of 40 to 45 years, 67.3 per cent of them had completed only primary education followed by 12.9 per cent having completed higher secondary education. There was a statistical association between age and educational qualification of Muslim women, that is, a pattern of decrease in education qualification with an increase in age indicating an improvement in the field of education among the young adult generation was observed, which supported the increased enrollment of Muslim women for higher education evidenced by the all India survey on higher education 2016 to 2017 (AISHE, 2017). Women qualified up to diploma and obtaining an education at home were three per cent among Muslim women in the age of 40 to 45 years. None of the women were illiterates.

Occupationalstatus among the Muslim women

Table X presents the occupational status among the Muslim women.

Table X

Occupational status among the Muslim Women

(N =566)

Type of occupation	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)		Association with age	
	N	%	N	%	N	%	χ2 value	P value
Doctors and engineers	1	0.5	1	0.5	0	0	135.2	0.000*
Homemakers	130	63.0	186	87.3	128	87.1		
Business	2	1	6	2.8	2	1.4		
Catering	0	0	1	0.5	4	2.7		
Tailors	3	1.5	7	3.3	5	3.4		
Teachers	4	1.9	4	1.9	1	0.6		
Students	60	29.1	0	0	0	0		
Saleswomen	3	1.5	3	1.4	2	1.4		
Maids	1	0.5	3	1.4	3	2.0		
Others	2	1	2	0.9	2	1.4		

*Significant at 1%

One Muslim woman each from 20 to 29 years and 30 to 39 years age group were professionals such as doctors and engineers in the population studied. Maitreyi(2004) found four per cent of the Muslim women (20 – 55 yrs) in India to be in professional jobs. The majority of the women were homemakers in all three age groups (63 - 87.3%)

which was higher than 46 per cent observed in a study conducted among Muslim women in Coimbatore city (Jerinabi and Kanniammal, 2009)when compared to a study, 29 per cent of Muslim women in the age of 20 to 29 years were students. Three per cent of the Muslim women between 30 to 45 years were tailors. An identical trend was observed among saleswomen (1.4 to 1.5%) and others (0.9 to 1.4%) in all three age groups. Nearly one per cent of the Muslim women performed other occupations such as front office workers and handling tuition. A statistically significant association between age and occupation was signifying the variation in occupation by age.Therefore most of the Muslim women were homemakers in all three age groups, among working women varied preferences for the different professions were observed.

4.1.3 Health status of the Muslim women

In the present study, the acute illness incidences, chronic illness prevalence, treatment preferences, medicine and supplement usage and sources of health information to maintain health status were used as indicators of health among Muslim women.

Incidence and frequency of acute illness

Morbidity pattern among the Muslim women

Table XI elicits information on Morbidity pattern among the Muslim women.

Table XI

Morbidity Pattern among the Muslim Women

(N = 566)

Nature of Illness*	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Acute Illness	153	74.3	178	83.6	119	81
Fever	66	32.0	76	35.7	48	32.7
Diarrhoea	10	4.9	13	6.1	6	4.1
Common cold	138	67	148	69.4	100	68.0
Chickenpox	6	2.9	1	0.5	0	0
Others	2	1.0	7	3.3	5	3.4

*Multiple responses

Acute illnesses are diseases with sudden onset and remain for a limited duration of time, frequent recurrence of acute diseases is attributed to low immunity (Young *et*

al., 2021). Table XI revealed 74 to 84 per cent occurrence of acute illness, within the past year among Muslim women. Among the illnesses, common cold incidences were highest ranging between 67 to 69 per cent in all three age groups followed by fever (32 to 36 per cent). Headaches, wheezing and acidity wasalso observed among the women, the incidences of which wasthree per cent in both 30 to 39 years and 40 to 45 years age group. The incidences of acute illness are represented in Figure 8, which showsoccasional occurrence in74 to 82 per cent of the Muslim women in all three age groups, 10.8 to 17 per cent of the women were healthy and did not acquire any acute illnesses in past one year. Among Muslim women of 30 to39 years and 40 to 45 years nine per cent exhibited monthly morbidity patterns suggesting low immunity among the women (Solana *et al*., 2012).

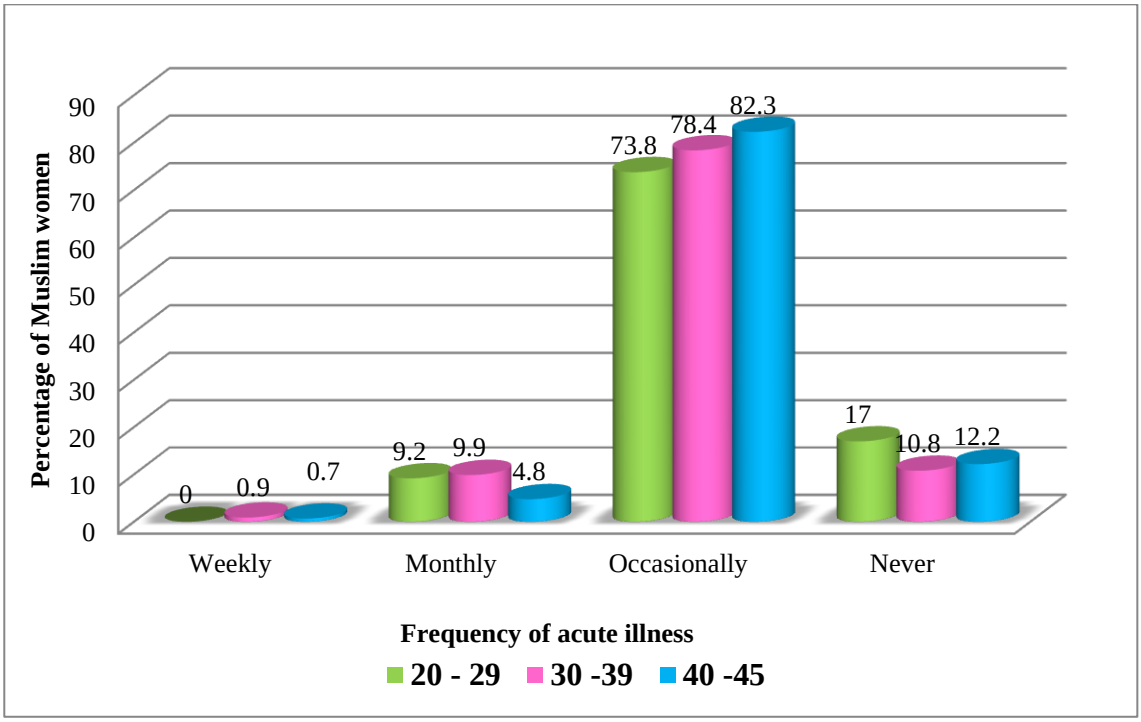


Figure 8: Frequency of Acute Illness

Prevalence of chronic illness

Table XII presents the prevalence of chronic illness.

Table XII
Prevalence of Chronic Illness

(N = 566)

Chronic illness*	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Hypertension	2	1	9	4.2	33	22.4
Diabetes mellitus	2	1	6	2.8	24	16.3
Respiratory tract infection	138	67.0	148	69.5	100	68.0
Arthritis	1	0.5	1	0.5	1	0.7
Thyroid	7	3.4	15	7.0	13	8.8
Allergies	13	6.3	14	6.6	11	7.5
Cancer	0	0	0	0	1	0.7
PCOD	11	5.3	4	1.9	0	0
CVD	0	0	1	0.5	1	0.7
Others	11	5.3	27	12.7	15	10.2

*Multiple responses

The prevalence of hypertension (22.4%) and diabetes (16.3%) was found to be comparatively higher inMuslim women above 40 years of age as shown in Table XII. Geldsetzer*et al.* (2018) found a similar higher occurance of hypertension and diabetes amongwomen older than 40 years. Concerning Muslim women in 20 to 29 years age group, one per cent were found to exhibit Type 1 diabetes and one per cent developed hypertension post pregnancy and five per cent suffered from polycystic ovarian syndrome (PCOD) the incidence of which was comparatively more in women between 20 to 29 years compared with other two age groups suggesting the prevalence to be higher among the young adult women in comparison with women above 30 years of age (Joshi *et al*., 2014).

Among the chronic illnesses, 67 to 70 per cent of the Muslim women showed the incidence of respiratory tract infection in all the three age groups, this was on par with the higher incidences of respiratory tract infection reported in the South Indian population (Waghmode*et al*., 2021).It is also evident that the incidences of the thyroid were seven per cent (30-39 years) and nine per cent (40 – 45 years) among Muslim women respectively. Hypertension, diabetes mellitus, thyroid, cancer and CVD showed an age related increase in prevalence. Other health conditions such as anaemia, varicose veins, migraine, ulcer, neurological problems, high cholesterol and Psoriasis were 12.7 per cent and 10.2 per cent respectively among Muslim women at the age of 30 to 39

years and 40 to 45 years. Lifestyle diseases such as hypertension, diabetes, thyroid, cancer and CVD showed an increase in average prevalence with an increase in age, showing an onset after 40 years among the women.

Health related practices

Table XIII shows details on health related practices.

Table XIII
Health Related Practices

(N=566)

Practices	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Access to treatment	203	98.5	210	98.6	145	98.6
No proper access to treatment	3	1.5	3	1.4	2	1.4
Treatment preferences*						
Ayurvedic medicine	33	16.0	18	8.5	18	12.2
Allopathic medicine	167	81.1	183	85.9	124	84.4
Homoeopathic Medicine	18	8.7	18	8.5	14	9.5
Others	5	2.4	9	4.2	7	4.7
Preferred Source for health information*						
Television programs	101	49.0	90	42.3	49	33.3
Social media	120	58.3	76	35.7	48	32.7

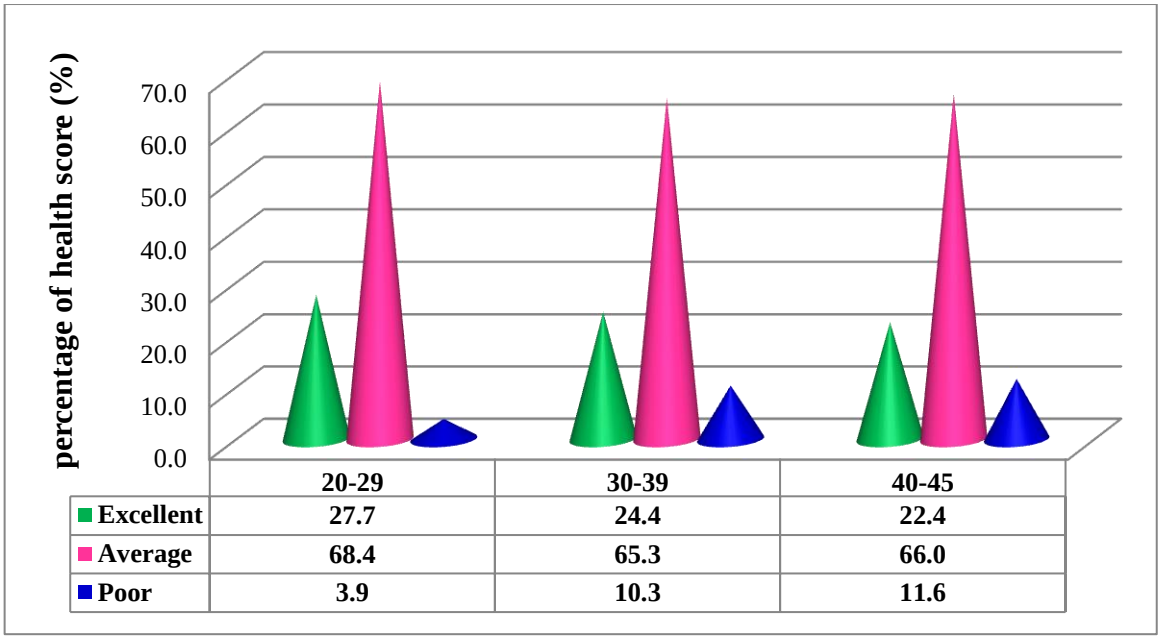
*Multiple responses

From Table XIII, it is observed that the majority of the Muslim women (99 %) had access to treatment in one or the other form, which was in contrast with 53 per cent Muslim women experiencing delayed clinical care due to preference of female doctors (Vu *et al*, 2016). The preference for treatment revealed above 80 per cent of the Muslim women preferred allopathic medicine, followed by ayurvedic(8 – 16%), among the other treatments preferences 2.4 to 4.7 per cent use of acupressure, accutouch and Siddha medicine was observed among the Muslim women. Regarding preferred sources to obtain health information among Muslim women, social media was used by 58.3 per cent of thewomenandtelevision was used by 49 per cent of Muslim women in 20 to 29 years age group, while in the other two groups television and social media usage reduced with an increase in age.

These medicines were for diabetes, hypertension, thyroid and gastritis. Very low (4 to 7%) per cent of the Muslim women in all three age groups consumed supplements such as iron, vitamin and mineral medicines. The frequency of consumption was daily in 35.4 per cent of Muslim women between 40 to 45 years of age and 12.6 per cent and 18.3 per cent among women between 20 to 29 years and 30 to 39 years. Drug allergieswere present among 11 to 15 per cent of the Muslim women in all three age groups.

Overall health status

Figure 9 depicts the overall health status



	20-29	30-39	40-45
Excellent	27.7	24.4	22.4
Average	68.4	65.3	66.0
Poor	3.9	10.3	11.6

***χ2= 45.09; p = 0.097^{NS}; NS – not significant**

Figure 9: Overall Health Status

The overall health score was provided based on incidences and frequency of acute illness and prevalence and duration of chronic illness. Out of seven, a score above six was rated excellent, four to six rated average and less than four was rated poor. From Figure 9, it is evident that a major portion of the Muslim women in all three age groups exhibited average health scores (65% to 68%). The excellent health scores showed a marginal reduction of health score with age such as in 20 to 29 years (27.7%),30 to 39 years (24.4%) 40 to 45 years(22.4%) of age reduction in scores was evident. Besides, 11.6per cent of Muslim women between 40 to 45 years exhibited poor health, followed

by 10.3 per cent in the age group of 30 to 39 years. Similar findings were reported in75 per cent of Muslim women in India with improved health facilities was observed by Firdaush and Das (2018) in a comparative study. The mean health score among Muslim women of different age groups was 5.56 ± 0.92 among women of 20 to 29 years of age, 5.36 ± 1.02 in women of 30 to 39 years and 5.26 ± 1.08 in 40 to 45 years of age. The difference in health score between the age groups was statistically non significant, a very weak association can be observed between health status and age among the Muslim women.

4.1.4 Dietary pattern of the Muslim Women

Table XIV shows the dietary pattern of the Muslim Women

Table XIV

Dietary Pattern of the Muslim Women

(N=566)

Constructs	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Type of diet						
Vegetarian	1	0.5	5	2.3	1	0.7
Non vegetarian	197	95.6	208	97.7	145	98.6
Ova vegetarian	8	3.9	0	0	1	0.7
Meal and snacks pattern						
< 3 meals	25	12.1	30	14.1	12	8.2
3 meals	174	84.5	183	85.9	135	91.8
> 3 meals	7	3.4	0	0	0	0
< 2 snacks	65	31.6	37	17.4	24	16.3
2 snacks	99	48.1	99	46.5	73	49.7
>2 snacks	42	20.4	76	35.7	50	34.0

Dietary habits provided an image of the food preferences and consumption practices, which is influenced by factors such as education, socioeconomic status, life stage, culture and lifestyle which directly determines the health status of an individual (Viorel*et al*., 2020; Krause *et al*., 2015).

Type of diet

A non vegetarian dietary habit among Muslims was evident from a study conducted among 100 Muslim women in Coimbatore city (Habeeba and Kalpana, 2018). In the present study, with an increased sample size of 566 Muslim women in the same area, the presence of vegetarians and ova vegetarians were also observed. From Table XIV,it is observed that the majority of the Muslim women in all three age groups were non vegetarians (96 to 99 %). With four per cent ova vegetarians in the age group of 20 to 29 years, very minimal proportions of them were vegetarians (0.5 to 0.7%). This ova vegetarian habits among the younger generation indicated a recent decrease in preference for non vegetation foods among the Muslim women of younger (20- 29 years) generation.

Meal and snack pattern

Regarding the number of meals consumed, Table XIV revealed that 85 to 92 per cent of the Muslim women in all three age groups consumed three meals per day.Radha and Lusiamary (2021) observed a three meals per day pattern among 90 per cent of the adults in Coimbatore city. Followed by three meals consumption was less than three meals in 14 per cent in 30 to 39 years, 12 per cent in 20 to 29 years and eight per cent in 40 to 45 years. Regarding the number of snacks consumed, a two snack pattern was observed in 47 to 50 per cent of Muslim women of all three age groups followed by more than two snacks in 36 per cent of Muslim women between 30 to 39 years and 34 per cent in women between 40 to 45 years. Three meal two snack pattern of consumption was more preferable among Muslim women irrespective of their age.

Skipping of meals

Table XV shows the skipping of meals.

Table XV

Skipping of Meals

(N=566)

Skipping of meals	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Yes	98	47.6	93	43.7	53	36.1
No	108	52.4	120	56.3	94	63.9
Type of meals skipped*						
Breakfast	82	83.7	79	84.9	46	86.8
Lunch	12	12.2	9	9.7	5	9.4
Dinner	16	16.3	9	9.7	7	13.2
Frequency of skipping meals						
Daily	23	11.2	27	12.7	10	6.8
Once or twice a Week	34	16.5	30	14.1	20	13.6
Occasionally	41	19.9	36	16.9	23	15.7
Never	108	52.4	120	56.3	93	63.3
Compensating for meals	55	56.1	54	58.1	34	64.1
Food substitutes*						
Fruit juice	24	43.6	8	14.8	6	17.6
Snacks	14	25.4	10	18.5	10	29.4
Others	20	36.4	37	68.5	19	55.9

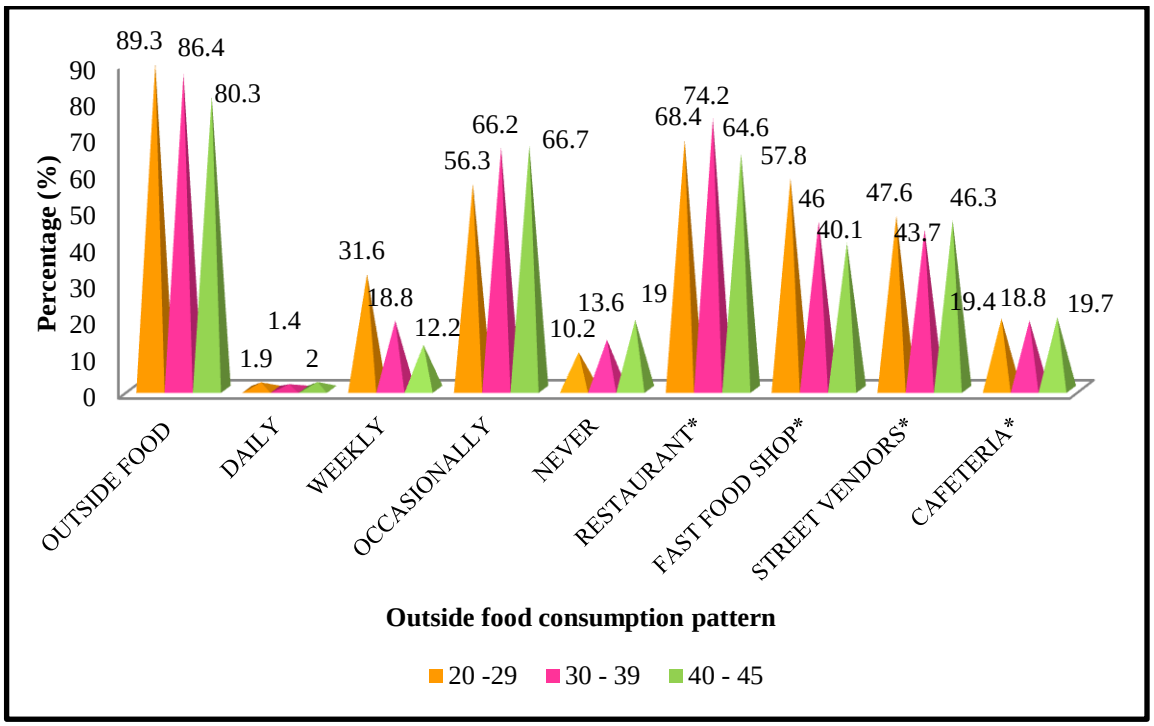
*Multiple responses

Out of the 566 Muslim women, 47.6 per cent of the women in the age group of 20 to 29 years skipped meals preceded by 43.7 per cent of women in 30 to 39 years and then 36.1per cent of women in the 40 to 45 years age group. Among the meal skippers, the majority of the women skipped breakfast (82– 85%) followed by skipping of dinner (9 – 16%). The reasons specified for skipping the meals was lack of time, which was similar to a literature review finding of breakfast as most frequently skipped meal and lack of time as a consistent correlate for skipping the meals (Pendergast*et al*., 2016). Eleven to thirteen per cent of the women in the age group of 20 to 29 years and 30 to 39 years skipped meals regularly.

Occasional skipping pattern was in the range of 16 to 20 per cent and once or twice weekly skipping was in the range of 14 to 17 per cent among the Muslim women in all three age groups. In all the three age groups, among the meal skippers, 54 to 64 per cent of the women compensated for the skipped meals, of which 43.6 per cent(20 -29 years) consumed fruit juices, while 68.5 per cent (30 to 39 years) and 55.9 per cent (40-45 years) compensated with other food such as coffee, tea, milk or health mix porridge. Muslim women skipped their breakfast very often, while only 60 per cent of them compensated for the skipped meals.

Habit of consumption of outside food

Figure 10 reveals the habit of consumption of outside food.



*Multiple responses

Figure 10: Habit of Consumption of Outside Food

The habit of consuming outside foods was observed in 80 to 90 per cent of Muslim women in all three age groups.The frequency of consumption of outside foods was occasional in56 - 67 per cent of the Muslim women in all three age groups.Thirtytwo per cent of Muslim women between 20 to 29 years consumed outside food on weekly basis. Among which 65 to 75 per cent of them preferred restaurants and 57.8 per cent of women consumed from fast food shops. Fast foods and street foods were

equally preferred by Muslim women in all three age groups. Hence, occasional consumption and restaurants were more preferable among the Muslim women in all three age groups.

Purchase and consumption of Vitamin D fortified foods

Table XVI depicts the purchase and consumption of Vitamin D fortified foods.

Table XVI

Purchase and Consumption of Vitamin D fortified foods

(N=566)

Constructs	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Reading food labels						
Yes	156	75.7	145	68.1	74	50.3
No	50	24.3	68	31.9	73	49.7
Components read in labels*						
Nutrient content	19	10.3	13	9.0	3	4.1
Ingredients	16	11.5	4	2.8	2	2.7
Manufacture date	7	4.5	10	6.9	2	2.7
Expiry date	144	92.3	145	100	73	98.7
Purchase of grocery*						
Departmental stores	94	45.6	84	39.4	49	33.3
Grocery stores	87	42.2	106	49.8	86	58.5
Petty shops	58	28.2	71	33.3	41	27.9
Others(Online)	25	12.1	12	5.6	4	2.7
Consumption of fortified foods						
Yes	24	11.7	16	7.5	11	7.5
No	182	88.3	197	92.5	136	92.5
Reason for not consuming						
Expensive	1	0.5	0	0	0	0
Not available	10	4.8	11	5.2	3	2.0
Not aware	171	83	186	87.3	133	90.5
Not applicable	24	11.7	16	7.5	11	7.5

*Multiple responses

Reading food labels

Reading food labels is an important aspect as it allows an individual to understand and select food based on its contents (Carrillo *et al*., 2012). The habit of reading labels was higher (76%) among the Muslim women in 20 to 29 years age group followed by 68 per cent in women between 30 to 39 years and lower up to 50 per cent in

40 to 45 years age group revealing lower knowledge among Muslim women above 40 years of age. Among the Muslim women who read labels, the majority of them (92 to 100%) read the expiry date on the food labels. The practice of reading nutrient content and ingredients were in the low range of four to ten per cent and three to twelve per cent among the Muslim women reading labels, which further showed a trend of decrease in practice with an increase in age. The reduced practice of reading ingredients and nutrient content may contribute to low chances of selecting foods containing Vitamin D.

Purchasing behaviour

The purchasing behaviour such as the selection of outlet from which a major portion of the purchase is made determines the access to food products due to variation in the availability of food products (Pawel and Tadeusz, 2012). The purchasing behaviour showed that Muslim women in the age of 30 to 39 years (50%) and 40 to 45 years(59%) preferred to purchase from grocery shops, while purchase from departmental stores was higher up to 46 per cent among Muslim women in20 to 29 years of age. Ramya *et al*. (2017) in a consumer survey found a similar 57 per cent of women purchasing from departmental stores in these group 21 to 30 years in Coimbatore city. This indicated a trend in purchase behaviour among the age group in the area irrespective of religious differences. Petty shop purchase was in the range of 28 to 33 per cent among women of all three age groups. Online purchase was 12 per cent in women between 20 -29 years of age which was higher than other age groups. These low to moderate levels of purchase from online stores and departmental stores may limit the access to Vitamin D dietary sources exclusively available at these outlets.

Consumption of Vitamin D Fortified foods

Figure 11depicts the consumption of Vitamin D fortified foods.

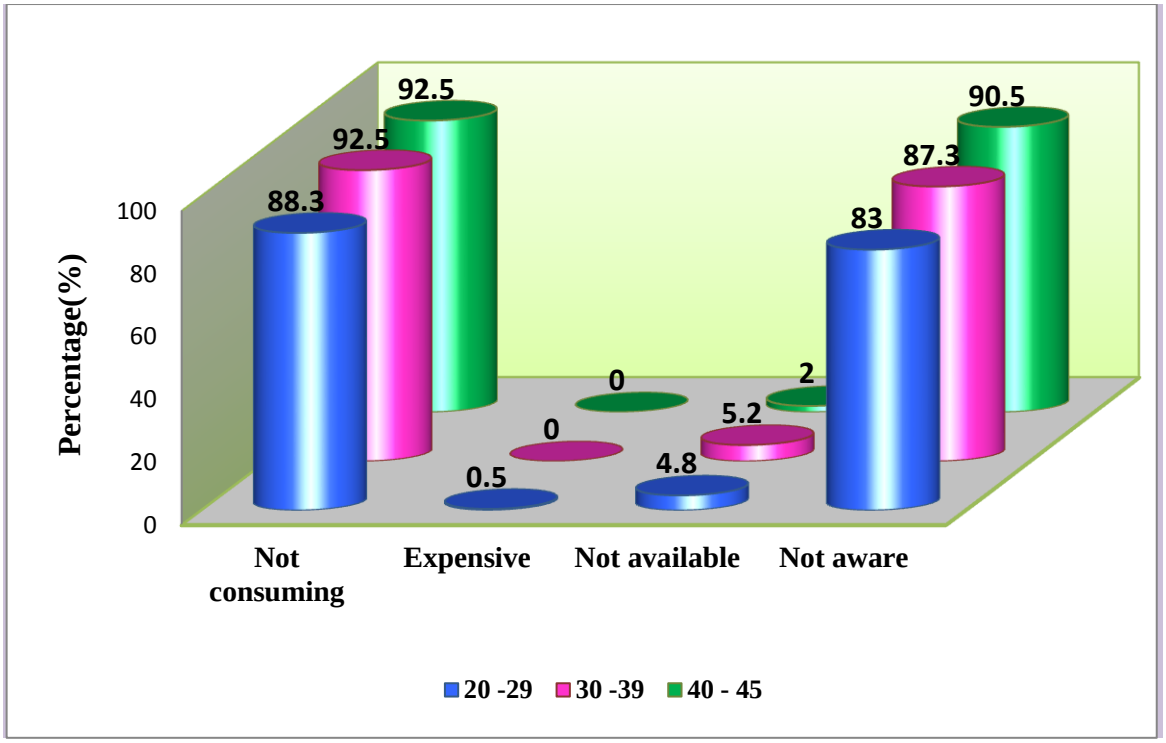


Figure 11: Consumption of Vitamin D Fortified Foods

Fortified foods consumption can be used as a tool to effectively prevent nutrient deficiencies among a population (Dwyer *et al*, 2015) and hence consumption of Vitamin D fortified foods may also contribute to the Vitamin D nutriture of an individual. From Figure 11, it is evident that known consumption of Vitamin D fortified foods was 12 per cent in Muslim women between 20 – 29 years of age; this was better when compared to 7.5 per cent known consumption in women between 30 – 45 years of age. The main reason specified was not being aware in 83 to 91 per cent of the Muslim women of which the highest was among women in 40 to 45 years of age. Low level of Vitamin D fortified food intake among the Muslim women was due to low knowledge among the women which may further increase the risk of Vitamin D deficiency among these women.

4.1.5 Lifestyle patterns of the Muslim women

The lifestyle practices comprise the type of education, dropout rate and reason, age at the time of marriage, age during the first pregnancy, number of children, miscarriage and stillbirth, which may exert influence on the health of women. Accordingly, these variables were considered in the current study.

4.1.5.1 Dress code practices

Muslim women follow the cultural practices of concealing themselves when outdoor, this practice may hinder the cutaneous production of Vitamin D. Being the major source to obtain Vitamin D, this practice may lead to Vitamin D insufficiency among Muslim women (Al-Yatama, 2019), these practices are also influenced by theregion an individual lives. Literature has suggested diversity in lifestyle and dress code preferences among Muslim women living in different regions (Patel, 2012). Thus, the Islamic dress code characteristics and practices among Muslim women were determined.

Characteristics of Islamic dress code

Table XVII shows details on characteristics of Islamic dress code

Table XVII
Characteristics of Islamic dress code

(N=566)

Constructs	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)		Association with age	
	N	%	N	%	N	%	χ2 value	P value
Wearing Islamic dress							18.87	0.001*
Yes	195	94.7	202	94.8	124	84.4		
No	`11	5.3	11	5.2	23	15.6		
Type of Islamic dress							75.75	0.000*
Jilbab(Abaya)	65	31.6	132	62.0	85	57.8		
Hijab	38	18.4	21	9.9	15	10.3		
Niqab	71	34.5	36	16.8	13	8.8		
Burqa	21	10.2	13	6.1	11	7.5		
Regular dressing	11	5.3	11	5.2	23	15.6		
Colour of Islamic dress							39.87	0.001*
Black	161	78.2	177	83.1	105	71.5		
Other colours	34	16.5	25	11.7	19	12.9		
Do not wear a hijab	11	5.3	11	5.2	23	15.6		

*Significant at 1%

Table XVIIdepicts that 95 per cent of the women between 20 to 39 years wore Islamic dress, which was moderately higher than 84 per cent of the Muslim women wearing Islamic dress in 40 to 45 years age group.Jilbab, hijab, niqab and burqa were the different Islamic dress codes identified to be practised by the Muslim women in Coimbatore city. Among these dress code practice of Jilbab was 62.0 per cent in30 to 39 years and 57.8 per cent in 40 to 45 years age group, while in the age group of 20 to 29 years 34.5 per cent wore niqab, 31.6 per cent wore jilbab, 18.4 per cent wore hijab and 10.2 per cent wore a burqa. Overall 60.2 per cent of the Muslim women wore the niqab and 38.6per cent wore a hijab, these figures were nearly similar to 57 per cent wearing niqab and 35 per cent wearing hijab in a study conducted on Muslim women in Mumbai (Karthick*et al*., 2017).

More preference for niqab and burqa, the two fully covered dresses among women between 20 to 29 years compared to women in other age groups suggested a recent increase in practice among the younger generation (20 to 29 years). The colour selected for Islamic dress was black in the majority of the women irrespective of age (73 - 83%). Figure 12 depictsthe preference of colours for Islamic dress code. Three per cent of the Muslim womenusedblue, grey and pink coloured dresses, while usage of brown, maroon, purple and green was observed in near two per cent of the women wearing an Islamic dress. The practice of wearing Islamic dress, type of Islamic dress and colour selected for Islamic dress showed associated with age indicating significant variance in these characteristics among the three age groups.

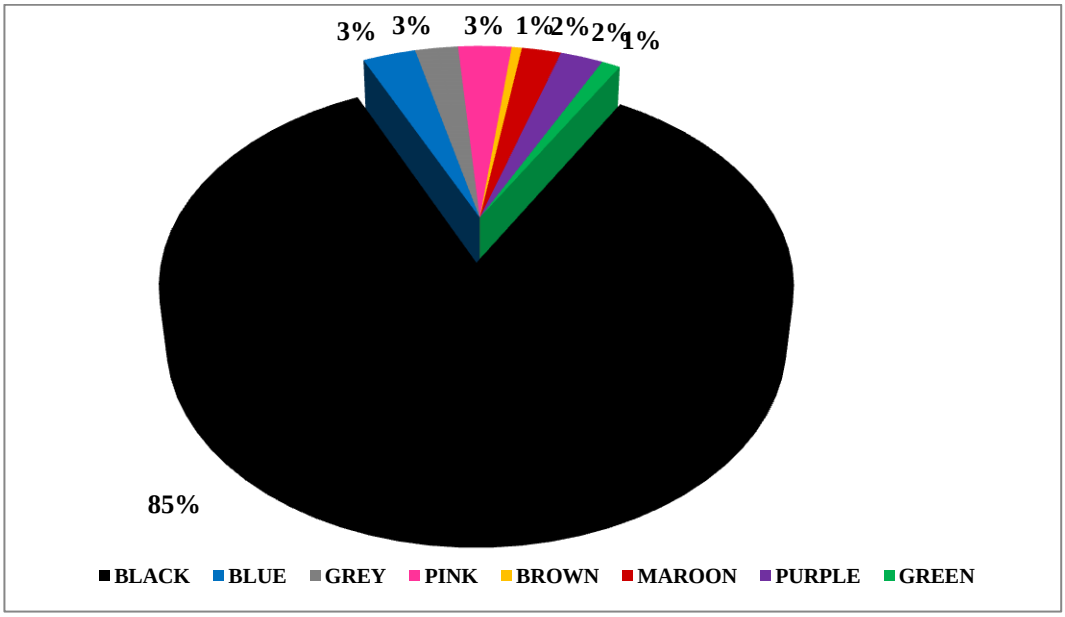


Figure 12: Preference of colours for Islamic Dress code

Practice and Duration of Islamic dress

Table XVIII gives data on the practice and duration of Islamic dress.

Table XVIII

Practice and Duration of Islamic Dress

(N= 566)

Characteristics	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Age of Start						
6 – 10 years	11	5.3	5	2.3	3	2.1
11 – 15 years	95	46.1	57	26.8	26	17.7
16 – 20 years	73	35.5	88	41.3	31	21.1
21 – 25 years	15	7.3	30	14.1	23	15.6
26 – 35 years	1	0.5	22	10.3	28	19.1
>35	0	0	0	0	13	8.8
Do not wear a hijab	11	5.3	11	5.2	23	15.6
Duration						
1 – 5 years	55	26.7	13	6.1	13	8.8
6 - 10 years	90	43.7	21	9.9	5	3.5
11 - 15 years	43	20.9	59	27.7	21	14.3
16 - 20 years	6	2.9	80	37.6	20	13.6
21 – 25 years	1	0.5	23	10.7	29	19.7
26 – 30 years	0	0	5	2.3	26	17.7
>31	0	0	1	0.5	10	6.8
Do not wear a hijab	11	5.3	11	5.2	23	15.6

Buyukuslu*et al*. (2014) determined a relationship between Vitamin D status and clothing style and Islamic dress starting age (negative correlation with duration of using Islamic dress). The age at which an individual starts concealing while outdoor and the period for which it has been practised, determine limitation to sunlight exposure leading to a chronic risk of Vitamin D deficiency (Ojah and Welch, 2012). Table XVIIIpresents that a major portion (>80%) of Muslim women in the age group of 20 to 39 years started wearing Islamic dress on or below the age of 20 years. The trend of starting

Islamic dress between 11 to 15 years was more (46%) followed by 16 to 20 years (36%) in women between 20 to 29 years of age. There was a decrease in an average Islamic dress starting age with a decrease in age revealing the earlier beginning of the practice among the younger generation. Higher per cent of Muslim women wearing Islamic dress for a longer duration were in 30 to 39 years age group showing 37.6 per cent wearing the Islamic dress for 16 to 20 years and 27.7 per cent wearing the dress for 11 to 15 years.

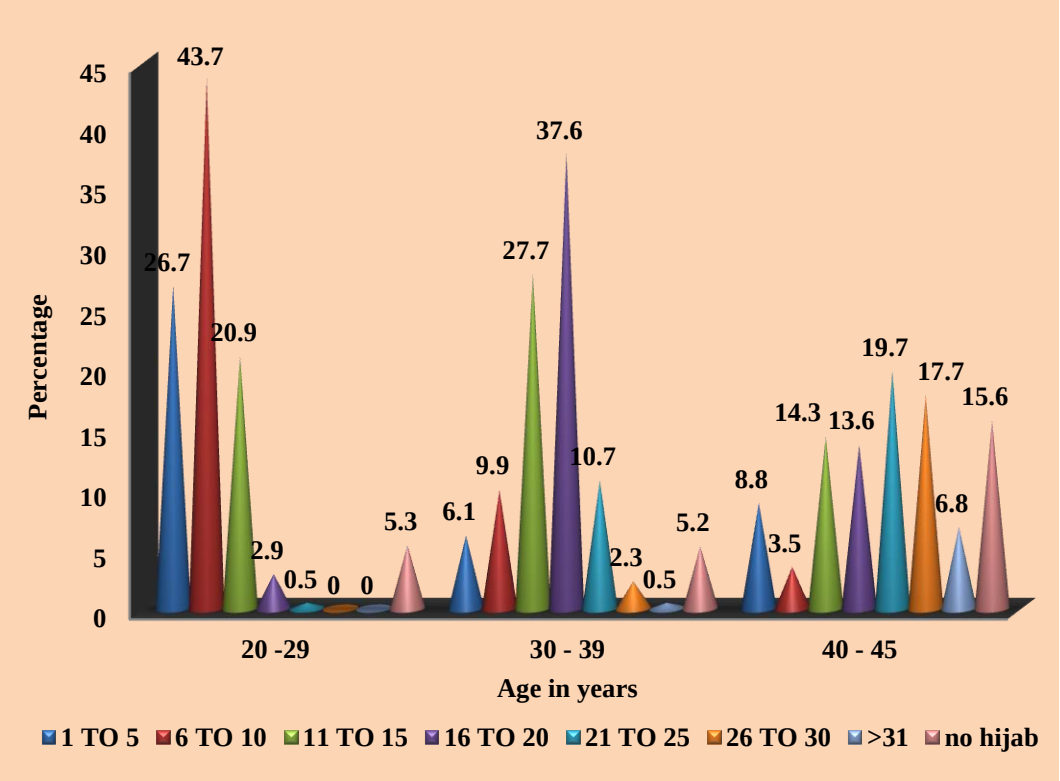


Figure 13: Duration of PractisingIslamic Dress Code

Williams and Vashi (2007) observed a similar increase in Muslim women of younger generation wearing hijab and among the second generation,jilbab practice was higher in American Muslim women. In the present study, among women of 40 to 45 years, 17.7 per cent wore Islamic dress for 25 to 30 years, while 19.7 per cent wore the dress for 21 to 25 years. In Muslim women who belong to the 20 to 29 years age group, 43.7 per cent were wearing Islamic dress for 6 to 10 years. From the figures, it is evident that as expected the duration of wearing was longer (21 - 30 years) in the age group of 40 – 45 years, which reduced with age. But, alonger practice observed among greater fraction of Muslim women in 30 to 39 years of age also suggests an increased

practice from the 30 to 39 years old Muslim women's generation indicating a greater likelihood of developing Vitamin D deficiency.The materials used for the Islamic dress were synthetic (50.5%), cotton (29%), viscose (6%),velvet and crepewere minimally identified in the survey.

4.1.5.2 Sunlight exposure

Pattern of exposure

Table XIX depicts the pattern of exposure.

Table XIX

(N = 566)

Pattern of Exposure

Sunlight exposure pattern	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)		Association with age	
	N	%	N	%	N	%	χ^2 value	P value
Duration of sunlight exposure							27.20	0.000*
< 20 minutes	118	57.3	126	59.1	51	34.7		
20 to 30 minutes	52	25.2	47	22.1	55	37.4		
30 to 60 minutes	20	9.7	27	12.7	21	14.3		
>60 minutes	16	7.8	13	6.1	20	13.6		
Time of the day							7.65	0.265^{NS}
No exposure	7	3.4	6	2.8	4	2.7		
6 to 11 am	72	35	66	31	46	31.3		
11 am to 3 pm	86	41.7	113	53.1	77	52.4		
3 pm to 6 pm	41	19.9	28	13.1	20	13.6		

*Significant at 1%; NS – Not significant

The sunlight exposure pattern such as duration of exposure, exposure time of the day and factors such as the use of parasols, covering when outdoor and avoiding sunlight were assessed to get a clear picture of the sunlight exposure pattern among the Muslim women (Humayun*et al*., 2012).

The practice of less than twenty minutes of sunlight exposure was 57 per cent in Muslim Women between 20 to 29 years and 59 per cent in women between 30 to 39 years. Among Muslim women between 40 to 45 years 20 to 30 minutes exposure was 37 per cent followed by less than 20 minutes in 35 per cent, greater than 60 minutes habits was observed in 14 per cent of these women.

This low level of sunlight exposure below 20 minutes indicated low outdoor activities among the Muslim women which were in line with very low outdoor physical activity and sunlight exposure among the veiled Muslim women observed by Le Goaziou*et al*. (2011) which limited sunlight exposure. A positively 42 to 53 per cent of the sunlight exposure was between 11 am to 3 pm in all three age groups which would support Vitamin D production.

Figure 14 depicts the duration of sunlight exposure.

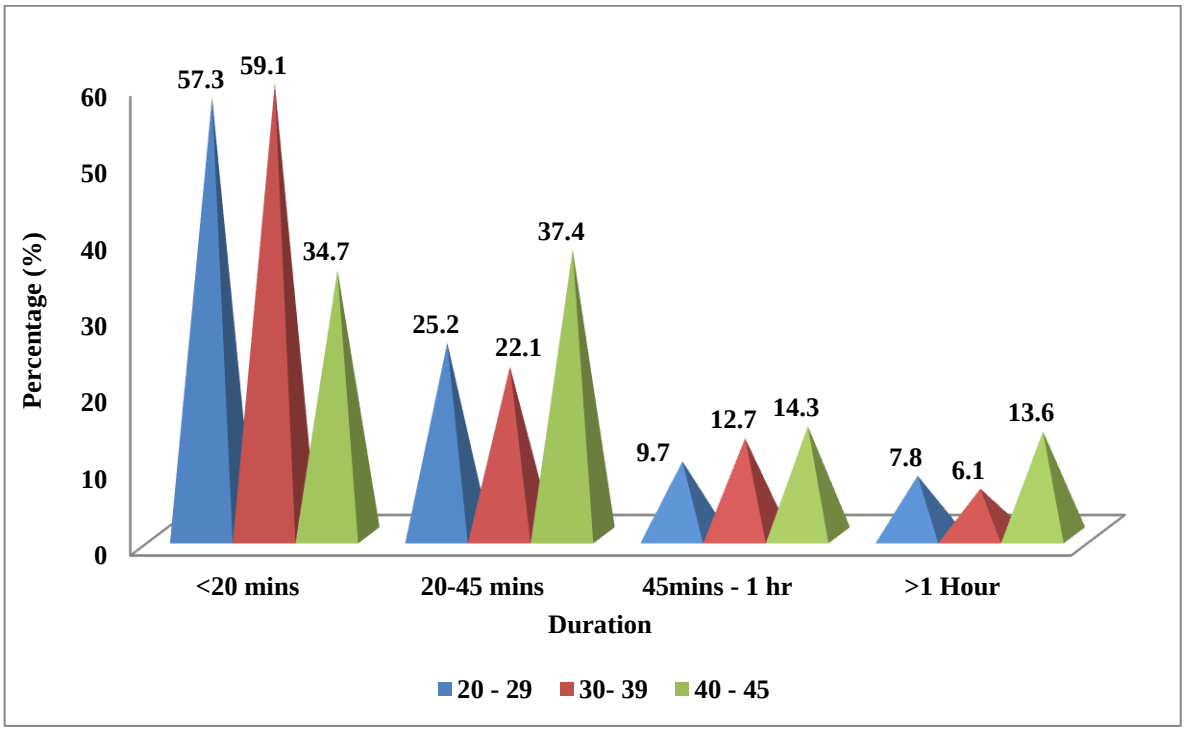


Figure 14: Duration of Sunlight Exposure

Duration of sunlight exposure showed significant variation between the three different age groups, while the time of exposure was not statistically significant with age showing a similar time of exposure among the age groups. Nearly three per cent of women were completely devoid of sunlight and a range of 31 to 35 per cent were exposed to sunlight between 6 am to 10 am in all three age groups. This pattern (6 am to 10 am) of sunlight exposure was observed among the working Muslim women, on their way to the workplace.

Use of parasol and dress cover

Table XX shows the use of parasols and dress cover.

Table XX

Use of Parasol and Dress Cover

Constructs	20 – 29 years (n = 206)		30 – 39 years (n = 213)		(N=566)	
	N	%	N	%	N	%
Use of Parasols						
Umbrella	21	10.2	25	11.7	15	10.2
Sunscreen creams	24	11.7	13	6.1	10	6.8
Sunscreen creams with Vitamin D enhancers	2	1	4	1.9	2	1.4
Reason for covering						
Religious	194	94.2	202	94.8	125	85.0
Not religious	12	5.8	11	5.2	22	15
Prevents cancer	2	1	0	0	0	0
Maintains skin complexion	48	23.3	19	8.9	3	2.0
Migraine	12	5.8	19	8.9	11	7.5
Others	8	3.9	6	2.8	5	3.4
Do not avoid sunlight	136	66.0	169	79.4	128	87.1
Extent of covering when outdoors						
Only head covering	135	65.5	164	77	110	74.8
Head with hands	9	4.4	7	3.3	4	2.7
Head with feet	4	1.9	1	0.5	1	0.7
Entire body cover	50	24.3	34	15.9	12	8.2
Regular covering	8	3.9	7	3.3	20	13.6

The use of parasols such as umbrellas and sunscreen creams was very low among Muslim women. A range of 10 to 12 per cent of Muslim women used an umbrella in all three age groups while among the age of 20 to 29 years 11.7 per cent of Muslim women used sunscreen creams. In a study conducted in Delhi, among 64 per cent of women taking part only two per cent of Muslim women used sunscreens (Mariam *et al*., 2019).Libon*et al*. (2017) from their research opined 50+ SPF (sun protection factor)sunscreens to significantly reduce the Vitamin D synthesis, in the present study among the sunscreen using Muslim women 15+ SPF was common. When examined the reasons for covering 94 to 95 per cent of the Muslim women between 20 to 39 years covered for sake of religion which was higher than 85 per cent observed in women between 40 to 45 years.

It was also evident that 87 per cent of women in 40 to 45 years, 79 per cent of women in 30 to 39 years and 66 per cent from 20 - 29 years did not avoid sunlight intentionally. Nearly 23 per cent of Muslim womenavoided sunlight to maintain complexion in 20 to 29 years age group. Arora*et al.*(2016) in Noida perceived a greater percentage of females avoiding sunlight among the younger generation (<25years). Among other reasons were pigmentation, rashes and burns were specified overall two to four per cent of the women had these issues on exposure to sunlight (Figure 15).

In contrast to Muslim women in Saudi, a major portion of the Muslim women studied in the range of 66 to 77 per cent in all three age groups cover their head, exposing face, hands and feet. The entire body cover was 24 per cent in women between 20 to 29 years. Even among women, wearing regular dress some had the habit of covering the head with a dupatta or saree when outdoors. Hand covering with gloves (4.4%) and feet covering with socks was two per cent in 20 to 29 years age group.

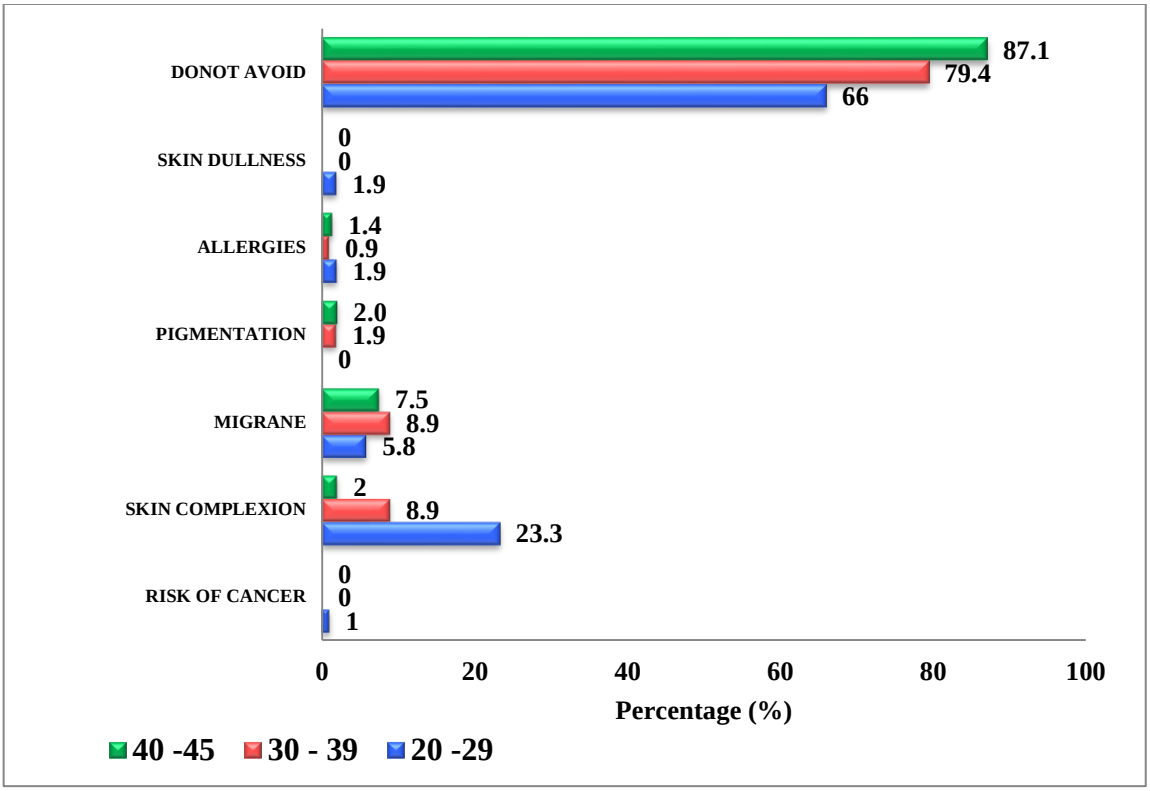


Figure 15: Reasons for Avoiding Sunlight Exposure

4.1.5.3 Physical activity pattern

Table XXI shows the physical activity pattern.

Table XXI

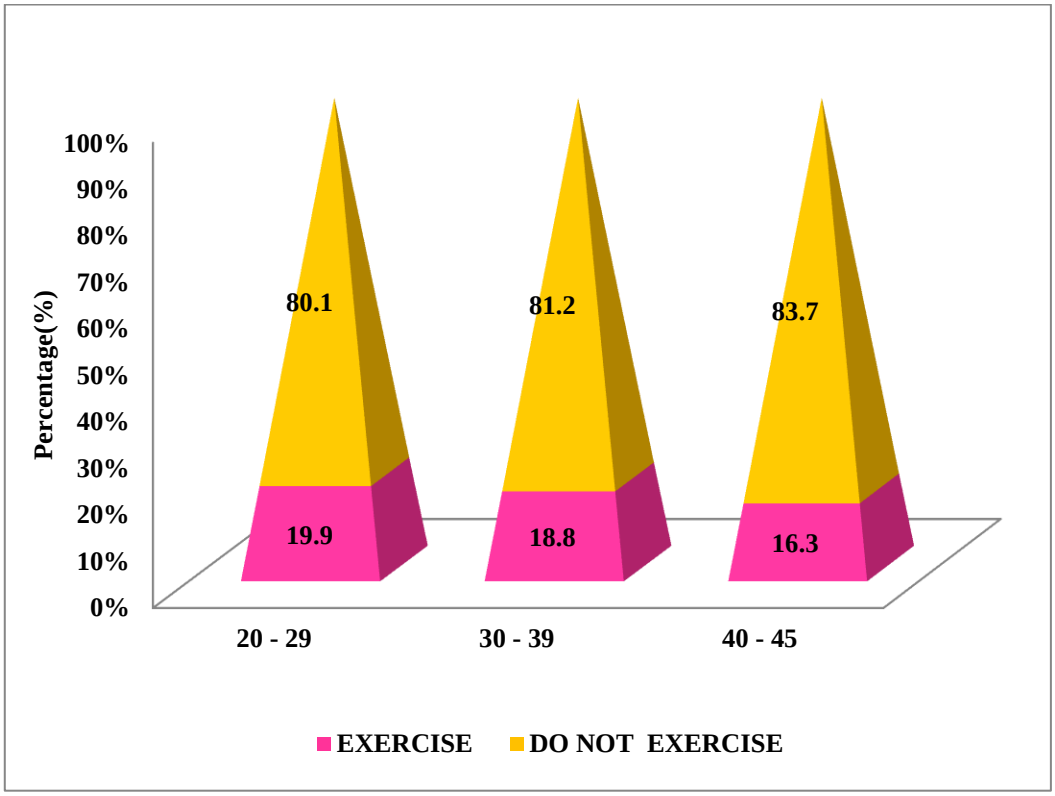
Physical Activity Pattern **N = 566**

Habits	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Exercising habits						
Yes	41	19.9	40	18.8	24	16.3
No	165	80.1	173	81.2	123	83.7
Frequency of exercise						
Daily	18	43.9	28	70	15	62.5
5 - 6 days/ week	5	12.2	0	0	2	8.3
3 – 4 days/week	11	26.8	4	10	4	16.7
1 – 2 days /week	7	17.1	8	20	3	12.5
Area of exercise						
Indoor	27	65.9	22	55	15	62.5
Outdoor	14	34.1	18	45	9	37.5
Time of the day						
Morning	33	80.5	30	75	17	70.8
Evening	5	12.2	8	20	6	25
Afternoon	2	4.9	1	2.5	0	0
Both	1	2.4	1	2,5	1	4.2
Type of exercise						
Walking	20	48.8	26	65	11	45.8
Jogging	2	4.9	0	0	2	8.3
Yoga	7	17.1	7	17.5	5	20.8
Others	12	29.3	7	17.5	6	25
Duration						
20 minutes	19	46.3	13	32.5	13	54.2
30 minutes	12	29.3	17	42.5	5	20.8
45 minutes	6	14.6	3	7.5	2	8.3
>1 hour	4	9.75	7	17.5	4	16.7

Physical activity is the expenditure of energy on daily activities such as leisure. travel, occupation, exercises etc. For every three women, one is doingsufficient physical activity. Low physical activity contributes largely to lifestyle diseases, while sufficient activities promote the overall wellbeing of an individual or community.

Income, permission from seniors, cultural anticipation, household workload and family roles were barriers identified limiting physical activity in women. Initiatives to stimulate income production, nutrition and guidance on physical activities about

condition and pursuit are recommended to overcome these constraints in women (WHO, 2004; WHO, 2020). From literature evidence the potential of physical activity to increase Vitamin D levels and vice versa, the impact of Vitamin D in improving physical activity through its contribution towards maintenance of muscle and bone health has been apparent (Fernandesand Barreto, 2017; Wicińskiet *al*., 2019).



χ^2= 0.74, p = 0.691^{NS}

Figure 16: Physical Activity among the Muslim Women

Figure 16revealed that among the Muslim women 19.9 per cent (20 -29 years), 18.8 per cent (30 to 39years) and 16.3 per cent (40 to 45 years)followed an exercising routine. Lack of time and understanding of the need for exercise was observed as the reason behind the low levels of physical activity. This was in line with the low levels of physical activities observed among the South Asian Muslim women pertaining to lack of understanding on benefits and recommendations for physical activities (Babakus and Thompson, 2012). There was no significant association between exercising and age; that is, the practice of exercising was equal among the Muslim women of all three age groups. In the Muslim women practicing exercises daily exercising pattern was higher up to 70 per cent and 62.5 per cent among 30 to 39 years and 40 to 45 years age group.

Among Muslim women between 20 to 29 years, 44 per cent exercised daily, while 27 per cent and 17percent exercised three to four days per week and one to two days per week. Indoor exercising pattern was between 55 – 66 per cent among the Muslim women irrespective of age. The majority (71 – 81%) of the Muslim women preferred to exercise in the morning hours. Exercising in the afternoon was as low as three to five per cent among the women. The type of exercise primarily preferred among the exercising women was walking 49 per cent among 20 to 29 years, 65 per cent among30 to 39 years and 46 per cent among 40 to 45 years followed by yoga and other exercises such as Gym exercising, physiotherapy exercises and aerobics.

Duration of exercises was predominantly 20 minutes in most of Muslim women (46%) in 20 to 29 years age group, 33 per cent in 30 to 39 years and 54 per cent in 40 to 45 years age group, followed by 30 minutes in 29 per cent (20 – 29 years), 42 per cent (30 – 39 years) and 21 per cent (40 to 45 years) the different age groups. Above one hour exercising pattern was seen among 17 to 18 per cent in the age group of 30 to 45 years.

4.1.6 Knowledge and attitude on Vitamin D

Table XXII depicts the knowledge and attitude on Vitamin D.

Table XXII

(N=566)

Knowledge and Attitude on Vitamin D

Constructs	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)		Association with Age	
	N	%	N	%	N	%	χ2 value	P value
Knowledge of Vitamin D							25.74	0.000*
Yes	116	56.3	72	33.8	52	35.4		
No	90	43.7	141	66.2	95	64.6		
Vitamin D testing							4.66	0.324^{NS}
Yes	7	3.4	6	2.8	8	5.4		
No	199	96.6	207	97.2	139	94.6		
Benefits of Vitamin D							33.81	0.000*
Bone health	56	27.2	25	11.7	15	10.2		
Reproductive health	2	1	2	0.9	1	0.6		
Immune health	3	1.5	4	1.9	5	3.4		
All of the above	11	5.3	4	1.9	2	1.4		
No idea	134	65.0	178	83.6	124	84.4		
Food sources							15.46	0.000*
Yes	47	22.8	21	9.9	15	10.2		
No	159	77.2	192	90.1	132	89.8		
Sunlight as source							27.03	0.000*
Yes	116	56.3	72	33.8	50	34		
No	90	43.7	141	66.2	97	66		
Fortified food source							2.75	0.252^{NS}
Yes	24	11.7	16	7.5	11	7.5		
No	182	88.3	197	92.5	136	92.5		
Government plan of fortification							7.02	0.03**
Yes	11	5.3	2	0.9	4	2.7		
No	195	94.7	211	99.1	143	97.3		
Attitude							17.21	0.000*
Fortified food intake	156	75.7	191	89.7	129	87.8		
Supplement intake	155	75.2	184	86.4	129	87.8	11.88	0.003*

NS – Not Significant; **Significant at 5 per cent; *Significant at 1 per cent

Knowledge among the Muslim women in the study showed that 56.3 per cent of the Muslim women in 20 to 29 years age group, 33.8 per cent in 30 to 39 years and 35.4 per cent in 40 to 45 years had heard the term Vitamin D. Kavitha*et al*. (2015) detected a similar figure of 59 per cent of women above 18 years have heard of Vitamin D in a study conducted in Tamilnadu. Only few Muslim women (3-5%) had tested Vitamin D

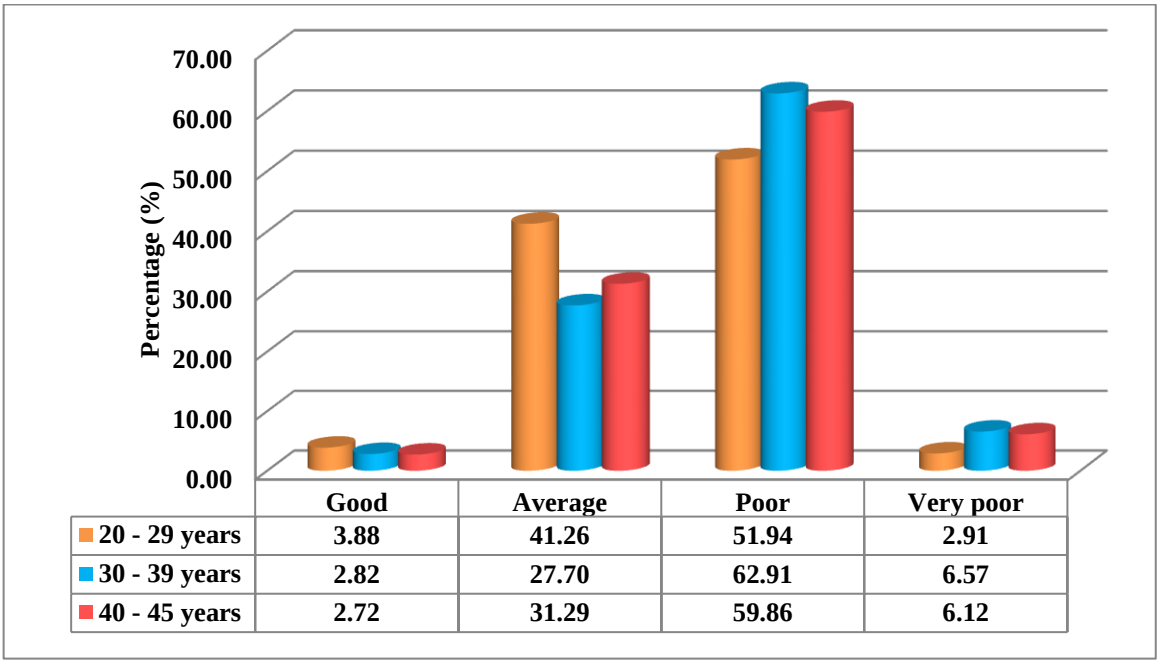
and knew its normal levels among the women studied. Sixty five per centbetween 20 to 29 years and 84 per cent between 30 to 45 years were not aware about the benefits of Vitamin D.

Among the Muslim women who were aware of the benefits of the vitamin, 26.2 per cent in the age groups of 20 to 29 years were aware of the Vitamin's role in bone health, while among women of 30 to 39 years and 40 to 45 years the knowledge was 11.7 per cent and 10.2 per cent. Aljefree*et al*. (2017) also noticed a reasonable knowledge about theimportance of Vitamin Dfor maintaining bone health. The knowledge of benefits of Vitamin D in reproductive and immune health was very minimal in the range of one to three per cent. Five per cent among the Muslim women in 20 to 29 years we're aware about all the benefits of Vitamin D. The knowledge about sunlight as a source of Vitamin D was 56.3 per cent (20 – 29 years), 66 per cent (30 – 39 years) and 34 per cent (40 – 45 years) by age.

Twenty three per cent among Muslim women in 20 – 29 years age group wereabout the dietary source of Vitamin D, while only 10 per cent of the women were aware of the dietary sources in the age groups of 30 to 45 years. These figures were converse to the knowledge about sunlight as a source in 80 per cent and knowledge on dietary sources in 57 per cent of Muslim women observed in a study in Mumbai (Karthik*et al*., 2017). Tariq *et al*. (2020) in Pakistani women observed knowledge about dietary sources of Vitamin D among 15.1 per cent of the women, which was in line with the present study. Twelve per cent of them were aware of fortified foods and five per cent were aware of the government's role in fortification among Muslim women in 20 to 29 years age group. In a study in Mumbai, none of the women was aware of the fortification of Vitamin D (Battalwar and Chavan, 2017) and the attitude towards intake of Vitamin D fortified foods was good in Muslim women in all three age groups. They were ready to include Vitamin D fortified foods in their daily diet if it was beneficial. Some Muslim women expressed concern about not preferring processed foods as a source of Vitamin D. Majority (75 - 88 %) of Muslim women were comfortable with the intake of Vitamin D supplements when prescribed by a medical practitioner.

The knowledge on Vitamin D, its benefits, food and sunlight sources showed significance associated with age, indicating a variation in the variables among the different age groups. while the knowledge on the fortified food source, Vitamin D testing and knowledge on levels was the same in all three age groups.

Overall Knowledge on Vitamin D



	Good	Average	Poor	Very poor
20 - 29 years	3.88	41.26	51.94	2.91
30 - 39 years	2.82	27.70	62.91	6.57
40 - 45 years	2.72	31.29	59.86	6.12

χ^2– 42.21, p<0.01

Figure 17: Overall Knowledge on Vitamin D

Each question under the knowledge category was provided one score to calculate the overall knowledge score for each Muslim woman out of nine, scores above seven were ranked as good, between four to six as average, two and three as poor and below two as very poor. Figure 17 showed that 51.94 per cent, 62.91 per cent and 59.86 per cent amongMuslim women from 20 to 29 years, 30 to 39 years and 40 to 45 years exhibited poor knowledge. The average knowledge on Vitamin D was 41.26 per cent among Muslim women between 20 to 29 years of age. Very poor knowledge was seven per cent among Muslim women between 30 to 45 years of age. This indicated better knowledge on Vitamin D among the younger generation (20 – 29 years). A significant association between age and knowledge score was observed.

4.1.7 Influence of dress code and knowledge on Vitamin D

Association of dress code with demography and lifestyle pattern

Table XXIII presents the association of dress code with demographic and lifestyle pattern.

Table XXIII
Association of Dress Code with Demography and Lifestyle Pattern

Constructs		Islamic dress practices				Association		
		No (n = 45)		Yes(n = 521)		χ^2	Df	'p' value
		No.	%	No.	%			
Marital status	Married	35	77.8	427	82.0	8.447	3	0.038**
	Unmarried	7	15.6	83	15.9			
	Divorced	-	-	5	1.0			
	Widow	3	6.7	6	1.2			
Education	Primary	22	48.9	185	35.5	10.823	5	0.055^{NS}
	Secondary	3	6.7	82	15.7			
	Higher secondary	6	13.3	102	19.6			
	Graduate	9	20.0	131	25.1			
	Postgraduate	4	8.9	14	2.7			
	Others	1	2.2	7	1.3			
Occupation	Non working	30	66.7	414	79.5	6.543	2	0.038^{**}
	Working	10	22.2	52	10.0			
	Students	5	11.1	55	10.6			
Socio economic status	Lower middle class	8	17.8	38	7.3	6.377	3	0.095^{NS}
	Middle class	15	33.3	215	41.3			
	Upper middle class	19	42.2	237	45.5			
	Upper class	3	6.7	31	6.0			
Age at marriage	Unmarried	7	15.6	83	15.9	1.730	3	0.630^{NS}
	<=20 yrs	19	42.2	264	50.7			
	21-25 yrs	16	35.6	140	26.9			
	> 25 yrs	3	6.7	34	6.5			
No. of children	0-1	16	13.3	218	20.2	9.79	12	0.634^{NS}
	2-3	27	60.0	291	55.9			
	4+	2	4.4	12	2.3			
Exposure to sunlight (duration)	= < 20 minutes	14	31.1	281	53.9	13.165	3	0.004*
	20 -30 minutes	13	28.9	141	27.1			
	30 – 60 minutes	11	24.4	57	10.9			
	>60minutes	7	15.6	42	8.1			
Exposure to sunlight (time)	.00	2	4.4	15	2.9	6.494	3	0.090^{NS}
	6 to 11 am	7	15.6	177	34.0			
	11 am to 3 pm	27	60.0	249	47.8			
	3 pm to 6 pm	9	20.0	80	15.4			
Sunscreen usage	No	41	91.1	478	91.7	0.022	1	0.882^{NS}
	Yes	4	8.9	43	8.3			
Extent of covering	Only head	10	22.2	399	76.6	432.699	4	0.000*
	Head and hands	-	-	20	3.8			
	Head and feet	-	-	6	1.2			
	Entire body	-	-	96	18.4			
	Regular cloth covering	35	77.8	-	-			
Physical activity	No	32	71.1	429	82.3	3.458	1	0.063^{NS}
	Yes	13	28.9	92	17.7			

* Significant at 1%, **Significant at 5%; NS – Not significant

In the above table, the association between Islamic dress practices and lifestyle and demographic variables such as socioeconomic status marital status,occupation, education, age at marriage, choice of institution, number of children, duration and time of exposure to sunlight, sunscreen usage, the extent of covering and practice of physical activity were associated using chi-square test. From the analysis, marital status and occupation showed a positive association with Islamic dress practices, significant at five per cent. This indicates a variation in the Islamic dress practices among the Muslim women of different marital status, on observation the variation is attributed to seven per cent of women being widows among women not practising Islamic dress and one per cent being widow among the Islamic dress practising women. In the case of occupation 22.2 per cent of working women did not practice Islamic dress compared to 10 per cent of working Muslim women who practised Islamic dress. This may be due to a decrease in opportunity and job status with religious attire or preference for a job observed in the literature (Ghumman and Jackson, 2010).

The association between education and Islamic dress practice was not significant, but the significance value 0.55 indicates a very weak association is evident. This difference was due to increased Muslim women opting for higher secondary education and graduation among the Islamic dress practising group, while postgraduates were nine per cent among women not practising Islamic dress. This inferred more women wearing Islamic dress pursued higher education compared with Muslim women not practising Islamic dress, which was similar to a study among Muslim women of different countries, suggesting Islamic dress practices did not affect educational levels among the Muslim women (Stephen, 2006). Association of socio economic status, age at marriage, number of children, time of exposure to sunlight and sunscreen usage was non significant, illustrating no difference in the above factors between Muslim women practising Islamic dress and those who did not practice Islamic dress. Regarding preference for an institution the results of the present study was converse with research suggesting a preference for women's institution among Muslim women (Attum*et al.*, 2019), this inferred a change in the trend of preference for women’s institution in the area studied.From the above table, the duration of sunlight exposure was found to be comparatively greater among Muslim women not practising Islamic dress, which was highly significant ($p<0.01$). Similarly, the extent of covering while in sunlight observed 22.2 per cent of the Muslim women not wearing Islamic dress had the habit of covering

the head when in sunlight, yet a statistically significant difference between covering pattern of Islamic dress wearing group and not wearing group was evident. Concerning the physical activity pattern, the association was not significant, but the significance value 0.063 is close to 0.05 pointing at a very weak difference in the physical activity practices between the two groups. Hence, Islamic dress practices affected physical activity practice, duration of sunlight exposure and extent of covering when in the sunlight among Muslim women. Literature also suggests low participation of Muslim women wearing Islamic dress in physical activities due to preference for dress code and controlled access to physical activity spaces (Nakamura, 2002; Laar*et al*., 2019).

Association of dress code with health and Knowledge

Table XXIV association of dress code with health and knowledge.

Table XIV

Association of Dress Code with Health and Knowledge

Constructs		Islamic dress code		Association		
		No (n = 45)	**Yes(n = 521)**	**'t' value**	**Df**	**'p' value**
Health score	Mean	5.43	5.41	0.133	564	0.894^{NS}
	Standard deviation	1.07	1.00			
Knowledge score	Mean	2.93	3.06	0.508	564	0.612^{NS}
	Standard deviation	1.62	1.60			

NS – Not significant

The mean health scores were compared between those who do not practice Islamic dress and those who practice Islamic dress. The mean health score for the Islamic dress practising group is 5.41 and the mean health score for the not practising group is 5.43. When comparing using t-test, the results show that there was no variance in the mean health scores of those who practice and those who do not practice Islamic dress. Likewise, the mean Knowledge scores of the two groups did not show significant differences indicating no association of health scores and knowledge scores with Islamic dress practice. Christie and Mason (2011) found a similarly limited knowledge on Vitamin D among women practising Islamic dress.

Association of Knowledge with demography and lifestyle pattern

Table XXV association of knowledge with demography and lifestyle pattern.

Table XXV

Association of Knowledge with Demography and Lifestyle Pattern

Constructs		Knowledge score		Association		
		No (n=566)	Mean ± SD	'F' value	Df	'p' value
Marital status	Married	462	2.93 ±1.58	9.604	3	0.000*
	Unmarried	90	3.79 ± 1.53			
	Divorced	5	2.80 ± 1.79			
	Widow	9	1.78 ± 0.67			
Education	Primary	207	2.41 ± 1.25	18.68	5	0.000*
	Secondary	85	2.85 ± 1.48			
	Higher secondary	108	3.21 ± 1.55			
	Graduate	140	3.77 ± 1.64			
	Postgraduate	18	4.56 ± 2.04			
	Others	8	3.50 ± 2.0			
Occupation	Working	62	2.77± 1.57	8.423	2	0.000*
	Non working	444	2.99 ±1.60			
	Students	60	3.83 ±1.37			
Socio economic status	Lower middle class	46	2.41 ± 1.36	11.430	3	0.000*
	Middle class	230	2.73 ± 1.35			
	Upper middle class	256	3.45 ± 1.68			
	Upper class	34	3.12 ± 2.03			
Type of Institution	Coeducation	295	3.04 ± 1.58	0.054	2	0.947^{NS}
	Women's institution	262	3.05 ± 1.63			
	Education at home	9	3.22 ± 1.56			
Islamic dress type	No practice	43	2.91 ± 1.62	4.850	4	0.001*
	Burqa	45	3.82 ± 1.75			
	Hijab	73	3.45 ± 1.64			
	Jilbab	285	2.89 ± 1.5			
	Niqab	120	2.95 ± 1.63			
Exposure to sunlight (duration)	= <20 mins	295	3.03 ± 1.55	2.228	3	0.084^{NS}
	20 -30 mins	154	3.24 ± 1.8			
	30 – 60 mins	68	3.06 ± 1.63			
	>60mins	49	2.57 ± 0.94			
Exposure to sunlight (time)	No exposure	17	2.71 ± 1.26	0.768	3	0.512^{NS}
	6 to 11 am	184	2.97 ± 1.6			
	11 am to 3 pm	276	3.07 ± 1.62			
	3 pm to 6 pm	89	3.22 ± 1.59			
Extent of covering	Only head	409	2.99 ± 1.56	2.660	4	0.032**
	Head and hands	20	3.00 ± 1.86			
	Head and feet	6	4.83 ± 1.94			
	Entire body	96	3.27 ± 1.71			
	Regular clothcovering	34	2.82 ± 1.40			
Physical activity	No	461	2.92 ± 1.48	4.104#	564	0.000*
	Yes	105	3.62 ± 1.98			

Consumption of Vitamin D fortified foods	No	515	2.82 ± 1.41	11.97#	564	0.000*
	Yes	51	5.33 ± 1.62			

t – value; * Significant at 1%, **Significant at 5%; NS – Not significant

From Table XXV the association of mean Knowledge scores were compared with lifestyle and demographic variables such as marital status, education, occupation, socio economic status, type of institution, duration and time of exposure to sunlight, the extent of covering during sunlight exposure, physical activity and consumption of Vitamin D fortified foods was analysed using ANOVA and t-test. The variance in mean knowledge score was highly significant between different occupations and marital status among Muslim women. In both the cases, the variance is due to higher scores observed in students who were unmarried, further among the widow's knowledge scores as low as 1.78 ± 0.67 was evident. The knowledge scores showed a pattern of decrease with a decrease in educational qualification, which was statistically significant at one per cent. This was on par with higher awareness observed due to 40 per cent of the undergraduate student population in a study in Scotland (O'Connor*et al*., 2018). Concerning the knowledge scores among Muslim women of different socio economic status, the variance was highly significant with the highest scores among the Muslim women belonging to the upper middle class (3.45 ± 1.68), followed by upper class (3.12 ± 2.03). The knowledge score showed no difference in time of sunlight exposure and choice of institution for education. The association between duration of exposure to sunlight and knowledge scores was not significant but with the p value 0.084, it can be inferred that knowledge showed a very weak association with duration of sunlight exposure, indicating that despite knowledge only a few Muslim women exposed themselves to sunlight for adequate duration. These findings were nearly similar to observations by Kung and Lee (2006) where the sunlight exposure was significantly low even among women who were aware of the importance of sunlight due to preferring not to go in the sun. A similar result was of low sunlight exposure despite adequate knowledge among the students in India was found in a study in India (Arora*et al*., 2016). Muslim women wearing burqa (3.82 ± 1.75) and hijab (3.45±1.64) showed marginally higher knowledge score compared to women wearing the niqab, jilbab and women not practising Islamic dress. This difference in scores was found to be statistically significant ($p<0.01$). A significant association between knowledge and extent of covering was evident, this association was inverse as the Muslim women using head and feet cover and entire body

cover was found to exhibit higher knowledge than the headcover and women wearing a regular dress. Better physical activity practices were observed in Muslim women with higher knowledge scores (3.62 ± 1.98), inferring an increase in knowledge to improve physical activity and thereby likelihood to develop better Vitamin D levels. Also, there was a strong association between knowledge score (5.33±1.62) and known intake of Vitamin D fortified foods among the women. Sandmann*et al*. (2015) on par with the present study reported an improved acceptance of Vitamin D fortified foods with an increase in knowledge. Hence, an increase in knowledge can be used as a tool to improve Vitamin D fortified food intake, physical activity practices and duration of sunlight exposure among Muslim women.

4.2 Health and Nutritional Status of Muslim Women

The health and nutritional status of 566 Muslim women were assessed using measures of anthropometry, clinical examination and a 3 day 24 hour recall diet survey. Calcium and Vitamin D was estimated in selected Muslim women. These are discussed as follows.

4.2.1 Anthropometric measurements

Anthropometric measurements are influenced by nutrition, genetics, environmental, social, lifestyle, cultural and health status of an individual. It helps to determine the weight, muscle mass, adiposity and prognosis of illness(Sánchez-García*et al*., 2007).In the present study, anthropometric measurements like height, weight, waist circumference and hip circumference were measured from which the Body mass index and waist hip ratio of all the Muslim women was calculated and age wise variations were studied.

Table XXVI gives the anthropometric measurements.

Table XXVI

Anthropometric Measurements

(N = 566)

Variables	**Standard Value #**	**20 – 29 years (n = 206)**		**30 – 39 years (n = 213)**		**40 – 45 years (n = 147)**	
		Mean ± SD	**Df**	**Mean ± SD**	**Df**	**Mean ± SD**	**Df**
Height (cm)	162	155.2 ± 6.9	-6.8	155.4 ± 6.2	-6.58	153.8 ± 6.2	-8.23
		't' =14.1 (p =0.00)*		**'t'= 15.43 (p =0.00)***		**'t' = 16.02 (p =0.00)***	
Weight (kg)	55	58.3 ± 11.8	3.30	68.9 ± 12.1	13.88	67.2 ± 11.03	12.22
		't' = 4.04 (p =0.00)*		**'t' =16.82 (p =0.00)***		**'t' = 13.43 (p =0.00)***	

BMI (kg/m^2)	20.95	24.2 ± 4.8	3.22	28.5 ± 4.85	7.58	28.5 ± 4.82	7.52
		't' = 9.43 (p =0.00)*		**'t' = 22.82(p =0.00)***		**'t' = 18.90 (p =0.00)***	
Waist Hip ratio (cm)	0.8**	0.87 ± .05	0.07	0.89 ± 0.05	0.09	0.89 ± 0.04	0.09
		't'=20.74 (p =0.00)*		**'t'= 27.65 (p =0.00)***		**'t'= 24.02 (p =0.00)***	

ICMR (2020) ** (WHO 2011); SD – Standard Deviation; Df– Difference; *Significant at 1%

Height of the Muslim women

Height of the Muslim women is presented in the Table XXVII.

Table XXVII

Height of the Muslim Women

Height (cm)	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
130.1 – 140	2	1.0	2	0.9	1	0.7
140.1 -150	52	25.2	37	17.4	41	27.9
150.1 – 160	106	51.5	132	62.0	80	54.4
160.1 – 170	43	20.9	39	18.3	24	16.3
170.1 - 180	3	1.5	3	1.4	1	0.7

From the above table, it is evident that height of 51.5 per cent of the Muslim women in 20 to 29 years, 62 per cent in 30 to 39 years and 54.4 per cent in 40 to 45 years of age were in the range of 150.1 -160 cm. the height of 20.9 per cent in 20 to 29 years, 18.3 per cent in 30 to 39 years and 16.3 per cent in 40 to 45 years of are was in the range of 160.1 to 170 cm, which was almost proximate to the standard height recommendedby ICMR (2020) for Indian women (162 cm). Height of 27.9 per cent and 25.2 per cent of the Muslim women between 40 to 45 years and 20 to 29 years of age was amidst 140.1 to 150 cm. A measure of 150.1 to 160cm was observed in many Muslim women. The mean height was 155.2 ± 6.9, 155.4 ± 6.2 and 153.8 ± 6.2, which was 6.8, 6.58 and8.23 cm lower than the standard values. This difference between the standard and mean height was statistically significant among Muslim women irrespective of age ($p<0.01$). These findings were nearly similar to 153 ± 6.0 observed among South Indian Muslim women between 15 to 49 years using National Family Health Survey (Shome *et al*., 2014) and on par with 155.3 cm observed in the age group of 31 to 40 years among Sunni Muslim women in Chennai (Mariam *et al*., 2017).

Body weight of the Muslim women

Figure 18 shows the body weight of the Muslim women.

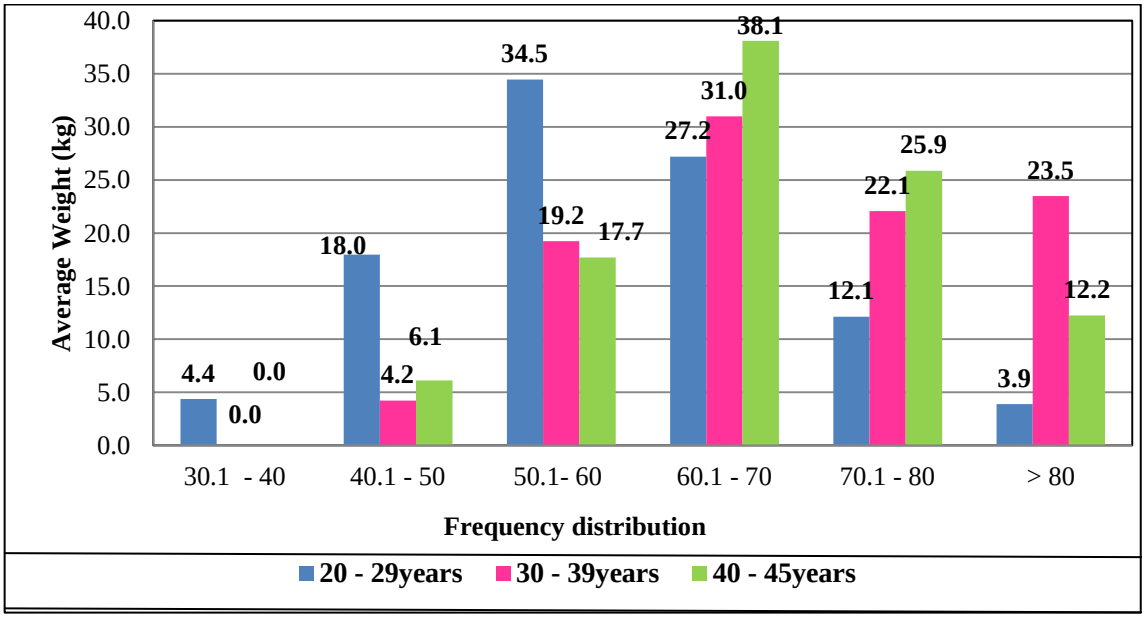


Figure 18:Body Weight of the Muslim Women

Among the Muslim women, between 40 to 45 years (38.1%), 30 to 35 years (31%) and 20 to 29 years (27.2%) weighed between 60.1 to 70 kg. The weight of 34.5 per cent and 18 per cent in the age group of 20 to 29 years weighed between 50.1 to 60 kg and 40.1 to 50 kg, which was comparatively more than the other two age groups. In 30 to 39 years age group 24 per cent among the Muslim women weighed above 80 kg, while 25.9 per cent (40 to 45 years) and 22.1 per cent (30 to 39 years) weighed between 70.1 to 80 kg. The figure reveals that women weighing 50.1 to 60 kg were more in 20 to 29 years and 60.1 to 70 kg were more in the other two age groups. The mean weight of 58.3 ± 11.8, 68.9 ± 12.1 and 67.2 ± 11.03 was higher than the ICMR (2020) standard weight for Indian women of 55 kg. The difference was higher in 30 to 39 years (13.88 kg) and 40 to 45 years (12.22 kg) compared to women between 20 to 29 years (3.3 kg), Further, the variance between mean weight and ICMR standards was highly significant. The mean weight observed in the current study was marginally higher compared to the mean weight of 60.82 kg noticed among Muslim women residing in Kumbakonam town (Vadivel, 2013). Mariam *et al.* (2017) found the mean weight among Shia and Sunni Muslim women from Chennai to be 70.36 kg and 73.23 kg among Muslim women between 30 to 40 years, which was almost proximate to the findings of the present study.

Body mass index of the Muslim women

Body mass index of the Muslim women is given in Table XXVIII .

Table XXVIII

Body mass index of the Muslim Women

(N=566)

Classification	WHO standard (2004)	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
		Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)
Underweight	<18.5	17.16 ± 0.92	23(11.2)	17.52 ± 0.54	2 (0.9)	18.13 ± 0.49	3 (2.1)
Normal	18.5-22.99	20.8 ± 1.36	65(31.5)	21.44 ± 1.08	28 (13.1)	21.52 ± 1.0	9 (6.1)
Overweight	23 – 27.49	25.44 ± 1.26	70 (34)	25.51 ± 1.34	62 (29.1)	25.7± 1.28	59 (40.1)
Obese Type I	27.5 - 32.49	29.49 ± 1.39	41(19.9)	30.07 ± 1.42	80 (37.6)	29.76± 1.4	49 (33.3)
Obese Type II	32.5 - 37.49	33.20 ± 0.24	3 (1.5)	34.59 ± 1.36	35 (16.5)	34.35± 1.12	24 (16.3)
Obese Type III	≥ 37.5	38.79 ± 4.64	4 (1.9)	40.76 ± 2.63	6 (2.8)	45.64± 9.13	3 (2.1)

***WHO South Asian criteria, 2004**

Table XXVIII reveals that, when compared with WHO South Asian criteria 2004, 11 per cent and among Muslim women between20 to 29 years of age 31.5 per cent were underweight (17.16 ± 0.92) and normal weight (20.8 ± 1.36), which was more compared to the Muslim women in the other two age groups. In 40 to 45 years and 20 to 29 years age group among Muslim women 40 per cent and 34 per cent of them were overweight, which was on par with the higher prevalence of overweight among the Muslim women from a study in India suggesting food patterns and indoor lifestyle influence the BMI among them (Rai*et al*., 2018). Prevalence of type I and type II obesity was evident among Muslim women in 30 to 39 years showing 37.6 per cent and 16.5 per cent prevalence, followed by 40 to 45 years showing 33.3 per cent and 16.3 per cent prevalence. The average BMI among type I and type II obese Muslim women in 30 to 39 years was 30.07 ± 1.42 and 34.59 ± 1.36 and in the age group of 40 to 45 years, it was 29.76± 1.4 and 34.35± 1.12 respectively. Type III obesity was observed in 2 to 3 per cent of the Muslim women in all three age groups, the mean BMI was 38.79 ± 4.64, 40.76 ± 2.63 and45.64± 9.13 in the 20 to 29 years, 30 to 39 years and 40 to 45 years respectively.

Therefore in the age group of 20 to 29 years underweight and normal Muslim women were more, whereas type I and type II obesity was comparatively more in the other two age groups. Overweight Muslim women were in all three age groups.

Waist- hip ratio of the Muslim women

Waist-hip ratio of the Muslim women is shown in Table XXIX.

Table XXIX
Waist-hip Ratio of the Muslim Women

Category	WHO Standard*	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
		Mean ± SD	n(%)	Mean ± SD	n(%)	Mean ± SD	n(%)
Low	≤ 0.80	0.78 ± 0.02	15 (7.4)	0.78 ± 0.04	7 (3.3)	0.78 ± 0.04	5 (3.4)
Moderate	0.81 – 0.85	0.83 ± 0.01	60 (29.1)	0.83 ± 0.01	40 (18.8)	0.83 ± 0.01	24 (16.3)
High	>0.86	0.89 ± 0.03	131 (63.5)	0.90± 0.03	166 (77.9)	0.90 ± 0.03	118 (80.3)

***WHO (2011)**

Average waist circumference was 77.9 ± 12.2, 90.4 ± 12.4 and 92.2 ± 10.6 among the Muslim women in the age group of 20 to 29 years, 30 to 39 years and 40 to45 years and the hip circumference was 89.4 ± 12.9, 102.0 ±12.44 and 103.8 ± 10.5 were 20 to 29 years, 30 to 39 years and 40 to 45 years respectively. Waist- hip ratio compares the waist circumference to hip circumference, it serves as an indicator of fat deposits around the waist (Baioumi, 2019). From Tables XXVI and XXIX it is evident that the mean waist hip ratio was 0.87 ± .05, 0.89 ± .05 and 0.89 ± 0.04 in the 20 to 29 years, 30 to 39 years and 40 to 45 years age group among the Muslim women. When compared with WHO (2011) standard for waist- hip ratio (0.8) the difference between the mean waist-hip ratio indicated, most (64 – 80%) of the Muslim women in all three groups were in high risk group exhibiting waist-hip ratio greater than 0.86. The incidence of which was higher above the age of 30 years. Vadivel (2013) in a study conducted at Kumbakonam, indicated abdominal obesity in 98.8 per cent of Muslim women, which was higher than the observations in the present study. Among Muslim women between 40 to 45 years, 16.3 per cent exhibited moderate risk. In 18.8 per cent and 29.1 per cent in the age of 30 to 39 years and 20 to 29 years, the waist-hip ratio was between 0.81 – 0.85 indicating moderate adiposity. A higher rate of abdominal obesity was apparent

among Muslim women, also an increase inwaist-hip ratio with a rise in age was observed.

4.2.2 Clinical Examination

Clinical signs and symptoms

Table XXX depicts the clinical signs and symptoms.

Table XXX

Clinical Signs and Symptoms

(N =566)

Signs and symptoms	20 – 29 years (n = 206)		30 – 39 years (n = 213)		40 – 45 years (n = 147)	
	N	%	N	%	N	%
Falling sick often	16	7.8	7	3.3	6	4.1
Fatigue	27	13.1	37	17.4	34	23.1
Leg pain	69	33.5	94	44.1	93	63.3
Depression	60	29.1	47	22.1	39	26.5
Impaired healing	2	1.0	10	4.7	3	2.04
Hair loss	121	58.7	120	56.3	80	54.4
Muscle cramps	14	6.7	7	3.3	7	4.8
Body pain	32	15.5	33	15.5	29	19.7
Back pain	42	20.4	72	33.8	59	40.1
Bone fracture (without external injury)	0	0	0	0	1	0.7
Premenstrual syndrome (PMS)	109	52.9	65	30.5	59	40.1

In the present study, the clinical signs and symptoms pertaining to Vitamin D deficiency such as the repeated occurrence of illness, fatigue, leg pain, body pain or myalgia, back pain, depression, hair loss, muscle weakness, PMS and fracture as suggested by the literature were examined among the 566 Muslim women (Thanapluetiwong*et al*., 2020; Saini, 2021; Yuan, 2018; Watson 2013; Heather*et al*., 2011). Near 8 percent in the age of 20 to 29 years fell ill frequently, which was marginally higher compared to the other two age groups. Feeling fatigue even while performing sedentary household chores showed an increasing trend with age from 13.1 per cent in 20 to 29 years followed by 17.4 per cent in 30 to 39 years to 23.1 per cent 40 to 45 years age group among the Muslim women.

The average occurrence of leg pain, back pain and fractures, symptoms associated with bone health which is the major function of Vitamin D, in all the three age groups showed an increase with the age of the Muslim women indicating the appearance of these signs and symptoms with an increase in age. Nearly 1.5 times higher incidences of back pain among women between 30 to 50 years compared with young women and its association with osteoporosis was reported in a study (Fernández- de- las- Peñas*et al*., 2011). In 33.5 per cent ofMuslim womenbetween 20 to 29 years leg pain was present, which increasing (44.1 %) in 30 to 39 years and (63.3 %) 40 to 45 years. Similarly, back pain was present in 20.4 per cent in the age of 20 to 29 years, 33.8 per cent in 30 to 39 years and 40.1 per cent in 40 to 45 years. Occurrence of fracture was not reported among the Muslim women between 20 to 39 years, while among Muslim women in the 40 to 45 years age group one woman (0.7%) reported hairline fracture without any external injury.

Calf muscle cramps and body pain (muscle pain) was observed in Muslim women in all three age groups. Among women between 20 to 29 years, 6.7 per cent had cramps in the calf muscles. Body pain was 19.5 per cent among Muslim women between40 to 45 years of age, while in the other two age groups the occurrence was 15.5 per cent. Depression was present in 29.1 per cent of the Muslim women between 20 to 29 years and 26.5 per cent between 40 to 45 years of age. In 54 to 59 per cent Muslim women of all the three age groups hair loss was present. Premenstrual syndrome symptoms were higher (52.9%) among theyoung Muslim women between20 to 29 years of age, which was on par with studies suggesting higher incidences at the rate of 66 to91.8 per cent among young adult women (Abay and Kaplan, 2019).

4.2.3 Diet survey

A diet survey helps to visualize the food and nutrient intake of an individual or a population. In the current study information from the frequency of food consumption and three day 24 hour dietary recall were used as indicators of food and nutrient intake of the Muslim women.

Frequency of food consumption among the Muslim women

Table XXXI presents the frequency of food consumption among Muslim women.

Table XXXI

Frequency of food Consumption among the Muslim Women

Food Groups	20 – 29 years (n =206)								30 – 39 years(n=213)								40 – 45 years(n=147)							
	Daily		Weekly		Occasionally		Never		Daily		Weekly		Occasionally		Never		Daily		Weekly		Occasionally		Never	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Cereals and Millets																								
Rice	204	99.0	2	1.0	-	-	-	-	212	99.5	-	-	1	0.5	-	-	146	99.3	1	0.7	-	-	-	-
Wheat	44	21.4	124	60.2	37	18.0	1	0.5	40	18.8	145	68.1	26	12.2	2	0.9	38	25.9	88	59.9	18	12.2	3	2.0
Maida	1	0.5	56	27.2	114	55.3	35	17.0	2	0.9	61	28.6	105	49.3	45	21.1	2	1.4	46	31.3	78	53.1	21	14.3
Ragi	9	4.4	45	21.8	66	32.0	86	41.7	12	5.6	52	24.4	48	22.5	101	47.4	8	5.4	32	21.8	50	34.0	57	38.8
Maize	-	-	-	-	3	1.5	203	98.5	-	-	-	-	-	-	213	100.0	1	0.7	-	-	-	-	146	99.3
Pearl millet	-	-	-	-	4	1.9	202	98.1	1	0.5	1	0.5	2	0.9	209	98.1	-	-	4	2.7	3	2.0	140	95.2
Oats	1	0.5	-	-	-	-	205	99.5	-	-	-	-	-	-	213	100.0	-	-	-	-	-	-	147	100
Pulses																								
Red gram dhal	29	14.1	158	76.7	13	6.3	6	2.9	25	11.7	180	84.5	6	2.8	2	0.9	16	10.9	123	83.7	4	2.7	4	2.7
Black gram dhal	85	41.3	98	47.6	18	8.7	5	2.4	111	52.1	96	45.1	5	2.3	1	0.5	74	50.3	69	46.9	2	1.4	2	1.4
Bengal gram dhal	25	12.1	122	59.2	42	20.4	17	8.3	26	12.2	123	57.7	50	23.5	14	6.6	20	13.6	76	51.7	42	28.6	9	6.1
Green gram	4	1.9	155	75.2	35	17.0	12	5.8	6	2.8	169	79.3	33	15.5	5	2.3	4	2.7	105	71.4	34	23.1	4	2.7
Peas	-	-	78	37.9	36	17.5	99	48.1	-	-	68	31.9	92	43.2	53	24.9	-	-	59	40.1	25	17.0	63	42.9
Chickpea	3	1.5	103	50.0	14	6.8	86	41.7	2	0.9	132	62.0	27	12.7	52	24.4	3	2.0	76	51.7	30	20.4	38	25.9
Roots and tubers																								
Potato	15	7.3	167	81.1	19	9.2	5	2.4	20	9.4	159	74.6	30	14.1	4	1.9	12	8.2	101	68.7	28	19.0	6	4.1
Carrot	10	4.9	159	77.2	33	16.0	4	1.9	13	6.1	166	77.9	31	14.6	3	1.4	13	8.8	101	68.7	28	19.0	5	3.4
Beetroot	4	1.9	147	71.4	37	18.0	18	8.7	7	3.3	152	71.4	42	19.7	12	5.6	10	6.8	89	60.5	39	26.5	9	6.1
Yam	0	0.0	85	41.3	58	28.2	63	30.6	1	0.5	77	36.2	63	29.6	72	33.8	1	0.7	54	36.7	50	34.0	42	28.6
Onion	206	100	-	-	-	-	-	-	213	100	-	-	-	-	-	-	147	100	-	-	-	-	-	-
Green leafy vegetables																								
Amaranth	7	3.4	74	35.9	46	22.3	79	38.3	9	4.2	71	33.3	25	11.7	108	50.7	7	4.8	61	41.5	17	11.6	62	42.2
Palak	3	1.5	84	40.8	45	21.8	74	35.9	8	3.8	80	37.6	31	14.6	94	44.1	4	2.7	56	38.1	27	18.4	60	40.8
Beet greens	2	1.0	43	20.9	36	17.5	125	60.7	5	2.3	35	16.4	29	13.6	144	67.6	4	2.7	36	24.5	18	12.2	89	60.5
Manathakkali	3	1.5	58	28.2	40	19.4	105	51.0	7	3.3	54	25.4	28	13.1	124	58.2	6	4.1	33	22.4	20	13.6	88	59.9
Fenugreek leaves	1	0.5	2	1.0	3	1.5	200	97.1	1	0.5	8	3.8	3	1.4	198	93.0	1	0.7	3	2.0	3	2.0	140	95.2

Drumstick leaves	2	1.0	15	7.3	4	1.9	185	89.8	2	0.9	18	8.5	6	2.8	187	87.8	0	0.0	13	8.8	6	4.1	128	87.1
Other vegetables																								
Brinjal	18	8.7	151	73.3	22	10.7	15	7.3	17	8.0	165	77.5	19	8.9	12	5.6	9	6.1	111	75.5	22	15.0	5	3.4
Beans	7	3.4	156	75.7	36	17.5	7	3.4	11	5.2	167	78.4	32	15.0	3	1.4	5	3.4	115	78.2	25	17.0	2	1.4
Pumpkin	4	1.9	118	57.3	53	25.7	31	15.0	8	3.8	127	59.6	50	23.5	28	13.1	3	2.0	82	55.8	45	30.6	17	11.6
Tomato	176	85.4	23	11.2	7	3.4	-	-	186	87.3	24	11.3	0	0.0	3	1.4	127	86.4	15	10.2	4	2.7	1	0.7
Mushroom	2	1.0	39	18.9	94	45.6	71	34.5	3	1.4	42	19.7	70	32.9	98	46.0	2	1.4	21	14.3	63	42.9	61	41.5
Ladies finger	10	4.9	157	76.2	34	16.5	5	2.4	4	1.9	161	75.6	41	19.2	7	3.3	6	4.1	106	72.1	30	20.4	5	3.4
Fruits																								
Apple	31	15.0	82	39.8	74	35.9	19	9.2	30	14.1	80	37.6	84	39.4	19	8.9	18	12.2	51	34.7	58	39.5	20	13.6
Pomegranate	27	13.1	95	46.1	70	34.0	14	6.8	25	11.7	82	38.5	84	39.4	22	10.3	16	10.9	64	43.5	52	35.4	15	10.2
Guava	13	6.3	81	39.3	82	39.8	30	14.6	17	8.0	63	29.6	110	51.6	23	10.8	7	4.8	53	36.1	63	42.9	24	16.3
Banana	63	30.6	88	42.7	45	21.8	10	4.9	62	29.1	67	31.5	68	31.9	16	7.5	41	27.9	58	39.5	35	23.8	13	8.8
Papaya	14	6.8	70	34.0	82	39.8	40	19.4	15	7.0	64	30.0	98	46.0	36	16.9	7	4.8	40	27.2	66	44.9	34	23.1
Fats and oils																								
Palm oil	26	12.6	-	-	3	1.5	177	85.9	40	18.8	1	0.5	2	0.9	170	79.8	31	21.1	1	0.7	-	-	115	78.2
Refined oil	110	53.4	1	0.5	5	2.4	90	43.7	135	63.4	5	2.3	6	2.8	67	31.5	89	60.5	4	2.7	5	3.4	49	33.3
Groundnut oil	58	28.2	23	11.2	12	5.8	113	54.9	51	23.9	12	5.6	8	3.8	142	66.7	41	27.9	14	9.5	3	2.0	81	55.1
Coconut oil	82	39.8	17	8.3	8	3.9	99	48.1	62	29.1	7	3.3	6	2.8	138	64.8	53	36.1	11	7.5	3	2.0	80	54.4
Fleshy foods																								
Chicken	14	6.8	129	62.6	44	21.4	19	9.2	13	6.1	111	52.1	67	31.5	22	10.3	4	2.7	98	66.7	40	27.2	5	3.4
Mutton	2	1.0	138	67.0	40	19.4	26	12.6	4	1.9	142	66.7	51	23.9	16	7.5	1	0.7	95	64.6	44	29.9	7	4.8
Beef	3	1.5	82	39.8	38	18.4	83	40.3	8	3.8	97	45.5	46	21.6	62	29.1	4	2.7	56	38.1	28	19.0	59	40.1
Fish	7	3.4	145	70.4	32	15.5	22	10.7	6	2.8	139	65.3	51	23.9	17	8.0	2	1.4	104	70.7	33	22.4	8	5.4
Salmon	-	-	27	13.1	50	24.3	129	62.6	1	0.5	21	9.9	61	28.6	130	61.0	-	-	16	10.9	43	29.3	88	59.9
Mackerel	-	-	30	14.6	59	28.6	115	55.8	-	-	25	11.7	72	33.8	116	54.5	-	-	19	12.9	49	33.3	79	53.7
Tuna	1	0.5	23	11.2	50	24.3	132	64.1	1	0.5	22	10.3	60	28.2	130	61.0	-	-	15	10.2	39	26.5	93	63.3
Dry fish	1	0.5	67	32.5	58	28.2	80	38.8	2	0.9	57	26.8	75	35.2	79	37.1	1	0.7	37	25.2	57	38.8	52	35.4
Egg	77	37.4	102	49.5	15	7.3	12	5.8	79	37.1	106	49.8	18	8.5	10	4.7	57	38.8	67	45.6	13	8.8	10	6.8

Milk and milk products																								
Milk	179	86.9	7	3.4	6	2.9	14	6.8	189	88.7	3	1.4	4	1.9	17	8.0	135	91.8	1	0.7	4	2.7	7	4.8
curd	87	42.2	66	32.0	26	12.6	27	13.1	98	46.0	51	23.9	42	19.7	22	10.3	59	40.1	38	25.9	37	25.2	13	8.8
Butter & ghee	36	17.5	73	35.4	63	30.6	33	16.0	28	13.1	57	26.8	81	38.0	46	21.6	18	12.2	50	34.0	56	38.1	102	69.4
Cheese	3	1.5	27	13.1	45	21.8	131	63.6	4	1.9	13	6.1	48	22.5	148	69.5	2	1.4	9	6.1	28	19.0	108	73.5
Paneer	-	-	-	-	2	1.0	204	99.0	-	-	1	0.5	1	0.5	211	99.1	-	-	-	-	-	-	147	100
Processed foods	#	17.0	60	29.1	45	21.8	66	32.0	36	16.9	49	23.0	48	22.5	79	37.1	28	19.0	32	21.8	29	19.7	58	39.5
Beverages																								
Tea	110	53.4	7	3.4	24	11.7	65	31.6	156	73.2	6	2.8	3	1.4	48	22.5	112	76.2	6	4.1	6	4.1	23	15.6
Coffee	32	15.5	24	11.7	38	18.4	112	54.4	41	19.2	10	4.7	44	20.7	118	55.4	33	22.4	7	4.8	31	21.1	76	51.7
Vitamin D fortified foods																								
Oil	109	52.9	6	2.9	5	2.4	86	41.7	135	63.4	6	2.8	5	2.3	67	31.5	86	58.5	2	1.4	4	2.7	55	37.4
Cereals	-	-	1	0.5	4	1.9	201	97.6	2	0.9	1	0.5	3	1.4	207	97.2	-	-	-	-	1	0.7	146	99.3
Milk and milk products	3	1.5	4	1.9	6	2.9	193	93.7	1	0.5	1	0.5	8	3.8	203	95.3	1	0.7	3	2.0	1	0.7	142	96.6
Biscuits	7	3.4	11	5.3	4	1.9	184	89.3	12	5.6	15	7.0	5	2.3	181	85.0	2	1.4	20	13.6	1	0.7	124	84.4
Supplements	10	4.9	10	4.9	4	1.9	182	88.3	8	3.8	20	9.4	-	-	185	86.9	5	3.4	6	4.1	0	0.0	136	92.5

The frequency of consumption of foods from different food groups varied between foods and among the Muslim women. The consumption of cereals and millets revealed that rice is the staple food was consumed daily by 99 per cent, while wheat was mostly (60 – 68%) consumed weekly among Muslim women irrespective of age.. Ragi is a rich source of both calcium as well as Vitamin D_2, among Muslim women maida and millets like ragi consumption were consumed weekly or occasionally. Minimal (<3%) consumption of oats, pearl millet and maize was observed among the women in all three age groups. The consumption pattern of pulses was not on daily basis in the Muslim families weekly three or four time pattern was observed. The pulses such as red gram dhal, black gram, green gram, Bengal gram, peas and chickpea were consumed weekly. Forty one to fifty two per cent of the women in all the age groups consumed black gram dhal daily as part of the idly or dosa batter. Peas was never consumed 43 to 48 per cent of the Muslim women in the age group of 20 to 29 years and 40 to 45 years. Among the roots and tubers onion was consumed every day (100%), while other roots and tubers like potato, carrots, beetroot and yam were consumed once or twice a week followed by occasional consumption pattern among the women disregarding age. The green leafy vegetables such as amaranth and palak were consumed once a week and sometimes occasionally. Beet greens and manathakkali were not preferred by 51 to 61 per cent of the women. Fenugreek and drumstick leaves were consumed barely by the women.

Other vegetables such as brinjal, beans and ladies finger were consumed once or twice a week by above 70 per cent of Muslim women in all three age groups. In near 85 per cent of the women, the consumption of tomatoes was daily. Mushrooms are rich sources of Vitamin D_2, literature has suggested equal effectiveness of Vitamin D obtained from mushrooms with those provided through supplements, highlighting its effectiveness in increasing and maintaining Vitamin D levels (Keegan *et al*., 2013) but among the Muslim women, only 14 to 18 per cent of them consumed mushrooms weekly. Occasional consumption was 45.6 per cent in 20 to 29 years, 32.9 per cent in 30 to 39 years and 42.9 per cent in 40 to 45 years Muslim women. Forty six per cent among Muslim women in 30 to 39 years and 41.5 per cent in 40 to 45years age group avoided mushrooms completely. The mushroom preferred for consumption was the button mushroom due to its local availability. Among the fruits, banana consumption was daily in near 30 per cent in the age group between 20 to 39 years in 40 to 45 years 40 per cent

daily consumption was observed. Other fruits such as apple, pomegranate, guava and papaya were consumed once or twice a week.

Refined oil was preferred for daily consumption by 53.4 per cent, 63.4 per cent and 60.5 per cent, followed by coconut oil by 39.8 per cent, 29.1 per cent and 36.1 per cent of the Muslim women between 20 to 29 years, 30 to 39 years and 40 to 45 years respectively. Daily consumption of groundnut oil (23 -28%) and palm oil (13 – 21%) was also observed among Muslim women. Consumption of flesh foods like chicken, mutton, beef and fish was weekly twice or thrice in most Muslim women irrespective of age. Forty per cent in the 20 to 29 years and 40 to 45 years age group did not consume beef, while 45.5 per cent between 30 to 39 years of age consumed beef weekly. Schmid and Walther (2013) reported meat to have low Vitamin D compared to liver, the highest values of Vitamin D were found in fish such as salmon, mackerel, tuna, herrings etc. and egg yolk contain Vitamin D between meat and liver. In the present study among the beef consumers, from observation, it was evident that beef liver a rich source of Vitamin D was consumed scarcely. Weekly consumption of fish was among the Muslim women was 70.4 per cent, 65.3 per cent and 70.7 per cent in the age group of 20 – 29 years, 30 to 39 years and 40 to 45 years, of which the consumption of fish such as salmon was preferred by only 13.1 per cent, 9.9 per cent and 10.9 per cent, mackerel was 14.6 per cent, 11.7 per cent and 12.9 per cent and tuna was 11.2 per cent, 10.3 per cent and 10 .2 per cent among the Muslim women in the age group of 20 to 29 years, 30 to 39 years and 40 to 45 years respectively, suggesting a low preference for Vitamin D rich fish. Low availability, high cost, mackerel causing gastritis were some of the reasons specified for not consuming. Daily consumption of eggs was observed in 37 to 39 per cent of Muslim women of all age groups.

Drewnowski (2011) identified milk and milk products as low cost sources to enhance calcium and Vitamin D intake. Among the Muslim women, 86.9 per cent, 88.7 per cent and 91.8 per cent in the age group of 20 to 29 years, 30 to 39 years and 40 to 45 years consumed milk. In 30 to 39 years and 40 to 45 years, most of the milk was consumed as tea or coffee. Forty to forty six per cent of the Muslim women consumed curd daily followed by weekly consumption in 24 to 32 per cent of them in all the age groups. Barely one to two per cent of the women consumed paneer, 63 to 74 per cent of them never included cheese in their diet. A pattern of weekly and occasional consumption of processed foods and daily consumption of tea was evident in all three

age groups among Muslim women. From observation tea consumption was 2 to 3 times among most of the Muslim women above the age of 30 years, some women also consumed tea 4 to 5 times a day. Vitamin D fortification is an effective approach to improve Vitamin D intake and levels in an individual, studies have shown a 1.2 nmol/l increase in Vitamin D levels with 1mcg intake of Vitamin D fortified foods (Black *et al*., 2012). Among the Vitamin D fortified foods daily consumption of Vitamin D fortified oil by 52.9 per cent (20-29years), 63.4 per cent (30 -39 years) and 58.5percent (40-45 years) of Muslim women was observed. The women barely consumed fortified foods such as Vitamin D fortified cereals, milk, biscuits and supplements and the main reason for not consuming was lack of awareness about the products.

Mean food intake of the Muslim women

Table XXXII and Figure19 elicits data on the mean food intake of the Muslim women equating with the recommended dietary allowances.

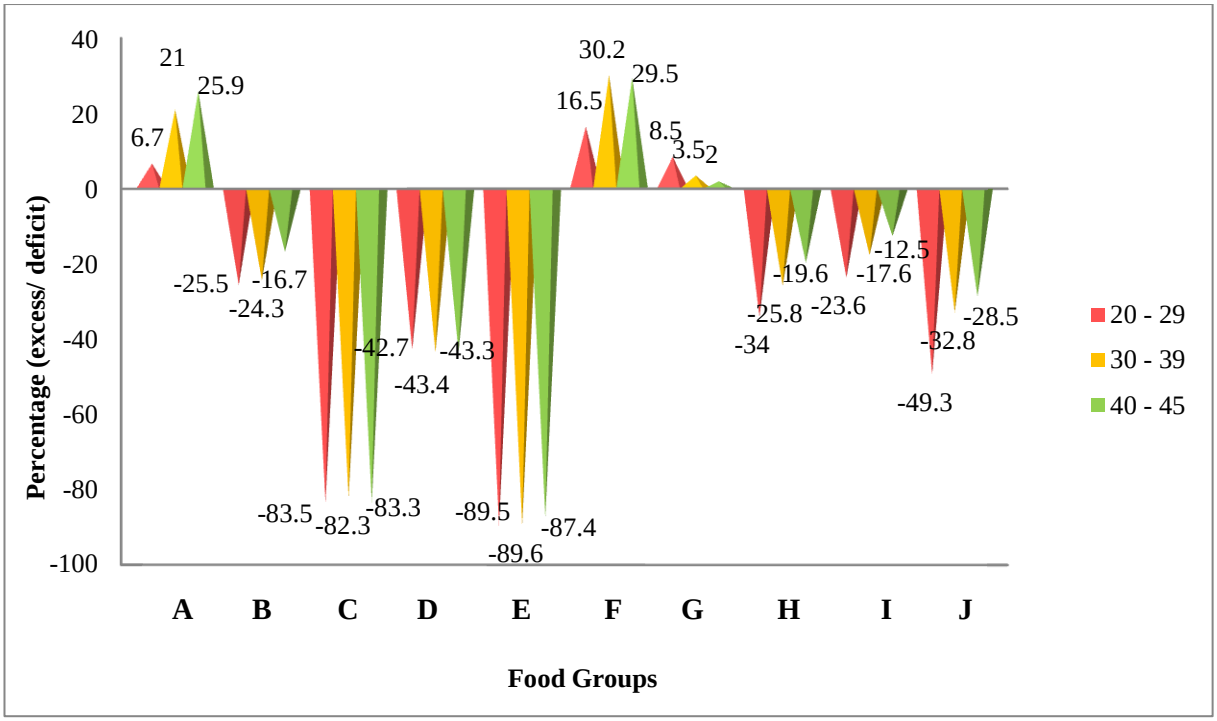
Table XXXII

Mean Food Intake of the Muslim Women

(N = 566)

Food Group	RDA**	20 – 29 years (206)		30 – 39 years(213)		40 – 45 years(147)	
		Actual intake	% Excess or Deficit ('t' value)	Actual intake	% Excess or Deficit ('t' value)	Actual intake	% Excess or Deficit ('t' value)
Cereals(g)	270	288.05± 52.3	+6.7 (4.96)*	326.7± 54.7	+21 (15.14)*	340.05 ± 45.4	+25.9 (18.73)*
Pulses (g)	60	44.7 ± 25.7	-25.5 (8.53)*	45.4± 24.8	-24.3 (8.57)*	49.8 ± 27.5	-16.9 (4.47)*
Green leafy vegetables (g)	100	16.5± 10	-83.50 (123.99)*	17.7± 9.5	-82.3 (126.78)*	16.7± 8.9	-83.3 (113.66)*
Roots and tubers (g)	200	114.7± 37	- 42.7 (33.1)*	113.2± 27.7	-43.4 (45.6)*	113.2± 27.7	-43.3 (32.6)*
Other vegetables (g)	200	21.1± 16.9	-89.5 (152.2)*	20.8± 20.7	-89.6 (126.5)*	25.3± 3	-87.4 (97.7)*
Animal foods (g)	60	69.9± 42.5	+16.53 (3.35)*	78.1± 50.6	+30.2 (5.2)*	77.7± 45.6	+29.5 (4.7)*
Fruits (g)	100	108.5± 45.5	8.52 (2.69)*	103.5± 40.5	3.54 $(1.27)^{NS}$	102.0± 36.8	2.01 $(0.66)^{NS}$
Milk and milk products (g/ml)	300	198.1± 93.0	-34 (15.73)*	222.6± 103.1	-25.8 (10.95)*	241.1± 97.31	-19.6 (7.34)*
Sugar and jaggery (g)	20	15.3± 4.0	-23.6 (16.8)*	16.4±4.5	-17.6 (11.72)*	17.5± 4.22	-12.5 (7.11)*
Fats and oils (g/ml)	20	10.1± 5.4	-49.3 (26.04)*	13.4 ± 5.6	-32.8 (17.1)*	14.3± 5.9	-28.5 (11.9)*

**ICMR (2010); *Significant at 1%; NS – Not Significant



A – Cereals
B – Pulses
C – Green leafy vegetables
D – Roots and Tubers
E – Other vegetables
F – Animal foods
G – Fruits
H – Milk and milk products
I – Sugars
J – Fats and oils

Figure 19: Mean Food Intake of the Muslim Women

From the above Table, it is evident that the intake of all the foods except cereals, fruits and animal foods was deficit compared to the recommended dietary allowance of ICMR (2010). Excess in per cent of cereal intake showed a trend of increase in consumption of cereals with an increase in age. Concerning pulse intake, it was observed that the consumption was deficit by25.5 per cent in 20 to 29 years, 24.3 per cent in 30 to 39 years and 16.7 per cent in 40 to 45 years age group among the Muslim women. The green leafy vegetable and other vegetable consumption were very low, a deficit in the range of 82 to 84 per cent and 87 to 89 per cent among the Muslim women in all three age groups. The intake of roots and tubers were deficit by 43 per cent in all the women, onion, potato and carrot were consumed, but the quantity of intake was low 114.7± 37 (20 -29 years), 113.2 ± 27.7 (30 -39 years) and 113.2 ± 27.7 (40 -45 years) which showed statistically significant variance compared to 200g suggested by ICMR. The animal food consumption was excess by 30.2 per cent in Muslim women in the age group of 30 to 39 years followed by 29.5 per cent in 40 to 45 years and 16.5 per cent in 20 to 29 years. Wang and Beydoun (2009) showed a positive association between meat consumption and risk of both peripheral and central adiposity, in accordance with this

study the abdominal obesity and obesity observed in the present study may be due to excess consumption of cereals and animal foods. This was on par with the high meat consumption detected among the Muslim community in Kerala (Wilson, 2010).

The consumption of fruits was marginally above the RDA among Muslim women. The excess per cent showed a pattern of decrease in consumption with an increase in age. Among the Muslim women between 20 to 29 years of age, the average intake of fruits was 108.5± 45.5, which was significant compared to the other two age groups. It was observed that tomato intake contributed to the major portion of the fruit intake among the women in all three age groups. Milk and milk product intake was deficit by 34 per cent in 20 to 29 years, 25.8 per cent in 30 to 39 years and 16.7 per cent in 40 to 45 years age group among the Muslim women. This increase in consumption among women in the age group of 40 to 45 years may be due to more beverage consumption among them. An increase in consumption of sugar and jaggery and fats and oil with a decrease in age was observed, among all the age groups the consumption was below RDA. In all the food groups, the consumption varied significantly from RDA except in the fruits intake among Muslim women in the age of 30 to 45 years when the intake did not vary much from the RDA. Gupta and Mishra (2014) in an analysis of diversity in food consumption among Indians pointed at a low probability of consuming all foods except meat. The result of which was on par with the present study, except for excess consumption of cereals and sufficient intake of fruits.

Mean nutrient intake of the Muslim women

Mean nutrient intake of the Muslim women of different age groups is given in Table XXXIII and Figure 20.

Table XXXIII
Mean Nutrient Intake of the Muslim Women

(N =566)

Nutrients	RDA##	20 – 29 years (n =206)		30 – 39 years (n = 213)		40 – 45 years (n =147)	
		Actual intake	% Excess or Deficit ('t' value)	Actual intake	% Excess or Deficit ('t' value)	Actual intake	% Excess or Deficit ('t' value)
Energy(Kcal)	1660	1923.3 ± 296.4	+15.9 (12.75)*	2072.9 ± 258.2	+24.87 (23.34)*	2176.8 ± 21.65	+31.1 (23.9)*
Proteins(g)	46	92.07 ± 26.7	+100.2 (24.77)*	106.4 ± 26.97	+131.2 (32.67)*	107.30 ± 24.3	+133.2 (30.5)*
Carbohydrate(g)	130	309.7 ± 50.2	+138.2 (51.35)*	334.5 ± 49.2	+157. 3 (60.66)*	353.9 ± 45.8	+172.2 (59.3)*
Fats(g)	20	47.8 ± 11.6	+139.1 (34.49)*	50.5 ± 11.4	+152.4 (39.08)*	52.8 ± 9.47	+164 (41.9)*
Fibre(g)	35	12.67± 3.21	-63.8 (99.83)*	12.63 ± 2.8	-63.9 (116.4)*	13.2 ± 2.54	-62.2 (104)*
Calcium (mg)	1000	749.5 ± 271.4	-25.1 (13.25)*	788.6 ± 224.5	-21.14 (13.74)*	818.5 ± 210.4	-18.2 (10.46)*
Phosphorus(mg)	1000	1357.7 ± 255.8	+35.8 (20.7)*	1465.3 ± 264.5	+46.5 (25.68)*	1506.4 ± 242.5	+50.6 (25.3)*
Iron(mg)	29	16.38 ± 4.4	-43.5 (41.26)*	17.19 ± 5.02	-40.7 (34.33)*	17.3 ± 4.5	- 40.5 (31.9)*
Beta carotene(mcg)	4800 #	1706.9 ± 578.1	-64.4 (76.8)*	1789.4 ± 588.6	-62.7 (74.65)*	1850.9± 564.7	-61.44 (63.32)*
Thiamine(mg)	1.4	1.28 ± 0.26	-8.6 (6.92)*	1.37 ± 0.32	-2.14 $(1.61)^{NS}$	1.42 ± 0.21	+1.43 $(1.15)^{NS}$
Riboflavin(mg)	1.9	1.41 ± 0.74	-25.8 (9.55)*	1.39 ± 0.59	- 26.84 (12.53)*	1.48 ± 0.56	- 22.1 (9.05)*
Niacin (mg)	11	14.11 ± 2.9	+28.3 (15.68)*	15.22 ± 3.7	+38.4 (16.56)*	15.98 ± 2.7	+45.3 (22.7)*
Vitamin B6(mg)	1.9	0.37 ± 0.16	-80.5 (139.7)*	0.40 ± 0.18	-78.94 (119.5)*	0.45 ± 0.18	-76.3 (96.7)*
Folic acid(mcg)	220	115.0 ± 40.1	-29.5 (23.25)*	158.11 ± 33.6	- 28.09 (26.88)	176.2 ± 42.6	- 19.9 (12.5)*
Vitamin C(mg)	65	76.5 ± 25.44	+17.7 (6.49)*	73.67 ± 23.2	+13.3 (5.45)*	76.1 ± 24.7	+17.1 (5.47)*
Vitamin D2(mcg)	-	40.78 ± 17.12	-	39.20 ± 13.3	-	41.52 ± 15.8	-
Vitamin D3(mcg)	-	0.84 ± 1.76	-	1.04 ± 2.05	-	0.78 ± 0.7	-
25 OH Vitamin D (mcg)	-	0.05 ± 0.10	-	0.08 ± 0.18	-	0.07 ± 0.25	-
Total Vitamin D (mcg)	600IU (15mcg)	41.7 ± 17.2	+177.7 (22.29)*	40.13 ± 13.65	+167.5 (26.87)*	42.1 ± 16.3	+180.6 (20.22)*

ICMR(2020) ; # ICMR 2010; * Significance at 1%

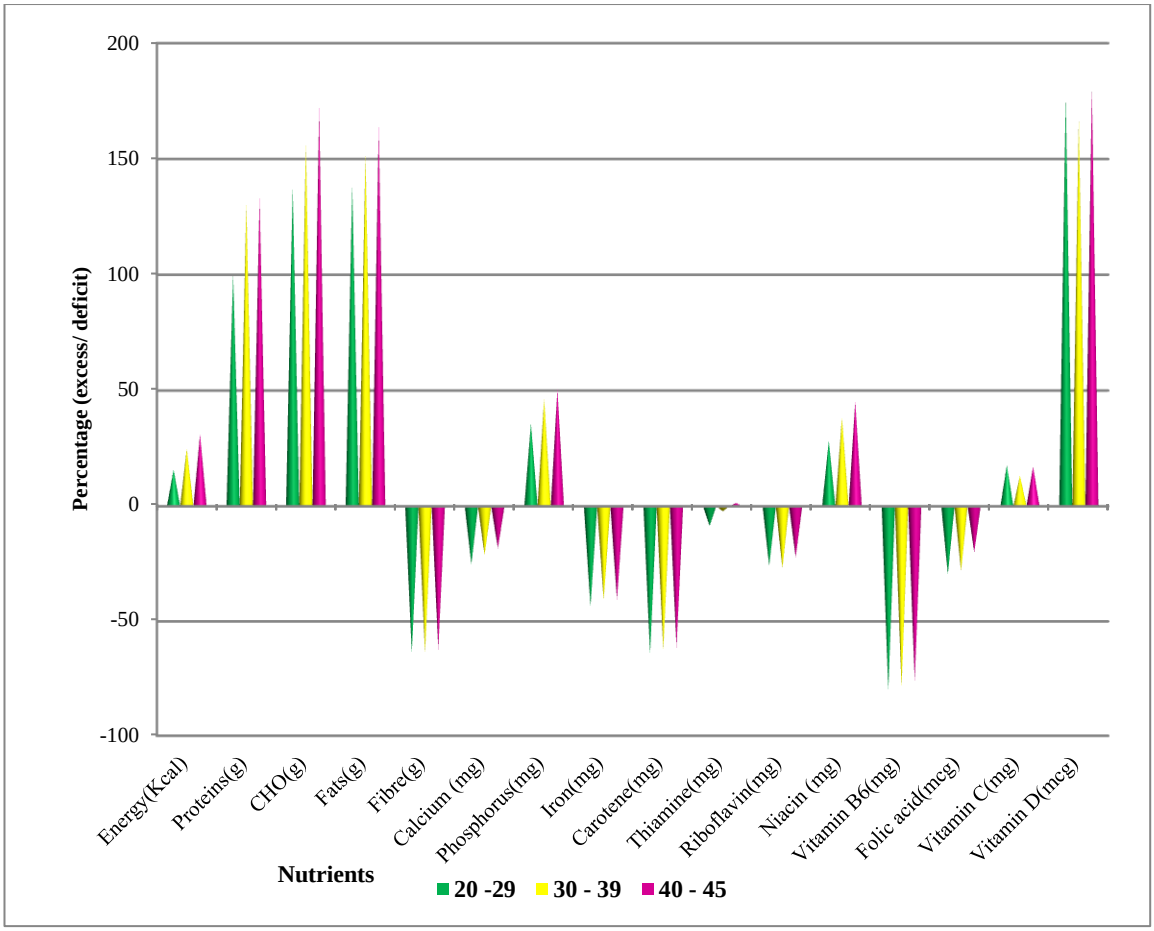


Figure 20: Mean Nutrient Intake of the Muslim Women

In the present study, the mean energy intake was higher than the recommended dietary allowances of ICMR (2020) by +15.9 per cent (20 -29 years), +24.9 per cent (30 – 39 years) and +31.1 per cent (40 – 45 years) among the Muslim women, Protein intake was in excess in the range of 100 to 133 per cent and the fat consumption was excess by 139 to 164 per cent, this may be attributed to more consumption of animal foods rich in proteins and fats as shown in Figure 19. This excess intake of energy, protein, carbohydrates and fats compared to RDA was highly significant and also an increase in energy, protein and fat consumption with an increase in age was observed. Fibre intake was of the Muslim women deficit in the range of 62 to 64 per cent in all the age groups. There was a deficit in micronutrients such as calcium, iron, beta carotene, thiamine, riboflavin, Vitamin B6 and folic acid, this may be because of low consumption of other vegetables green leafy vegetables and roots and tubers among the Muslim women in all the three age groups. A similar deficit of micronutrients and excess in intake of energy, protein and fats was observed in a study conducted among 100 Muslim women in the same area of Coimbatore city (Habeeba and Kalpana, 2018), In the current study

including566 Muslim women, an excess in Vitamin C and moderate consumption of thiamin was evident.

From the above graph, it can be inferred that iron consumption was deficit by 43.5 per cent, 40.7 per cent and 40.5 per cent and calcium intake was deficit by 25.1 per cent, 21.14 per cent and 18.2 per cent in Muslim women in the age group of 20 to 29 years, 30 to 39 years and 40 to 45years. Consumption of niacin and phosphorus was in excess among Muslim women in all three age groups. Vitamin C intake was moderately excess in the range of 13 to 17 per cent among all the age groups, which may be due to moderately excess intake of fruits. Vitamin D intake among the women disclosed consumption in three different forms the Vitamin D_2, Vitamin D_3 and 25 hydroxyl Vitamin D form, the findings revealed consumption of Vitamin D_2 to be higher than the other two forms of the Vitamin among Muslim women, mean intake of 40.78 ± 17.12 (20 – 29 years), 39.20 ± 13.3 (30 – 39 years) and 41.52 ± 15.8 (40–45 years) was observed. which might be due to more amount of Vitamin D_2 cereals, pulses and spices that form a major portion of the Indian diet. Despite excess intake of animal foods, the mean Vitamin D_3 intake was in the range of 0.78 to 1.04 mcg. This may be due to improper selection of animal foods leading to low consumption of Vitamin D_3 rich sources such as salmon, mackerel, tuna and organ meat like liver evident in Table XXXI. Studies have also disclosed a 75 per cent lower Vitamin D_3 content in farmed salmon compared to wild salmon. Limiting the availability of Vitamin D_3 rich sources (Lu *et al*., 2007). Statistical analysis found a significant variation from RDA in all the nutrients, except thiamine the intake of which was near sufficient among Muslim women.

Association between Body Mass Index and Energy intake

Table XXXIV depicts the association between Body Mass Index and Energy intake of the Muslim women.

Table XXXIV

Association between Body Mass Index and Energy Intake

Age	Number (N = 566)	BMI and energy intake	
		'r' value	'p' value
20 – 29 years	206	0.207	0.003*
30 – 39 years	213	0.217	0.001*
40 – 45 years	147	0.214	0.009*

***Significant at 1%**

From the above table, it is evident that Body Mass Index and energy intake among the Muslim women between 20 to 29 years of age showed a positive correlation with the value 0.207, at one percentage significance (0.003). Among the women, in between 30 to 39 years and 40 to 45 years of age , a similar highly significant ($p<0.01$) positive correlation at 'r' value 0.217 and 0.214 was evident. This suggests an increase in BMI with an increase in energy intake among Muslim women irrespective of their age.

4.2.4 Serum Calcium and Vitamin D status of Selected Muslim Women

The twinning of the two nutrients calcium and Vitamin D for carrying out vital functions such as formation and maintenance of bone health has to lead to suggestions of combined estimating of these two nutrients. In the present study serum, calcium and Vitamin D levels of 37 selected Muslim women was assessed to understand the Vitamin D nutriture among the Muslim women.

Serum Vitamin D levels of the Muslim women

Table XXXV depicts the Serum Vitamin D levels of the Muslim.

Table XXXV

Serum Vitamin DLevels of the Muslim Women

Vitamin D Status	Reference Range*	Muslim Women (20 – 45 YRS)	
		Number (n = 37)	Percentage (%)
Deficient	<20ng/ml	35	94.6
Insufficiency	20-30ng/ml	2	5.4
Sufficiency	30-100ng/ml	-	-
Toxicity	100ng/ml	-	-
Mean Vitamin D levels		9.19 ± 3.84	
Median (range)		17.44 (5.02 – 22.46)	

* Vitamin D Standardization Program (VDSP, 2010)

Serum Vitamin D levels of the selected Muslim women revealed that 35 Muslim women (94.6%) out of 37 were deficient showing levels below 20 ng/ml and the Vitamin D levels of the remaining two Muslim women was insufficient (20 – 30ng/ml) as suggested by Vitamin D standardization program (2010). Further, the mean Vitamin D levels were as low as 9.19 ± 3.84 ng/ml the upper and lower of which was between 5.02 – 22.46 ng/ml. Suchitra *et al*. (2021) in a study conducted in a South Indian town, Kumbakonam detected nearly similar mean serum 25 OH Vitamin D levels of 10.55 ng/ml among Muslim women. None of the selected Muslim women appeared to exhibit sufficient or toxic levels of Vitamin D. This high prevalence of deficiency is of great concern and requires intervention to address this issue among the Muslim women.

Serum calcium levels of the Muslim women

Table XXXVI depicts Serum calcium levels of the Muslim women.

Table XXXVI

Serum Calcium Levels of the Muslim Women

Calcium levels	Reference Range*	Muslim Women (20 – 45 Years)	
		Number (n = 37)	Percentage
Low	<8.5 mg/dl	3	8.1
Normal	8.5-10.5 mg/dl	34	91.9
High	>10.5 mg/dl	0	0
Mean Calcium levels		9.18 ± 0.50	
Median (range)		9.14 (7.90 – 10.50)	

* Krueger *et al.* (2003)

From the Table, it is perceivable that the majority (91.9%) of the selected Muslim women had calcium levels within normal range. Nearly eight per cent of the selected Muslim women had low levels of calcium below 8.5mg/dl. None of the women had high levels of calcium. The mean calcium level was 9.18 ± 0.50 mg/dl, which was within normal levels. Büyükuslu*et al*. (2014) observed a nearly similar mean calcium level of 9.0 ± 0.2 mg/dl among the women wearing Muslim style clothing. In the present study, it was observed that the calcium levels were lower in Muslim women aged above 40 compared to women of other ages.

Relationship of Serum Vitamin D levels with lifestyle and demographic factors

Table XXXVII shows the relationship of SerumVitamin D levels with lifestyle and demographic factors.

Table XXXVII

Relationship of SerumVitamin DLevels with Lifestyle and Demographic Factors

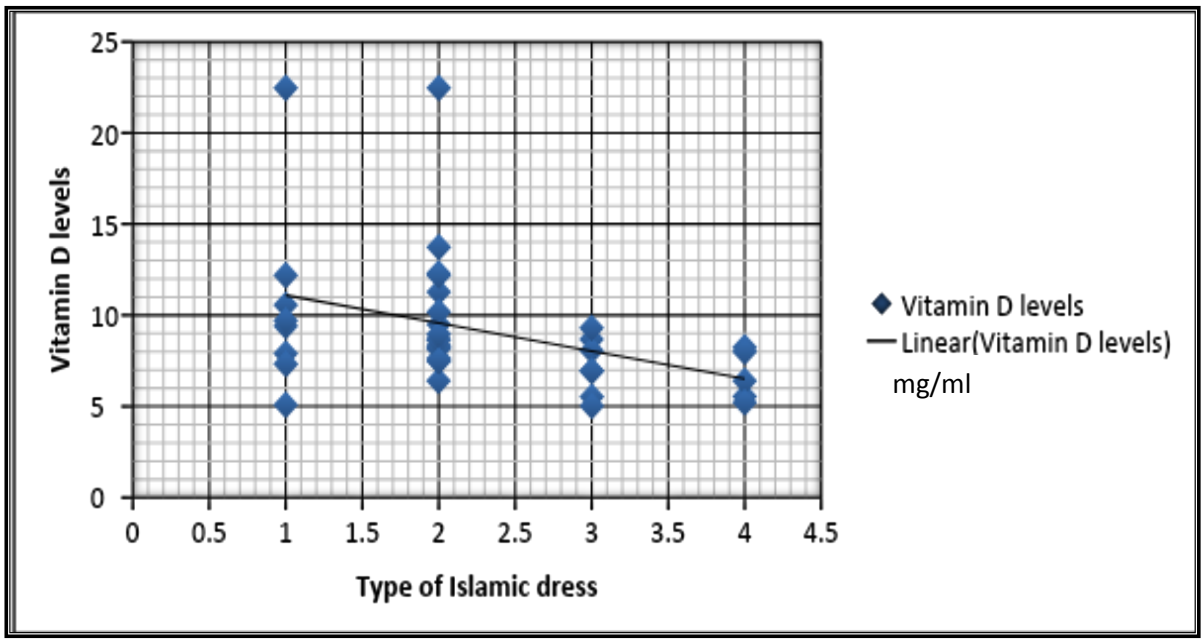
Constructs	Serum Vitamin D levels (ng/ml)					
	Mean ± SD	Correlation coefficient (r)	P value	Regression coefficient (β)	Standard error	P value
Age	33.49±5.84	-.047 NS	0.784	-0.051 NS	0.146	0.730
Occupation	-	-	-	0.451 NS	1.523	0.769
Education	1.70±0.75	-0.202 NS	0.230	-1.161 NS	0.898	0.206
Type of Islamic Dress	2.24±0.95	-.368*	0.020	-1.208 NS	0.734	0.111
Duration of practising Islamic dress code	13.59± 6.88	-.207 NS	0.219	-0.069 NS	0.117	0.560
Duration of exposure to sunlight	1.73±0.99	.389*	0.017	1.078 NS	0.779	0.177
Physical activity	-	-	-	-0.905 NS	1.609	0.578

*Significant at 5%(2 – tailed); NS – Not significant

From the Table XXXVII, it is obvious that serum Vitamin D levels showed a negative correlation with age, education, type of dress and duration of practising Islamic dress, physical activites and a positive correlation with duration of exposure to sunlight and occupation, of which, the relation of Vitamin D levels with type of Islamic dress and duration of exposure to sunlight was significant. From the regression results, the R value indicated that the 30.8 per cent changes in serum Vitamin D levels were due to the factors included, and it was also obvious that none of the relationships was significant when taken together. This might be due to the low sample size (n=37). Based on the regression coefficient similar to correlation age, education, Islamic dress and duration of practising Islamic dress code had a negative effect on serum Vitamin D levels. from the coefficient value, it can be interpreted that there will be a 0.051 ng/ml decrease in Vitamin D levels for every increase in age (in years). This was on par with the study showing a difference in skin production of Vitamin D between the young and the aged due to a reduction in response to ultraviolet rays (Gallagher, 2013). Education levels coefficient indicated a 1.161 ng/ml decrease in Vitamin D levels with the decrease in Vitamin D levels with increase in educational qualification. From Table XXIII it is evident that most of Muslim women practicing Islamic dress pursued high education. The dress code among these Muslim women may be the reason for the low Vitamin D

levels evident among educated women. This was contrary to a study suggesting a lack of Vitamin D knowledge to cause a decrease inVitamin D levels(Zareef*et al.*, 2021).

The relationship with Islamic dress type indicated an increase in concealing in Islamic dress type will result in a decrease in Vitamin D levels by 1.208 ng/ml, which indicated that the Muslim women wearing a burqa and niqab are more likely to exhibit low Vitamin D levels followed by jilbab and then hijab (figure 21). In a study, similar 1.36 times higher odds of Vitamin D deficiency was observed among fully veiled Muslim women and a decrease in Vitamin D levels with an increase in the different cloth covering was evident (Mohammed *et al*., 2021). The duration of Islamic dress practice showed that as the duration increased the Vitamin D levels decreased by 0.069 ng/ml. Büyükuslu*et al.*(2014) also evidenced a negative relationship between the duration of practising Islamic dress and Vitamin D status among young Muslim women. Duration of sunlight exposure had a positive effect on Vitamin D levels, that is with an increase in the duration of sunlight exposure an increase of 1.078 ng/ml Vitamin D levels is observed. This is on par with studies suggesting an increase in Vitamin D levels with an increase in the duration of exposure to sunlight (Nimitphong and Holick, 2013; Abulmeaty, 2016).



1 – Hijab 2 – Jilbab 3 – Niqab 4 – Burqa

Figure 21:Relationship of SerumVitamin DLevels with Type of Islamic Dress

Physical activity and occupation are dichotomous variables, the interpretation suggested an average increase in Vitamin D levels of non working women compared to working women. This may be due to sunlight light exposure mainly during the morning before 11 am and evening after 3 pm observed among the working women in the baseline survey. Further, these blood samples were collected during the covid lockdown period, which may also affect the Vitamin D levels among these women. These findings also suggested physically inactive Muslim women were likely to have more Vitamin D levels by 1.895 ng/mi compared to physically active Muslim women. This finding was in contrast with literature evidence suggesting physical activity increases Vitamin D levels(Marcos and Waldivino, 2017) As a whole, the findings revealed duration of sunlight exposure and the type of Islamic dress have more effect on Vitamin D levels compared to other factors noticeable from both correlation and regression results. From Table XXIII a significant association between Islamic dress code practice and sunlight exposure was evident. Duration of sunlight exposure was lower among the Muslim women wearing Islamic dress and also the amount of covering in Islamic dress prevents Vitamin D production.Concerning the influence of Islamic dress on other factors, it is evident that Islamic dress is the major determinant of Vitamin D levels of Muslim women thereby having an impact on Vitamin D status.

Relationship of body measures and symptoms with Serum Vitamin D levels

Table XXXVIII shows the relationship of body measures and symptomswith Vitamin D levels.

Table XXXVIII

Relationship of Body Measures and Symptoms with Vitamin DLevels

Body measures and symptoms	Vitamin D levels(ng/ml)	
	Pearson Correlation (r)	'P' value
Weight (kg)	-0.308 ^{NS}	0.063
Height (cm)	-0.012 ^{NS}	0.943
BMI (kg/m^2)	-0.322 ^{NS}	0.052
Leg pain	-0.282 ^{NS}	0.091
Regular body pain	-0.175 ^{NS}	0.300
Back pain	-0.418*	0.010

*Significant at 1%; NS – Not significant

From the above table, it is obvious that the correlation of all the body measures and symptoms was negative with serum Vitamin D levels. This indicated an inverse relationship. In the case of weight, a very weak relationship showing decrease in Vitamin D levels with an increase in weight was obvious. Similarly, a weak relationship showing a decrease in serum Vitamin D levels with an increase in BMI was observed. Lagunova*et al*. (2009) found a similar increase in BMI contributing to a decrease in Vitamin D levels. Among the symptoms only back pain showed a statisticallysignificant negative relationship with Vitamin D levels, indicating an increase in incidences of back pain with a decrease in serum Vitamin D levels. This was on par with a study by Joshua*et al*. (2017) who found an association between lower back pain and serumVitamin D levels. Therefore, the Vitamin D levels decreased with an increase in weight, BMI and back pain in Muslim women.

Relationship of SerumVitamin D and Calcium Levels

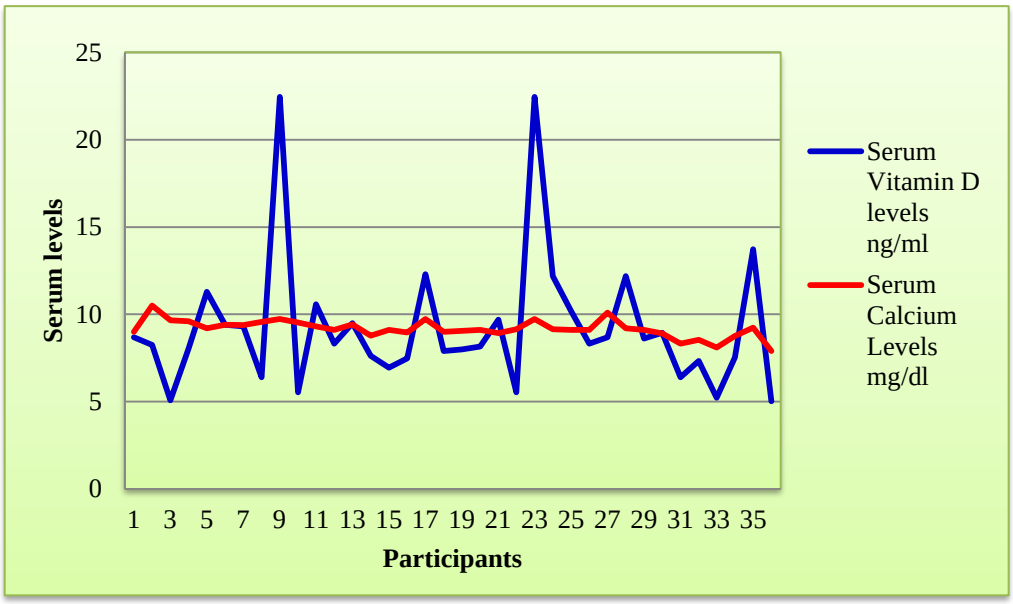


Figure 22:Relationship of SerumVitamin D and Calcium Levels

Form the above figure shows the calcium and Vitamin D levels of the selected Muslim women. There was a correlation between calcium and Vitamin D levels which was significant at 5 percent.

Relationship of nutrient intake with Vitamin D levels

Table XXXIX shows the relationship of nutrient intake with Vitamin D levels.

Table XXXIX

Relationship of Nutrient Intake with Vitamin DLevels

Constructs	Vitamin D levels (ng/ ml)	
	Pearson Correlation (r)	'P' value
Energy (kcal)	0.136^{NS}	0.422
Proteins (g)	0.63^{NS}	0.710
Fat (g)	0.139^{NS}	0.411
Calcium(mg)	0.079^{NS}	0.642
Vitamin D_2(mcg)	0.361^{**}	0.031
Vitamin D_3(mcg)	0.127^{NS}	0.455
Total Vitamin D(mcg)	0.387**	0.018

**Significant at 5%(2 – tailed); NS – Not significant

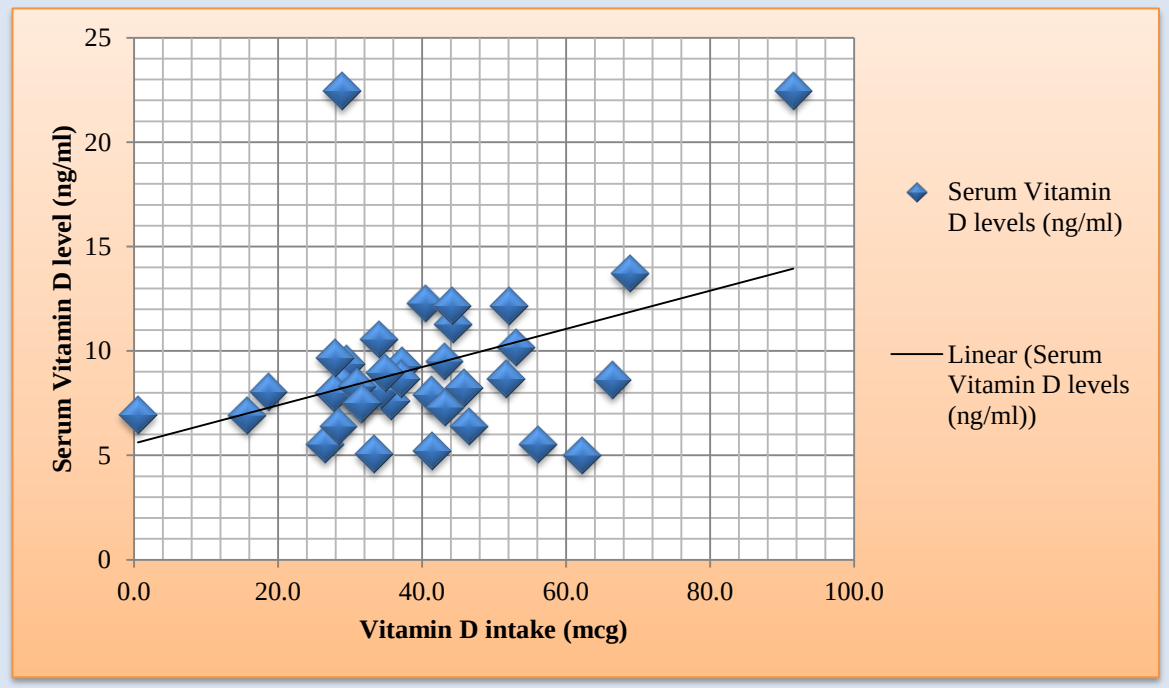


Figure 23:Relationship of Vitamin DLevels with Vitamin DIntake

Nutrient intake with Vitamin D levels the correlation was not significant for all the nutrients except Vitamin D_2 and total Vitamin D. A positive correlation coefficient indicated an increase in Vitamin D levels with an increase in intake of energy, proteins, fat and Vitamin D_3, but this association was not significant. From Figure 23, there was a significant rise in the Vitamin D levels with an increase in consumption of Vitamin D_2 and total Vitamin D. As previously evident (Table XXXIII) the intake of Vitamin D among the Muslim women was mostly in the form of Vitamin D_2. This significant increase in Vitamin D levels with an increase in Vitamin D_2 intake is thus favourable.

4.3 Identification and Analysis of Vitamin D Fortified Foods

As the first component of the present study, a market survey for Vitamin D fortified products was conducted and in the second component, the nutrients, calcium and Vitamin D content of selected fortified products were quantified. The findings of which are explained furtherance.

4.3.1 Market survey

In the present study, a market survey was conducted to identify the Vitamin D fortified foods, understand the degree of Vitamin D fortification, characteristics of Vitamin D fortified products and accessibility to Vitamin D fortified products.

Categorization of different stores

Figure 24shows the Categorization of different stores.

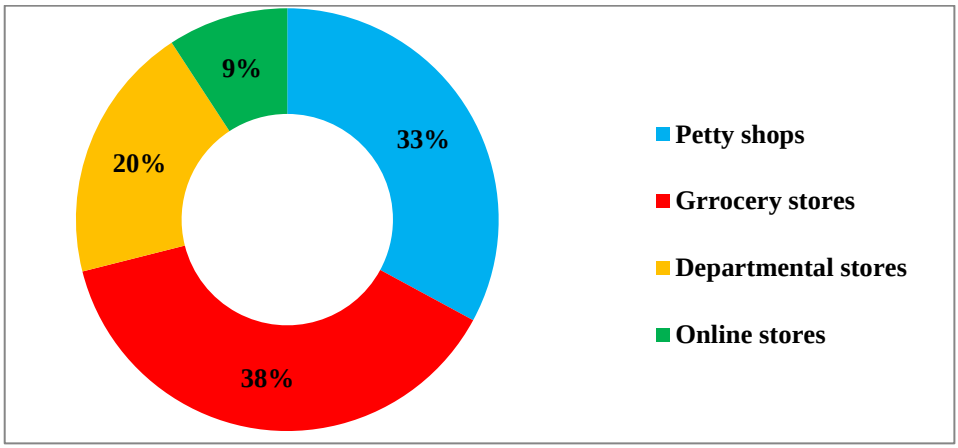


Figure 24: Categorization of Different Stores

A total of 76 shops were surveyed in Coimbatore city. As the wholesale shops did not permit for the survey, these shops were not included in the survey. Further, the purchasing pattern among Muslim women also did not show a purchase from the wholesale market. The shops surveyed were categorised according to the classification of retailers in India (Panagariya andBhagwati, 2013). Among them, 33 per cent (25) were petty shops, 38 per cent (29) were grocery stores, 20 per cent (15) were departmental stores and 9 per cent (6) were online stores. Commonly used online stores were selected for the survey.

Vitamin D fortified foods identified in the market

Table XL gives Vitamin D fortified foods identified in the market.

Table XL

Vitamin DFortified Foods identified in the market

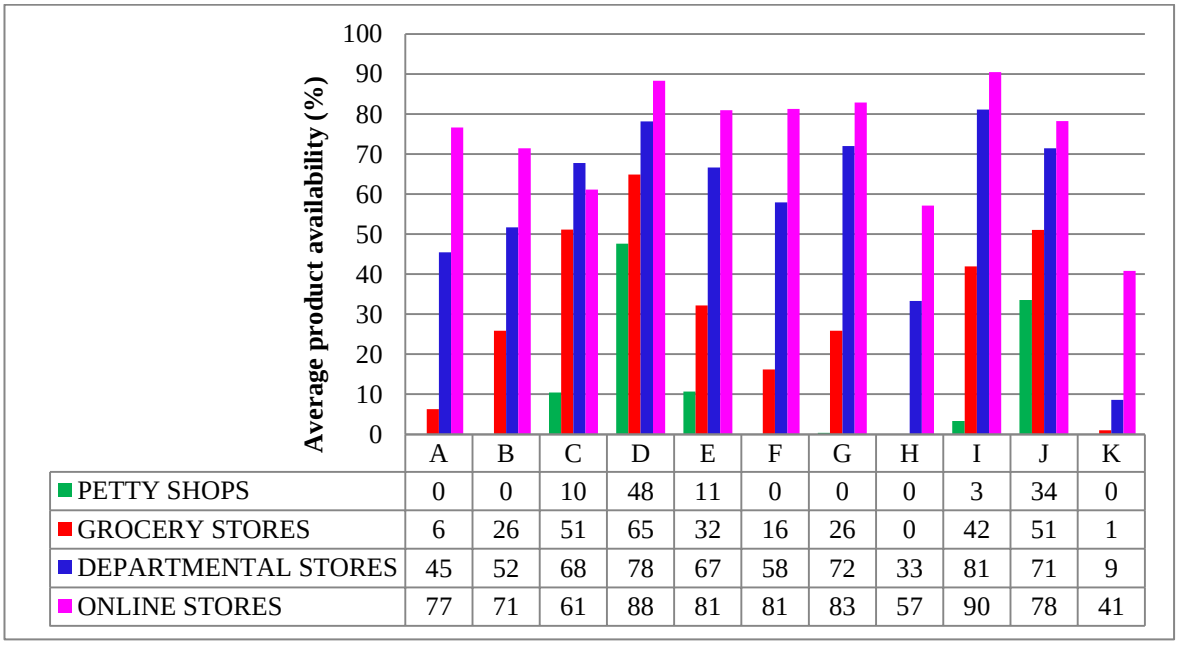
Products	Number (n = 108)	Percentage (%)
Foods		
Milk and Milk products	11	10.2
Cereals	4	3.7
Cooking oil	18	16.7
Biscuits	11	10.2
Glucose powder	3	2.7
Egg	1	0.9
Baby Foods and formula		
Infant formula	16	18.8
Baby foods	10	9.2
Health drinks		
Toddlers	6	5.5
Regular	21	19.4
Disease specific	7	6.5

In the market survey around 108 products were identified, which were categorized into foods, baby foods and formula and Health drinks. The products under the foods category were further grouped into milk and milk products (10.2%), cereals (3.7%), cooking oils (16.7%), biscuits (10.2%), glucose powder (2.7%) and egg (0.9%). The milk and milk products identified included packed milk, milk powder and flavoured milk. The other milk products such as yoghurt, buttermilk, cheese and butter are commonly fortified with Vitamin D (Ganesan*et al*., 2011; Hirvonen*et al*., 2007) due to their fat content were not fortified in Coimbatore city. Among the cereals, only four products were found to be fortified with Vitamin D, which was in converse to the majority of cereals and milk fortified with Vitamin D observed in the USA (Calvo*et al*., 2004). All the Vitamin D fortified cooking oils identified were packed refined sunflower oil. This was on par with the observation were 69 per cent of the packed oils were fortified in India (https://economictimes.indiatimes.com/news/economy/policy/fssai-mulling-making-fortification-of-edible-oil-with-vitamins-a-d-

mandatory/articleshow/78333515.cms?from=mdr) Fortification in other oils such as coconut oil, groundnut oil, gingelly oil and palm oil were not evident. Eleven different biscuits showing Vitamin D fortification at various levels were identified. Sugars such as glucon D and glucovita were fortified with Vitamin D. One product under eggs was identified among the Vitamin D fortified products. Low availability of Vitamin D fortified foods as in the present study was revealed from a literature review (Aparna*et al*., 2018). Apart from the foods 16 baby foods and 10 baby formulas were fortified with Vitamin D, studies have suggested Vitamin D is present in most of the infant formulas (Abrams, 2020). The products from Health drinks were grouped based on age and specification for consumption. Six products for toddlers, 21 products for consumption for adults and seven disease specific Health drinks for diabetes and renal conditions were identified. No fortification of orange juice, soya milk and low fortification of cereals was observed, similarly to Sadat-Ali *et al*. (2013) observation of no orange juice or cereals were fortified in Saudi Arabia.

Vitamin D fortified products available in local shops and stores

Figure 25 depicts Vitamin D fortified products available in local shops and stores.



	A	B	C	D	E	F	G	H	I	J	K
PETTY SHOPS	0	0	10	48	11	0	0	0	3	34	0
GROCERY STORES	6	26	51	65	32	16	26	0	42	51	1
DEPARTMENTAL STORES	45	52	68	78	67	58	72	33	81	71	9
ONLINE STORES	77	71	61	88	81	81	83	57	90	78	41

A- Milk and milk products
B- Cereals
C- Cooking oils
D – Biscuits
E – Glucose powder
F – Infant formula
G – Baby foods
H – Eggs
I – Health drinks (Toddlers)
J – Health drinks (Adults)
K - Disease specific supplements

Figure 25:Vitamin DFortified Products availablein Local Shops and Stores

The mean availability of Vitamin D fortified products in different stores was calculated. From the above figure, it is evident that the availability of all the products was high in online stores compared to other shops and stores. From there the availability showed a decrease with a reduction in the size of the stores and shops, departmental stores sold more Vitamin D fortified products followed by grocery stores and then petty shops. Among the Vitamin D fortified products available in petty shops biscuits and adult Health drinks were 48 per cent and 34 per cent. Health drinks included malted drinks and flavoured drinks available in sachet and box packages, which were universally available in all types of shops and stores. Grocery stores availability of cooking oil (51%), biscuits (65%), toddler Health drinks (42%) and regular Health drinks (51%) was greater. Average cooking oil availability was more in departmental stores (68%) than online shops (61%). Vitamin D fortified biscuits, milk and milk products, infant formulas, baby foods, eggs, glucose powder, Health drinks for toddlers, adults and specific for diseases were available more in departmental stores compared with grocery stores and petty shops. Disease specific supplement availability was comparatively greater up to 40 per cent in online stores. Overall the availability in departmental stores and online stores was higher, emphasizing the importance of purchase behaviour from these stores for better access to Vitamin D fortified foods. This was on par with the report of USDA (2018) suggesting supermarkets and hypermarkets be more effective in fulfilling the needs of the customers (Mishra and Anthony, 2018).

Forms of Vitamin D fortified products

The different forms of Vitamin D fortified products have been shown in Figure 26.

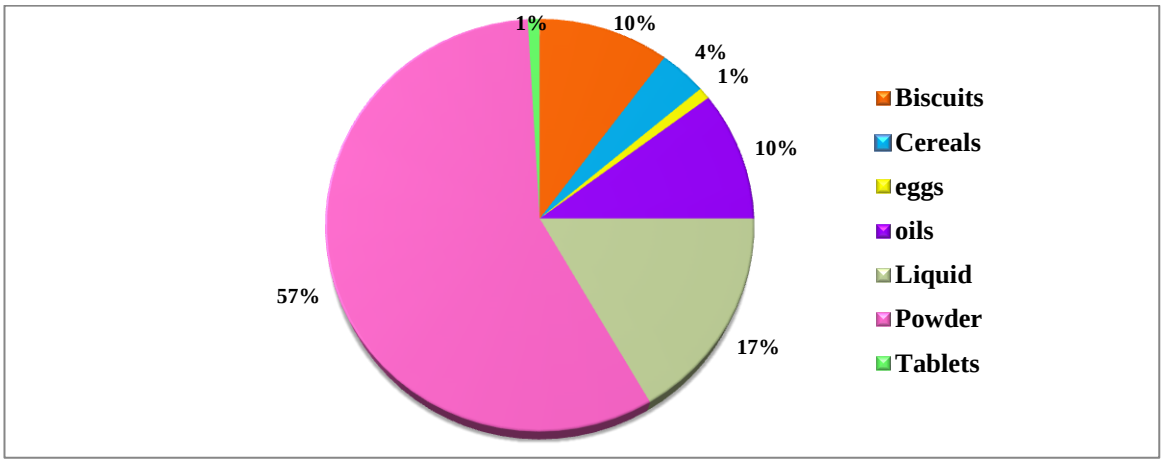


Figure 26:Forms of Vitamin DFortified Foods

The products identified were in different forms, 57 per cent of the products were in the powder form contributed by health drinks, milk powder, glucose powder, infant formulas and baby foods. Four per cent were cereal pellet forms. Products in Liquid form (17%) and oil form(10%) were mostly milk and products and oils. Glucovita was present in tablet form (1%).

Types ofVitamin D fortification

Figure 27 depicted the types of Vitamin D fortification.

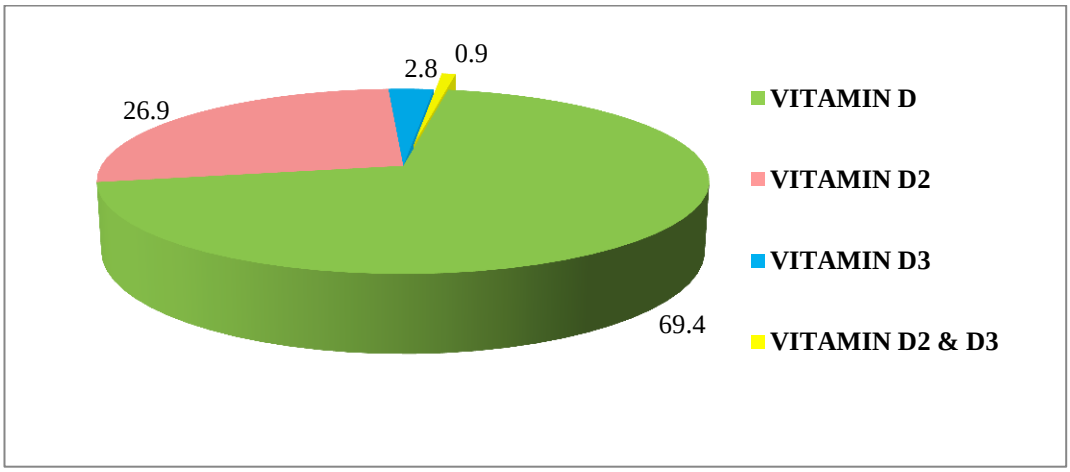


Figure 27: Types of Vitamin DFortification

The data on different types of Vitamin D fortification as obtained from the product label specification were of four different types Vitamin D, Vitamin D_2, Vitamin D_3 and both Vitamin D_2 and D_3. The Vitamin D form specification was present in69.4 per cent of the products, which denoted that in these products the type of Vitamin D added was not specified or differentiated. Twenty seven per cent of the products were fortified with Vitamin D_2, while only three per cent of the products were fortified with Vitamin D_3. This was in converse with 99 per cent Vitamin D_3 preparations identified among Indian supplements and similar Vitamin D_2 fortification was observed in oil and milk in a study in Rajasthan and Madhya Pradesh (Lhamo *et al*., 2016; Bhagwat *et al*., 2014). Nearly one per cent of the products were fortified with both Vitamin D_2 and Vitamin D_3. Vitamin D3 is the most bioavailable type of Vitamin D. Less per cent of the products fortified with this form may contribute to less effectiveness of fortification (Tripkovic*et al*., 2012). Further unavailability of the type of Vitamin D used for fortification in nearly 70 per cent of the products. Does not provide a clear understanding of the effectiveness based on the type of Vitamin D fortification.

Calcium and Vitamin D content of the fortified products (as specified in the label)

Table XLI shows the calcium and Vitamin D content of the fortified products (as specified in the label).

Table XLI

Calcium and Vitamin DContentof the Fortified Products(as specified in the label)

Products	Mean Calcium content mg/100g/ml	Mean Vitamin D content mcg/100g/ml	Proportion of RDA(%)# /100g/ml	Cost of the product /100g/ml	Relation between Vitamin D content and cost 'r' value
Foods					
Milk and Milk products	220.7 ± 266.9	1.85 ± 2.7	12.4	14.06 ± 13.0	0.036**
Cereals	366.8 ± 66.5	4.72 ± 0.9	31.5	55.96 ± 15.6	
Cooking oil	-	9.35 ± 3.2	62.4	18.26 ± 4.34	
Biscuits	158.5 ± 225.8	2.33 ± 1.8	15.5	14.01 ± 3.9	
Glucose powder	166.7 ± 15.3	13.5 ± 5.2	90	46.73 ± 31.7	
Egg	49 ± 0	15 ±0	100	12 ± 0	
Baby foods and infant formulas					
Infant formula	471.3 ± 122.9	6.88 ± 1.9	68.8	128.36 ± 39.8	0.000*
Baby foods	415.9 ± 43.7	5.13 ± 0.4	51.3	78.68 ± 13.8	
Health drinks					
Toddlers	587.5 ± 297.2	7.73 ± 3.04	51.5	103.97 ± 49.1	0.771^{NS}
Adults	680.1 ± 328.2	7.47 ± 4.9	49.8	82.12 ±42.2	
Disease specific	400.6 ± 236.4	4.96±1.4	33.1	168.3 ± 49.1	

**Significant at 5 %; *Significant at 1%; NS – Not Significant; # - ICMR(2020)

From the above table, the mean calcium per 100g/ml among the foods was more up to 366.8 ± 66.5 in the identified cereals, followed by 220.7 ± 266.9 in milk and milk products. In the baby foods and infant formula, the content was 471.3 ± 122.9 and 415.9 ± 43.7, which was nearly similar. Mean Vitamin D content per 100g/ml was 15mcg in egg, 13.5 ± 5.2 in glucose powder, followed by cooking oil (9.35 ± 3.2) and health drinks for toddlers (7.73 ± 3.04) and adults (680.1 ± 328.2). The levels of Vitamin D fortification in milk identified during the survey was 200IU per litre. This value was much lower than 400 IU per litre achieved through the complementary strategy in Rajasthan (Bhagwat*et al*., 2014). Further, the local milk used usually were not fortified with Vitamin D and only the packed milk showing very low consumption were fortified with Vitamin D. Thirteen out of 18 oils identified were fortified with 11.25 mcg/100ml

of Vitamin D, which was within the 11 to 16 mcg Vitamin Dfortification of oil recommended by FSSAI (https://ffrc.fssai.gov.in/commodity?commodity=fortified-oil). The Vitamin D content per 100g of the product when compared with the recommended dietary allowances suggested by ICMR (2020), which is 15 mcg or 600 IU for adults and 10mcg or 400 IU for infants and toddlers. Per hundred gram of Cooking oil (68.4%), glucose powder(90%), infant formulas (68.8%), baby foods (51.3%) and health drinks (33 – 52%) were fortified with more amount of Vitamin D. However, the likelihood of consumption of these products is mostly within 30 g due to their portion size and hence, cannot be used an effective source of Vitamin D.

Eggs, cereals, infant formulas and baby foods providing 100, 31.5, 68.8 and 51.3 per cent of the daily Vitamin D requirement may prove more effective fortified foods, followed by milk and biscuits. These findings suggest a poor selection of Vitamin D fortification vehicles and also low availability of Vitamin D from bulk consumption of Vitamin D fortified foods. Therefore Vitamin D fortified foods cannot be solely used as an effective source of dietary Vitamin D. The cost of the product and Vitamin D content showed a positive correlation, which was significant in the food, infant formula and baby foods group and not significant in the health drinks group. Ritu and Gupta (2014) in a study on medicinal supplements observed an equivalent increase in the amount of Vitamin D with the increase in the cost of the product.

4.3.2 Calcium and Vitamin D content of fortified egg and milk

Two random samples of Vitamin D fortified milk and egg were collected from the stores after the market survey to estimate the calcium and Vitamin D content using quantitative methods. Table XLII gives the calcium and Vitamin D content of Vitamin D fortified egg and milk.

Table XLII

Calcium and Vitamin DContent of Fortified Egg and Milk

Nutrients /100g*	Raw egg	Boiled egg	Egg refrigerated for 24 hours	Raw milk	Boiled milk	Milk refrigerated for 24 hours
Moisture (%)	76.7 ± 0.15	80.03 ± 0.09	76.63 ±0.388	90.29 ±1.19	84.17 ± 0.568	89.88 ± 0.47
Ash (g)	0.85 ± 0.02	0.94 ± 0.07	0.85 ±0.01	0.51 ± 0.03	0.52 ±0.01	0.49 ± 0.01
Calcium (mg)	48.31 ± 0.35	41.83 ± 1.07	47.51 ± 0.70	90.14 ± 0.46	94.4 ± 0.98	89.6 ±0.81
Vitamin D (mcg)	ND** (<0.05 mg/100g)	ND** (<0.05 mg/100g)	ND** (<0.05 mg/100g)	ND** (<0.05 mg/100g)	ND** (<0.05 mg/100g)	ND** (<0.05 mg/100g)

*triplicate samples; **ND –Not detected; < 0.05 mg/100g - method detection limit

From TableXLII , it is apparentthat the ash content (g) of raw Vitamin D fortified egg was 0.85 ± 0.02, moisture and calcium content(g) were 76.7 ± 0.15 and 48.31 ± 0.35 respectively obtained by computing the mean of triplicate analysis results. On boiling, there was a 4.5g increase in the raw weight of the egg, further the mean moisture content increased to 80.03 ± 0.09 (%), contributed by water used for cooking. The ash content (g)was marginally higher (0.94 ± 0.07) in comparison with the raw egg. The calcium content (g) of the egg decreased to 41.83 ± 1.07 on boiling. This may be due to the hard boiling of the egg. Réhault-Godber*et al.* (2019) found a similar reduction in calcium content of hens egg from 56mg/100g to 50mg/100g on hard boiling, while on the soft boiling egg the calcium retention was better. On refrigeration for 24 hours, ash content (0.85 ±0.01 g) was similar to the raw egg. whereas, the moisture and calcium content of the refrigerated eggs showed a difference of 0.04 and 0.8, which may have been lost during storage. A study on the properties by Luo*et al.* (2020) observed a mild decrease in moisture content of eggs stored at 4^{o} C, indicating moisture losses during storage. Also, these losses increase with time and temperature. Concerning Vitamin D in all three egg samples it was not detected, this may be due to the content of the Vitamin D fortified eggs lying below the method detection limit of the HPLC method used in the present study.

Among the Vitamin D fortified milk variations such as raw, boiled and refrigerated, moisture and ash content of raw milk was 90.29 ±1.19 and 0.51 ± 0.03 respectively. This moisture content decreased to 84.17 ± 0.568 in the boiled milk, this

change may be attributed to vapourization during the process of boiling. A 0.01g/100ml increase in ash content and 4.26mg/100ml increase in the calcium content of boiled milk compared to raw milk was observed, this was on par with results obtained in an analysis of boiled milk where the increase in calcium is attributed to evaporation leading to the concentration of minerals (Bahman et al., 2012). Conversely, studies have also reported the loss of calcium in the range of 6 to 7 per cent in boiled milk (Shrihari and Varsha, 2016) The contents of refrigerated milk did not exhibit much variation in comparison with raw milk. Similar to eggs the Vitamin D content of Vitamin D fortified milk was not detected.

True retention of the nutrients

Figure 28 depicts the true retention of the nutrients.

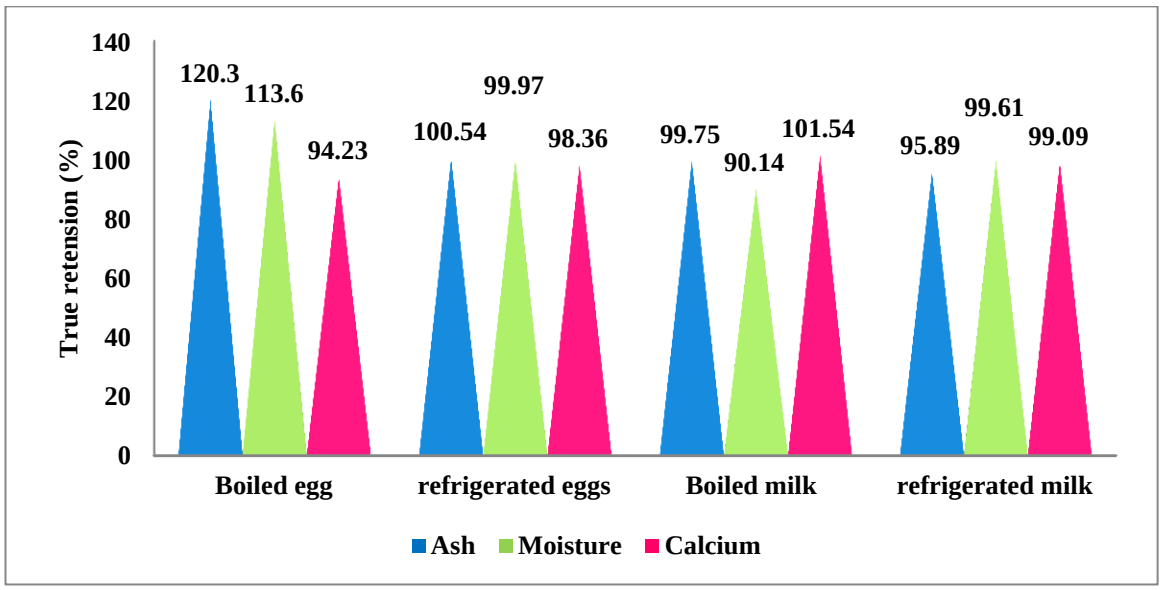


Figure 28: True Retention of the Nutrients

The true retention of the nutrients calcium, ash and moisture in Vitamin D fortified eggs boiled and refrigerated and Vitamin D fortified milk both boiled and refrigerated was calculated with USDA (2007) true retention formula. From the above figure, maximum retention of ash was evident in boiled and refrigerated eggs, while calcium retention was high in boiled milk (101.54%), followed by refrigerated milk (99.9%). The moisture content in boiled eggs was higher than in other samples (113.6%) due to the absorption of water during boiling. Boiled milk showed 90.14 per cent retention of moisture. Overall the retention of the nutrients was above 90 per cent for all four samples. As Vitamin D content was not detected, true retention could not be

calculated. But the literature suggests losses in Vitamin D during quantitative estimation of boiled egg and food composition tables (Réhault-Godbert*et al.,* 2019; Longvah*et al*., 2017).

A difference of 0.69 between the label calcium specification 49 mg/100g and estimated calcium value 48.31mg/100g in Vitamin D fortified eggs and 3.46 between label calcium specification 93.6mg/100ml and estimation value 90.14 mg/100ml was observed. The values 15mcg in Vitamin D fortified egg and 0.5 mcg in Vitamin D fortified milk as specified in the product labels were not detectable during the analysis. Studies comparing the estimated content of Vitamin D fortified foods and supplements with their label information has suggested considerable deviation between the content and label information(Garg*et al.,* 2013; Verkaik-Kloosterman*et al.,* 2017) which may also contribute to the availability of Vitamin D from fortified foods. Hence, low quantity and quality of Vitamin D fortification, poor selection of fortification vehicles, lack of mandatory regulation, inaccurate interpretation of intake due to deviation in label specification and low Knowledge on Vitamin D fortified foods and their availability were some of the issues identified in the survey and analysis. This part of the study was carried out in view of supplementation to determine the effectiveness of Vitamin D fortified foods in improving Vitamin D levels of the Muslim women in the following phase. On account of onset of Covid pandemic blood sample collection was not permissible due to infection while handling fluids. Also, disapproval of visitors among the participants owing to fear of Covid 19 lowered the possibility of conducting a supplementation study. Thus the findings of this phase were used as a part of educational intervention models developed to enhance knowledge and inculcate practices, as the results of the baseline survey revealed very low Knowledge on Vitamin D and negative practices concerning Vitamin D among Muslim women.

4.4 Impact Evaluation

4.4.1 Impact of digital health intervention and telephonic counselling on knowledge, attitude and practice

From the Baseline survey low knowledge on Vitamin D and negative practices associated withVitamin D and less interest in using televisions and digital gadgets for accessing health information was evident among the Muslim women. Literature suggests health intervention to have a positive effect on Knowledge, attitude and practice thereby

preventing disease (Chawla*et al*., 2019). Owing to the Covid pandemic, lockdown situation and increase awareness on online mode of education, digital health intervention involving education using digital technology and one to one telephonic counselling were identified to be practicable in the population under study. Thus a comparative study on the effectiveness of these interventions as delivered through the two different strategies were evaluated.

Knowledge, attitude and practice among the selected Muslim women

From the 566 Muslim women studied in the baseline survey, 210 were included randomly for the intervention study of which 11 were dropouts. Knowledge, attitude and practice of these selected women 199 Muslim women were assessed using 22 questions, the responses of which were used for evaluation.Scores were provided for each question, from which overall scores for knowledge, attitude and practice was 9, 3 and 14 respectively. These scores reflected the KAP among the selected Muslim women.

Table XLIII gives the knowledge, attitude and practice among the selected Muslim women.

Table XLIII

Knowledge, Attitude and Practice among the Selected Muslim Women

(N = 199)

Constructs	Scores Allotted	20 -29 years (n == 78)	30 -39 years (n = 68)	40 -45 years (n = 53)	Association between age and overall scores F value
Knowledge about Vitamin D					
Vitamin D levels	1	0.17 ± 0.38	0.12 ± 0.32	0.11 ± 0.32	4.84*
Benefits	2	0.35 ± 0.70	0.13 ± 0.45	0.19 ± 0.52	
Food sources	2	0.39 ± 0.80	0.12 ± 0.44	0.11 ± 0.47	
Importance of sunlight	1	0.27 ± 0.45	0.19 ± 0.40	0.15 ± 0.36	
Fortified foods	3	0.18 ± 0.68	0.04 ± 0.36	0.00	
Overall Knowledge	9	1.35 ± 2.06	0.60 ± 1.55	0.57 ± 1.14	
Attitude towards Vitamin D					
Sunlight	1	0.54 ± 0.50	0.81 ± 0.40	0.77 ± 0.42	4.43**
Fortified foods	1	0.85 ± 0.36	0.85 ± 0.36	0.89 ± 0.32	
Supplements	1	0.69 ± 0.46	0.79 ± 0.41	0.77 ± 0.42	
Overall attitude	3	2.08 ± 0.95	2.46 ± 0.82	2.43 ± 0.75	
Practices facilitating Vitamin D					
Time and duration of sunlight exposure	3	0.79 ± 0.93	1.09 ± 0.89	1.17 ± 0.89	4.12**
The extent of exposure to sunlight	3	1.06 ± 0.98	1.22 ± 0.96	1.42 ± 0.95	
Outdoor physical activity	3	0.17 ± 0.44	0.21 ± 0.53	0.13 ± 0.44	
Parasol usage	2	1.69 ± 0.57	1.85 ± 0.43	1.89 ± 0.38	
Inclusion of Vitamin D rich foods and fortified products	3	0.32 ± 0.88	0.18 ± 0.71	0.21 ± 0.74	
Overall practice	14	4.04 ± 1.60	4.54 ± 1.50	4.81 ± 1.64	

*Significant at 1 %; **Significant at 5 %

From Table XLIII, it is perceptible that the mean knowledge score among the selected women was between 0.57 to 1.35 out of 9 with the better score in the Muslim women of 20 to 29 years showing a reduction of knowledge scores with age. This difference was significant at 5 per cent. From observation, during the survey, even students in other disciplines apart from nutrition and sciences revealed low knowledge levels. This was on par with low Vitamin D knowledge observed among university students in Muslim majority countries (Tariq *et al.*, 2020). The knowledge about Vitamin D levels and fortified foods was the lowest in all the three age groups and none of the Muslim women between of 40 – 45 years knew Vitamin D fortified foods.

Knowledge on the importance of sunlight was comparatively better than the other knowledge scores.

Attitude towards sunlight exposure, fortified foods and Vitamin D supplements was higher (>80%) in Muslim women between the age of 30 to 39 years and 40 to 45years. These women expressed an approving outlook towards healthy practices. While between the age of 20 to 29 years moderate aversion towards going out in sunlight for the sake of maintaining complexion and less preference for medicinal supplements was observed. No significant association between age and attitude was evident. Lack of knowledge, cultural dress practices, minimal outdoor activities, low physical activities and less intake of Vitamin D rich dietary sources and fortified foods are some of the factors identified as cause ofVitamin D deficiency in the present research. Studies have found an association between low levels of Vitamin D and low knowledge and behaviour, suggesting an improvement in knowledge and practices related to the vitamin would support in enhancing the Vitamin D levels (Aljefree*et al*., 2017).

Concerning the practices related to enhancing Vitamin D levels, the overall scores point at better practices among the Muslim women in the age group of 40 to 45 years, followed by women in the age group of 30 to 39 years. However, these scores were very low in the range of 4.04 to 4.81 out of 14. A similar poor practice score of 2.34 out of 7 was observed in a study in Sharjah(Salmanpour*et al*. 2016**).** The use of parasols was found to be very low among the Muslim women in all three age groups. Similarly, practices such as the inclusion of fortified foods, outdoor physical activities, time and duration in the sunlight were also very low. The average scores for time and duration spent in sunlight showed a pattern of increased exposure to sunlight with age. The scores provided for the extent of exposure to sunlight based on the amount of skin exposed was between 1.6 to 1.42 out of 3, which may be due to the Islamic concealing dress practices among these women, these findings was on par with low body exposure to sunlight observed among Muslim girls by Siddiqui (2007). Overall scores showed a significant difference with age.

Impact of digital health intervention and telephonic counselling on knowledge ofVitamin D

The selected 199 Muslim women were divided into three groups before intervention as Group I, Group II and Group III. Group, I was provided with digital health intervention, Group II was given dietary modification using telephonic counselling and Group III was the control group. The lockdown situation and leisure

time after household tasks were more favourable to get the women involved in the intervention program.

Table XLIV and Figure 29 shows the impact of digital health intervention and telephonic counselling on knowledge of Vitamin D.

Table XLIV

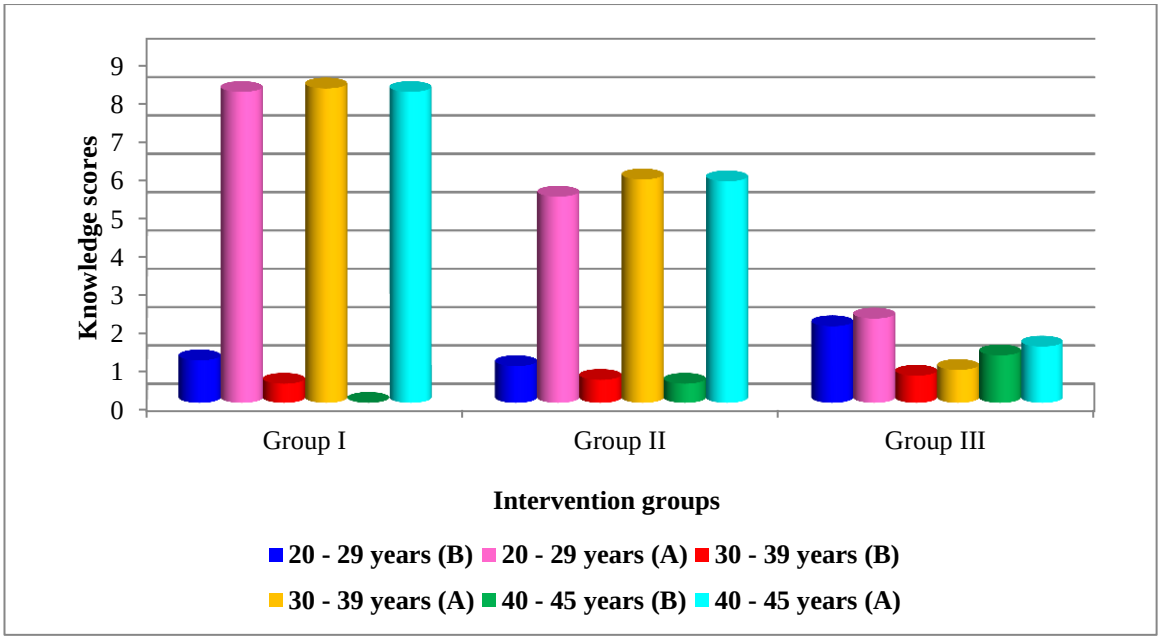
Impact of Digital Health Intervention and Telephonic Counselling on Knowledge of Vitamin D

(N=199)

Age in years	Intervention groups	Aspects	n	Before	After	Df	't' value
20 – 29	**Group I**	Serum levels	27	0.19±0.4	0.96±0.19	-0.78	7.98*
		Benefits		0.22±0.64	1.89±0.32	-1.67	12.75*
		Food sources		0.22±0.64	1.93±0.38	-1.70	12.23*
		Sunlight		0.33±0.48	0.96±0.19	-0.63	6.65*
		Fortified foods		0.15±0.60	2.37±0.79	-2.22	12.95*
		Overall		**1.11±2.15**	**8.11±1.05**	**-7.00**	**15.56***
	Group II	Serum levels	26	0.23±0.43	0.77±0.43	-0.54	4.72*
		Benefits		0.23±0.5	1.19±0.4	-0.96	8.19*
		Food sources		0.23±0.7	1.85±0.5	-1.62	10.25*
		Sunlight		0.23±0.4	0.77±0.4	-0.54	5.40*
		Fortified foods		0.04±0.20	0.81±0.9	-0.77	4.12*
		Overall		**0.96±1.95**	**5.38±1.4**	**-4.42**	**11.15***
	Group III	Serum levels	25	0.08±0.28	0.12±0.3	-0.04	1.00^{NS}
		Benefits		0.60±0.9	0.64±0.9	-0.04	1.00^{NS}
		Food sources		0.72±1.0	0.76±1.0	-0.04	1.00^{NS}
		Sunlight		0.24±0.6	0.32±0.48	-0.08	1.44^{NS}
		Fortified foods		0.36±0.99	0.36±0.99	0.00	-
		Overall		**2.0±2.0**	**2.20±2.0**	**-0.20**	**2.00^{NS}**
30 – 39	**Group I**	Serum levels	24	0.08 ± 0.3	0.92 ± 0.3	-0.83	10.72*
		Benefits		0.17 ±0.6	1.92±0.3	-1.75	14.10*
		Food sources		0.08±0.41	2.0± 0.0	-1.92	23.00*
		Sunlight		0.17±0.38	1.00±0.0	-0.83	10.72*
		Fortified foods		0.00	2.38±0.8	-2.38	15.12*
		Overall		**0.50±1.4**	**8.21±0.8**	**-7.71**	**24.87***

Age in years	Intervention groups	Aspects	n	Before	After	Df	't' value
	Group II	Serum levels	23	0.09±0.3	0.87±0.3	-0.78	8.90*
		Benefits		0.13±0.5	1.35±0.6	-1.22	8.70*
		Food sources		0.09±0.4	1.91±0.4	-1.83	15.20*
		Sunlight		0.17±0.39	0.78±0.4	-0.61	5.85*
		Fortified foods		0.13±0.6	0.91±0.9	-0.78	4.72*
		Overall		**0.61±1.95**	**5.83±1.4**	**-5.22**	**14.68***
	Group III	Serum levels	21	0.19±.4	0.19±0.4	0.00	-
		Benefits		0.10±0.3	0.19±0.51	-0.10	1.45^{NS}
		Food sources		0.19±0.5	0.19±0.5	0.00	-
		Sunlight		0.24±0.4	0.29±0.5	-0.05	1.00^{NS}
		Fortified foods		0.00	0.00	0.00	-
		Overall		**0.71±1.3**	**0.86±1.4**	**-0.14**	$\mathbf{1.83^{NS}}$
40 – 45	**Group I**	Serum levels	18	0.00	1.0 ±0	-1.0	-
		Benefits		0.00	1.83± 0.4	-1.83	20.28*
		Food sources		0.00	2.0±0.0	-2.0	-
		Sunlight		0.00	1.0±0.0	-1.0	-
		Fortified foods		0.00	2.28±1.1	-2.28	25.17*
		Overall		**0.00**	**8.11±1.4**	**-8.11**	**9.00***
	Group II	Serum levels	18	0.17±0.4	0.83±0.4	-0.67	5.83*
		Benefits		0.17±0.4	1.39±0.5	-1.22	9.46*
		Food sources		0.00	1.78±0.7	-1.78	11.7*
		Sunlight		0.17±0.4	0.89±0.3	-0.72	6.65*
		Fortified foods		0.00	0.89±1.2	-0.89	3.19*
		Overall		**0.50±1.0**	**5.78±1.7**	**-5.28**	**11.7***
	Group III	Serum levels	17	0.18±0.4	0.24±0.4	-0.06	1.00^{NS}
		Benefits		0.41±0.8	0.47±0.8	-0.06	1.00^{NS}
		Food sources		0.35±0.8	0.41±0.8	-0.06	1.00^{NS}
		Sunlight		0.29±0.47	0.35±0.5	-0.06	1.00^{NS}
		Fortified foods		0.00	0.00	0.0	-
		Overall		**1.24±1.5**	**1.47±1.4**	**-0.24**	$\mathbf{1.73^{NS}}$

*Significant at 1%; Significant at 5 %; NS – Not significant; Df - the difference



(B) – Before intervention (A) – After intervention

Figure 29: Impact of Digital Health Intervention and Telephonic Counselling on Knowledge of Vitamin D

A significant increase in knowledge after providing intervention among the Muslim women in all three age groups was observed. Concerning Group I and Group II, the increase in knowledge comparing knowledge scores before and after the intervention was significant at one per cent for all the aspects. The difference in mean overall knowledge score increase in Group I was 7.00 (20–29years), 7.71(30–30 years) and 8.11(40-45 years) and in Group II it was 4.42 (20–29years), 5.22 (30–30 years) and 5.28 (40-45 years). In Group III, a difference of 0.20 (20–29years), 0.14 (30–30 years) and 0.24 (40 -45 years) were apparent. From these values, it is obvious that the digital intervention was more effective in increasing the knowledge compared to telephonic counselling, which was on par with literature evidence demonstrating the effectiveness of digital intervention (Halse*et al.*, 2019; Tudor *et al.*, 2019) This may also be due to affinity of the present-day towards the digital technology (González-Patiño and Esteban-Guitart, 2019) and also the Muslim women mentioned that digital videos and memes facilitated repeated viewing, which may not be possible with telephonic counselling. When examining the improvement in different areas of knowledge, the increase in knowledge about fortified foods was more in Group I compared to Group II. An increase in the scores among Group III was distinguishable, but it was not significant. Thus

digital education offered for a period of eight days can be effectively used to improve knowledge irrespective of age.

Impact of digital health intervention and telephonic counselling on attitude towards Vitamin D

Table XLV shows the Impact of digital health intervention and telephonic counselling on attitude towards Vitamin D.

Table XLV
Impact of Digital Health Intervention and Telephonic Counselling on Attitude towards Vitamin D

(N=199)

Age in years	Intervention groups	Attitude	N	Before	After	Df	't' value
20 – 29	**Group I**	Sunlight	**27**	0.67±0.5	0.85±0.4	-0.19	1.99^{NS}
		Fortified foods		0.93±0.3	0.96±0.2	-0.04	1.00^{NS}
		Supplements		0.63±0.5	0.74±0.5	-0.11	1.36^{NS}
		Overall		**2.22± 0.8**	**2.56±0.6**	**-0.33**	**2.79****
	Group II	Sunlight	**26**	0.54±0.5	0.92±0.3	-0.38	3.43*
		Fortified foods		0.85±0.4	0.88±0.3	-0.04	0.37^{NS}
		Supplements		0.69±0.5	0.88±0.3	-0.19	2.44**
		Overall		**2.08±0.9**	**2.69±0.6**	**-0.62**	**3.9***
	Group III	Sunlight	**25**	0.40±0.5	0.48±0.5	-0.8	1.44^{NS}
		Fortified foods		0.76±0.4	0.80±0.4	-0.4	1.0^{NS}
		Supplements		0.76±0.4	0.76±0.4	0.0	-
		Overall		**1.92±1.12**	**2.04±1.02**	**-0.12**	**1.81^{NS}**
30 – 39	**Group I**	Sunlight	**24**	0.83±0.4	0.88±0.3	-0.04	0.57^{NS}
		Fortified foods		0.83±0.4	0.96±0.2	-0.13	1.81^{NS}
		Supplements		0.75±0.4	0.88±0.3	-0.13	1.37^{NS}
		Overall		**2.42±0.9**	**2.71±0.6**	**-0.29**	**1.77^{NS}**
	Group II	Sunlight	**23**	0.83±0.4	0.91±0.3	-0.09	1.45^{NS}
		Fortified foods		0.83±0.4	0.87±0.3	-0.04	0.57^{NS}
		Supplements		0.74±0.5	0.78±0.4	-0.04	1.00^{NS}
		Overall		**2.39±0.7**	**2.57±0.7**	**-0.17**	**2.15****
	Group III	Sunlight	**21**	0.76±0.4	0.81±0.4	-0.05	1.00^{NS}
		Fortified foods		0.90±0.3	0.95±0.2	-0.05	1.00^{NS}
		Supplements		0.90±0.3	0.95±0.2	-0.05	1.00^{NS}
		Overall		**2.57±0.8**	**2.71±0.6**	**-0.14**	**1.37^{NS}**
40 – 45	**Group I**	Sunlight	**18**	0.89±0.3	1.00±0.0	-0.11	1.46^{NS}
		Fortified foods		0.89±0.3	0.94±0.2	-0.06	0.57^{NS}
		Supplements		0.78±0.43	0.89±0.3	-0.11	1.46^{NS}
		Overall		**2.56±0.3**	**2.83±0.4**	**-0.28**	**1.76^{NS}**
	Group II	Sunlight	**18**	0.72±0.5	0.94±0.2	-0.22	1.72^{NS}
		Fortified foods		0.89±0.4	1.0±0.0	-0.11	1.46^{NS}
		Supplements		0.67±0.5	0.72±0.5	-0.06	1.00^{NS}
		Overall		2.28±0.8	2.50±0.9	-0.22	0.94^{NS}
	Group III	Sunlight	**17**	0.71±0.5	0.82±0.4	-0.12	1.46^{NS}
		Fortified foods		0.88±0.3	0.94±0.2	-0.06	1.00^{NS}
		Supplements		0.88±0.3	0.94±0.2	-0.06	1.00^{NS}
		Overall		**2.47±0.9**	**2.71±0.6**	**-0.24**	**1.73^{NS}**

*Significant at 1%; Significant at 5 %; NS – Not significant; Df - difference

The findings of the current study revealed that there was a significant increase in overall attitude towards sunlight, fortified foods and supplements, among Muslim women in between 20 to 29 years of age in both the intervention groups. In Group II among Muslim women between the age of 20 to 29 years also a significant increase in attitude towards sunlight was observed, this may be attributed to a change in attitude after intervention among the women who showed a negative attitude towards the sunlight to preserve complexion as discussed in Table XLIII. There was no significant difference in attitude scores after intervention among Muslim women in both 40 to 45 years and 30 to 39 years age group, except in overall scores among Muslim women in Group II. This may be because the majority (>80%) of the Muslim women in this age group (30-45 years) had a positive attitude towards Vitamin D even before the intervention. hence a significant difference in attitude was not obvious. The changes in attitude among the Muslim women in Group III was not significant.

Impact of digital health intervention and telephonic counseling on practices enhancing Vitamin D

Table XLVI and Figure 30shows the impact of digital health intervention and telephonic counseling on practices enhancing Vitamin D.

Table XLVI

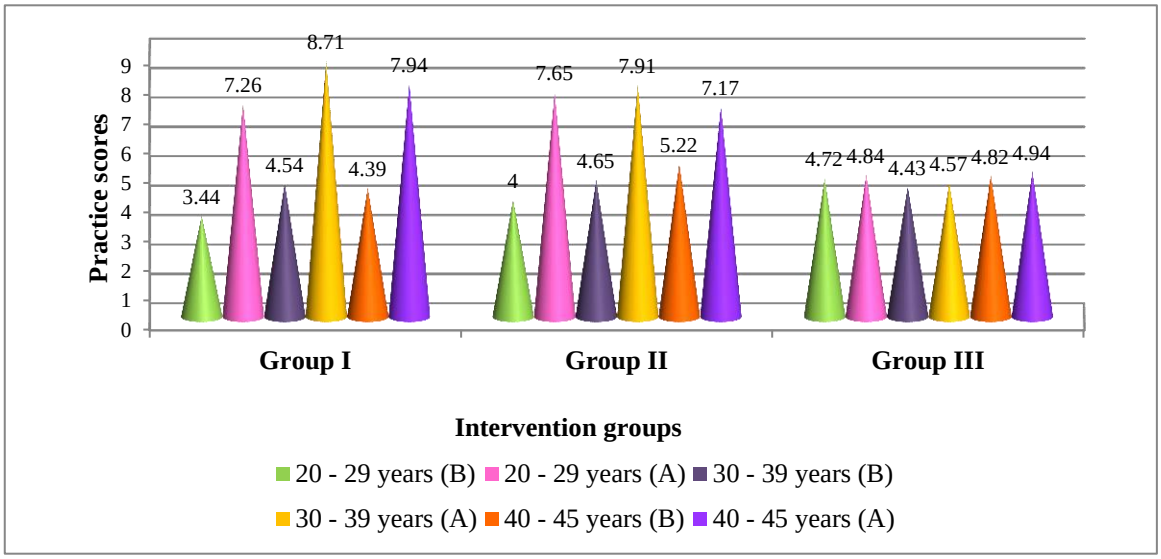
Impact of Digital Health Intervention and Telephonic Counselling on Practices Enhancing Vitamin D

(N=199)

Age in years	Intervention groups	Practices	N	Before	After	Df	't' value
20 – 29	**Group I**	Sunlight exposure	**27**	0.63±0.9	1.70±1.1	-1.07	4.40*
		Extent of exposure		0.74±0.9	1.41±1.2	-0.67	2.79**
		physical activity		0.15±0.5	0.33±0.7	-0.19	1.99^{NS}
		Parasol usage		1.70±0.5	1.81±0.6	-0.11	0.90^{NS}
		Intake of dietary sources		0.22±0.80	2.0±1.27	-1.78	5.86*
		Overall		**3.44±1.4**	**7.26±2.5**	**-3.81**	**6.27***
	Group II	Sunlight exposure	**26**	0.81±0.9	1.54±0.7	-0.73	3.24*
		Extent of exposure		1.15±0.97	2.12±1.2	-0.96	5.35*
		physical activity		0.16±0.5	0.64±1.1	-0.48	2.39**
		Parasol usage		1.54±0.65	1.77±0.7	-0.23	2.29**
		Intake of dietary sources		0.35±0.98	1.62±1.1	-1.27	5.46*
		Overall		**4.0±1.4**	**7.65±2.6**	**-3.65**	**8.30***

	Group III	Sunlight exposure	**25**	0.96±1.02	1.0±1.0	-0.04	1.0^{NS}
		Extent of exposure		1.32±0.99	1.36±1.0	-0.04	1.0^{NS}
		physical activity		0.20±0.4	0.24±0.5	-0.04	1.0^{NS}
		Parasol usage		1.84±0.5	1.84±0.5	0.00	-
		Intake of dietary sources		0.40±1.8	0.40±1.8	0.00	-
		Overall		**4.72±1.8**	**4.84±1.8**	**-0.12**	$\mathbf{1.81^{NS}}$
30 – 39	**Group I**	Sunlight exposure	**24**	1.08 ±0.9	1.92±1.0	-0.83	3.61*
		Extent of exposure		1.33±1.0	1.96±1.0	-0.63	2.46**
		physical activity		0.17±0.5	0.63±1.1	-0.46	2.11**
		Parasol usage		1.83±0.5	1.88±0.5	-0.04	1.00^{NS}
		Intake of dietary sources		0.13±0.6	2.33±1.1	-2.21	9.48*
		Overall		**4.54±1.4**	**8.71±3.0**	**-4.17**	**7.31***
	Group II	Sunlight exposure	**23**	1.22±1.0	1.83±0.9	-0.61	3.48*
		Extent of exposure		1.00±1.0	1.52±1.4	-0.52	2.31**
		physical activity		0.30±0.6	0.65±0.9	-0.13	2.34**
		Parasol usage		1.87±0.5	2.0±0.0	-1.65	1.37^{NS}
		Intake of dietary sources		0.26±0.9	1.91±1.2	-3.26	5.53*
		Overall		**4.65±1.6**	**7.91±2.5**	**-3.26**	**5.94***
	Group III	Sunlight exposure	**21**	0.95±0.8	0.95±0.8	0.00	-
		Extent of exposure		1.33±0.9	1.38±0.9	-0.05	1.00^{NS}
		physical activity		0.14±0.5	0.19±0.5	-0.05	1.00^{NS}
		Parasol usage		1.86±0.4	1.86±0.4	0.00	-
		Intake of dietary sources		0.14±0.7	0.19±0.7	-0.05	1.00^{NS}
		Overall		**4.43±1.6**	**4.57±1.6**	**-0.14**	$\mathbf{1.83^{NS}}$
40 – 45	**Group I**	Sunlight exposure	**18**	1.44±0.92	2.00±0.8	-0.56	2.75**
		Extent of exposure		1.00±1.0	1.78±.73	-0.78	3.29*
		physical activity		0.11±0.3	0.61±1.0	-0.50	2.30**
		Parasol usage		1.83±0.5	1.94±0.2	-0.11	1.46^{NS}
		Intake of dietary sources		0.00	1.61±1.2	-1.61	5.50*
		Overall		**4.39±1.5**	**7.94±2.3**	**-3.56**	**6.85***
	Group II	Sunlight exposure	**18**	1.0±0.97	1.22±1.1	-0.22	0.75^{NS}
		Extent of exposure		1.61±0.9	2.06±1.1	-0.44	2.20**
		physical activity		0.17±0.51	0.50±0.9	-0.33	1.84^{NS}
		Parasol usage		1.94±0.2	2.0±0.0	-0.06	1.00^{NS}
		Intake of dietary sources		0.50±1.2	1.39±1.1	-0.89	2.12**
		Overall		**5.22±±1.9**	**7.17±2.6**	**-1.94**	**3.17***
	Group III	Sunlight exposure	**17**	1.06±0.8	1.06±0.8	0.00	-
		Extent of exposure		1.65±0.8	1.65±0.8	0.00	-
		physical activity		0.12±0.5	0.18±0.5	-0.06	1.00^{NS}
		Parasol usage		1.88±0.3	1.88±0.3	0.00	-
		Intake of dietary sources		0.12±0.5	0.18±0.5	-0.06	1.00^{NS}
		Overall		**4.82±1.4**	**4.94±1.4**	**-0.12**	$\mathbf{1.46^{NS}}$

*Significant at 1%; Significant at 5 %; NS – Not significant; Df - difference



(B) – Before intervention (A) – After intervention

Figure 30: Impact of Digital Health Intervention and Telephonic Counselling on Practices Enhancing Vitamin D

Considering the unique lifestyle and cultural practices among Muslim women. To provide solutions within the cultural limitation. Sunlight exposure within the home premises was promoted through the intervention program with guidance for effective sunlight exposure It was discernible that the difference in overall practice scores was 3.81 (20 – 29 years), 4.17(30 – 39 years) and 3.56 (40 – 45 years) respectively, While the difference in Group II was 3.65 among Muslim women in the age group of 20 to 29 years, 3.26 in 30 to 39 years and 1.94 in the age group of 40 to 45 years. This showed an increase in overall practice among all three age groups in Group I followed by Group II, exhibiting minor differences except among the Muslim women in between40 to 45 years of age in Group II, where the increase in practice was minimal.

In the case of duration of sunlight exposure and extent of exposure, the difference before and after the intervention was statistically significant in both the intervention groups in the age group of 20 to 29 years and 30 to 39 years. Among Muslim women in Group II between 40 to 45 years of age, the difference in sunlight exposure was not significant after the intervention, while the extent of exposure was significant. This increase in the extent of exposure was due to the practice of exposing to sunlight in the home premises after intervention and also the availability of sunlight in windows, balconies and private spaces, The suggestions of sunlight exposure in private space while cutting and chopping vegetables, drying hair and teaching children was favoured as lack of time and cultural norms were the two major reasons observed to contribute to low sunlight exposure among these women. These results were in converse with a study

where low availability of private spaces in modern buildings hindered the sunlight exposure among Muslim women(Christie and Mason, 2011; Aljefree *et al*., 2017). The difference of increase in score for duration and time of sunlight exposure was between 0.56 to 1.7 among the Muslim women. Sunlight exposure being the major source of Vitamin D may have a direct effect on Vitamin D levels. supporting studies conducted in Coimbatore among college girls have demonstrated an increase of 1.03ng/ml in Vitamin D levels following sunlight exposure for 45 minutes for a period of 50 days (Francis and Balasasirekha, 2020).

Regarding the physical activity among Muslim women between 20-29 years, presentin Group II astatistically significant improvement in physical activities was evident. Among Muslim women in the age group of 30 to 39 years, there was a significant increase in physical activity in both the intervention group, But among women in 40 to 45 years increase was not significant. The intake of Vitamin D rich dietary sources and fortified foods had increased significantly after intervention in both the intervention groups irrespective of age. The changes in attitude among the Muslim women in Group III was not significant. These findings disclosed an average increase in practices observed on evaluation after a period of two months among the Muslim women in both Group I and Group II. This average increase in interest in Vitamin D enhancing practices may be due to the favorability of lockdown situations, knowledge provided on the role of Vitamin D in enhancing immunity to fight Covid 19 and a positive attitude towards healthy practices within cultural norms. Regular and improved practices could help in enhancing the Vitamin D levels, thereby preventing Vitamin D deficiency.

4.4.2 Impact of digital health intervention and dietary modification on food and nutrient intake of the Muslim women

The dietary modification was suggested only for the 67 participants in Group II. Participants in Group I and Group III were not suggested with specific dietary modifications.Twenty four hour three day dietary recall intake data before and after the intervention was collected providing an interval of two months in all the 199 Muslim women, from which the impact of digital intervention and suggestion of dietary modification on the diet of the Muslim women was evaluated.

Impact of digital health intervention and dietary modification on food intake of the Muslim women (20 -29years)

Table XLVII and Figure 25 depicts the impact of digital health intervention and dietary modification on food intake of Muslim women (20-29years).

Table XLVII

Impact of Digital Health Intervention and Dietary ModificationonFood Intake of the Muslim Women(20 -29years)

(N =78)

Food groups	Group I (n=27)				Group II (n=26)				Group III(n = 25)			
	Before	**After**	**Df**	**'t' value**	**Before**	**After**	**Df**	**'t' value**	**Before**	**After**	**Df**	**'t' value**
Cereals(g)	305.8± 61.4	299.9± 58.2	5.91	1.13^{NS}	298.0± 52.5	263.9± 50.1	34.1	3.05*	280.1± 59.3	299.6± 43.9	-19.51	2.15**
Pulses (g)	48.09± 30.36	49.27± 24.30	-1.18	0.16^{NS}	52.7± 27.1	58.9± 18.5	-6.2	1.12^{NS}	46.64 ± 19.4	37.42± 23.7	9.22	1.44^{NS}
Green leafy vegetables (g)	19.55± 12.0	15.75± 6.66	3.80	1.65^{NS}	15.6± 9.5	22.01± 10.6	- 6.41	2.12**	19.4± 13.8	17.7± 10.8	1.70	0.49^{NS}
Other vegetables(g)	19.5± 16.8	24.5 ± 16.42	-4.98	1.14^{NS}	27.45± 23.7	50.97 ± 29.1	- 23.5	3.77*	27.12± 20.22	21.73± 20.2	5.59	1.04^{NS}
Milk and milk products(g)	215.9± 94.6	176.4± 109.7	39.5 1	1.80^{NS}	215.8± 97.07	224.42± 69.1	- 8.62	0.57^{NS}	197.1± 85.63	236.4± 113.0	-39.40	1.26^{NS}
Flesh foods(g)	71.84± 38.0	72.98± 44.23	-1.14	0.10^{NS}	69.9±36. 4	82.4±38 .7	- 12.5	1.53^{NS}	78.1±58 .0	65.6± 38.20	12.50	0.93^{NS}
Fats and oil (g/ml)	11.25 ± 4.76	9.50 ± 5.82	1.76	1.36^{NS}	12.75±5. 53	11.34± 3.71	1.41	1.41^{NS}	11.3±5. 77	13.93± 5.95	-2.64	1.86^{NS}

*Significant at 1%; Significant at 5 %; NS – Not significant; Df - difference

In the age group of 20 to 29 years the intake of all the foods except flesh foods and cereals was deficit when compared to ICMR (2010) recommended dietary allowance. In Group II, there was a highly significant reduction in cereal consumption, whereas in Group I the difference was not significant and in Group III an excess consumption of cereals was noticeable. Similarly, a significant increase in the green leafy vegetable and other vegetable consumption was evident in Group II compared to Group I and Group III, where the difference was not significant. Also, no significant increase in the intake of foods such as pulses, milk and milk products, fresh foods and fats and oils was obvious among the Muslim women in the age group of 20 to 29 years. The increase in food intake was observed only in Group II and no significant increase was seen in the other two groups in the age group of 20 to 29 years.

Impact of digital health intervention and dietary modificationon nutrient intake of the Muslim women (20 -29years)

Table XLVIII depicts the Impact of digital health intervention and dietary modification on nutrient intake of Muslim women(20 -29years).

Table XLVIII

Impact ofDigital HealthIntervention and Dietary Modificationon Nutrient Intake of the Muslim Women (20 -29years)

(N =78)

Nutrients	Group I(n=27)				Group II (n= 26)				Group III (n= 25)			
	Before	After	Df	't' Value	Before	After	Df	't' value	Before	After	Df	't' Value
Energy (kcal)	1919.6± 392.6	2052.8± 296.1	-133.2	1.85^{NS}	2017.6± 395.8	2085.6± 279.8	-68.0	0.89^{NS}	1900.0± 2.99.9	1993.8 ±295.1	-93.8	1.11^{NS}
Protein (g)	92.5±31.6	92.2±27.1	0.37	0.05^{NS}	80.7± 28.1	112.7 ± 32.2	-31.9	3.44*	94.7 ±25.2	95.7 ± 28.3	-1.0	0.14^{NS}
Fat (g)	44.4±12.9	51.8±12.7	-7.39	2.22**	51.5 ± 13.5	49.8± 9.8	1.68	0.55^{NS}	46.83 ± 9.8	50.97± 10.8	-4.14	1.38^{NS}
Calcium(mg)	721.8± 331.4	845.8± 281.8	-124.0	1.56^{NS}	831.9± 339.5	929.7± 409.4	-9.72	0.89^{NS}	719.0 ± 195.9	770.4± 210.8	-43.9	0.66^{NS}
Iron(mg)	14.9±3.8	18.5±5.5	-3.62	3.26*	16.9±7.0	21.6 ±3.8	-2.86	1.75^{NS}	16.29±1 6.34	16.34± 3.8	-0.06	0.06^{NS}
Vitamin D2(mcg)	40.7±24.1	49.5±13.7	-8.8	1.59^{NS}	44.8 ± 19.61	49.05± 18.0	-4.24	0.09^{NS}	37.72± 14.3	36.33± 12.9	1.39	0.39^{NS}
Vitamin D3(mcg)	0.58±0.4	2.15±5.8	-1.6	1.39^{NS}	1.36± 3.7	1.35± 1.07	0.00	0.01^{NS}	0.61 ± 0.45	0.71± 0.59	-0.10	0.67^{NS}
25 (OH)Vitamin D (mcg)	0.05±0.06	0.05±0.07	0.00	0.26^{NS}	0.05 ± 0.1	0.08±0.1	-0.03	1.52^{NS}	0.02 ±0.03	0.05± 0.09	-0.03	1.74^{NS}
Total Vitamin D(mcg)	41.28± 24.2	51.7±13.0	-10.42	1.92^{NS}	46.2± 19.9	50.5± 18.2	-4.27	-0.91^{NS}	38.35±1 4.23	37.09± 13.03	1.26	0.35^{NS}

*Significant at 1%; Significant at 5 %; NS – Not significant; Df - difference

The intake of energy, protein, fats and Vitamin D_2 was excess compared to RDA suggested by ICMR (2020). This excess in energy, protein and fat may be due to excess consumption of cereals and flesh foods observed in Table XLVII and the excess of Vitamin D_2contributed by high Vitamin D_2Content noticed in cereals such as wheat and ragi, pulses and spices (Longvah*et al*., 2017) which are present in the daily diet of the Muslim women. Overall there was no significant increase in Vitamin D intake before and after intervention in all three groups. The increase in iron and fat along with Vitamin D_3 intake was observed in Group I, this increase may be due to the replacement of normal meat with organ meat observed during the survey as suggested during the digital intervention. An increase in iron intake due to an increase in green leafy vegetables is noticeable in Group II, But the increase in levels was not significant. Hence, no significant increase in Vitamin D intake could be brought about through dietary modification among Muslim women in the age group of 20 to 25 years.

Impact of digital health intervention and dietary modification on food intake of the Muslim women (30 -39years)

Table XLIX depicts the Impact of digital health intervention and dietary modification on the food intake of Muslim women (30 – 39 years).

Table XLIX

Impact of Digital Health Intervention and Dietary Modification on Food Intake of the Muslim Women (30 -39years)

(N = 68)

Food groups	Group I(n= 24)				Group II (n = 23)				Group III (n = 21)			
	Before	**After**	**Df**	**'t' value**	**Before**	**After**	**Df**	**'t' value**	**Before**	**After**	**Df**	**'t' value**
Cereals(g)	329.27 ± 49.3	323.9± 49.5	5.35	0.93^{NS}	298.9± 87.7	290.9± 57.9	8	0.66^{NS}	302.0± 47.2	303.9 ±43.5	-1.86	0.36^{NS}
Pulses (g)	45.45± 26.48	39.75± 20.12	5.70	0.74^{NS}	49.71± 26.3	61.3± 126.7	-11.6	1.54^{NS}	50.3±24.6	45.6± 28.31	4.70	0.61^{NS}
Green leafy vegetables (g)	16.49± 6.2	20.98± 8.5	-4.48	1.93^{NS}	17.1± 12.5	27.35± 12.5	-10.3	2.90*	16.3± 7.48	21.1±13.3	-4.75	1.40^{NS}
Other vegetables(g)	17.07± 15.3	22.4±1 8.53	-5.29	1.07^{NS}	22.0± 21.4	43.19± 36.6	-21.2	2.74**	22.13± 21.1	23.1± 17.6	-0.98	0.18^{NS}
Milk and milk products(g)	248.9± 64.63	228.9± 111.6	20.08	0.68^{NS}	197.2± 117.1	190.3± 83.6	6.9	0.42^{NS}	205.1± 124.8	261.4±12 3.9	-57.3	1.46^{NS}
Flesh foods(g)	74.77± 46.9	74.12± 39.6	0.65	0.05^{NS}	96.85± 73.4	108.72 ± 52.8	-11.9	1.08^{NS}	74.5±47.7	75.9±42.7	-1.47	0.11^{NS}
Fats and oil (g/ml)	15.38± 3.84	13.65± 7.6	1.73	0.99^{NS}	11.97± 5.75	11.0 ± 5.19	0.97	0.83^{NS}	13.7±5.9	13.0±4.36	0.66	0.36^{NS}

*Significant at 1%; Significant at 5 %; NS – Not significant; Df - difference

Similar to the Muslim women between the age of 20 to 29 years among the Muslim women of 30 – 39years there was a deficit in consumption of all foods except cereals and animal foods compared to ICMR (2010), also there was a significant increase in the green leafy vegetable and other vegetable consumption among Muslim women in Group II compared to other groups. Also, an increase in flesh food and pulses intake was observed from the difference value, but it was not statistically significant. The increase in pulses consumption 61.3± 126.7after intervention met the daily pulse requirement of 60 g suggested by ICMR. Overall there were significant differences in some food intake among the Muslim women in Group II compared with the two other groups.

Impact of digital health intervention and dietary modification on nutrient intake of the Muslim women (30 -39years)

Table L depicts the impact of digital health intervention and dietary modification on nutrient intake of theMuslim women (30 – 39 years).

Table L

Impact ofDigital Health Intervention andDietary Modification on Nutrient Intake of the Muslim Women (30 -39years)

(N =68)

Nutrients	Group I(n = 24)				Group II (n = 23)				Group III (n = 21)			
	Before	After	Df	't' value	Before	After	Df	't' value	Before	After	Df	't' value
Energy (kcal)	2074.9± 241.7	2045.7± 303.0	29.22	0.44^{NS}	1995.9± 37.33	2094.3± 230.7	-98.5	1.28^{NS}	1998.3 ± 236.3	2102.0±243.8	-103.6	1.79^{NS}
Protein (g)	107.4± 25.2	109.9± 28.0	-2.6	0.40^{NS}	82.2± 37.9	130±28.1	-48.8	0.18*	98.37± 20.98	108.0± 25.9	-9.7	1.29^{NS}
Fat (g)	51.1±9.6	49.41± 10.4	1.7	0.70^{NS}	49.3± 23.1	56.58± 11.1	-7.27	0.34*	47.7±8.02	52.9± 10.6	-5.16	1.67^{NS}
Calcium(mg)	810.3±214.4	798.3± 281.9	12.04	0.20^{NS}	788.4± 379.5	812.3± 173.8	-23.9	0.30^{NS}	793.8± 215.8	906.0± 340.1	-112.1	1.31^{NS}
Iron(mg)	16.0 ± 3.7	17.53± 4.0	-1.54	1.48^{NS}	16.94± 7.04	21.6± 3.76	-4.65	2.78^{NS}	17.40±5.5	17.73±3.22	-0.34	0.28^{NS}
Vitamin D2(mcg)	36.6±11.1	40.9±17.2	-4.32	1.03^{NS}	32.0± 14.79	56.14± 18.4	-24.1	5.14*	39.1± 14.9	33.61± 10.47	5.44	1.23^{NS}
Vitamin D3(mcg)	1.07±1.07	0.75± 0.80	0.32	1.39^{NS}	1.06± 0.07	1.14± 0.72	-0.08	0.30^{NS}	0.93±1.04	0.73± 0.59	0.20	0.99^{NS}
25 (OH)Vitamin D(mcg)	0.16±0.35	0.05±0.10	0.11	1.47^{NS}	0.16± 0.28	0.10± 0.11	0.06	0.88^{NS}	0.06± 0.09	0.19± 0.39	-0.13	1.39^{NS}
Total Vitamin D(mcg)	37.81±11.0	41.7± 14.09	-3.9	0.93^{NS}	33.2± 15.0	57.37± 18.38	-24.1	5.08*	40.05± 15.0	34.53± 10.6	5.52	1.24^{NS}

*Significant at 1%; Significant at 5 %; NS – Not significant; Df - difference

The nutrient intake of the Muslim women between 30 to 39 years before intervention showed an excess intake of energy, protein, fats and Vitamin D compared to ICMR (2020) recommendations similar to the Muslim women in the age group of 20 to 29 years. An increase in protein, fats and Vitamin D_2 was observed among Muslim women in the age group of 30 to 39 years in Group II. This increase may be due to an increase in intake of pulses and flesh foods discernible from Table XLIX. The difference in iron intake was also more in Group II compared to the other two groups, but not statistically significant. These findings suggest that a moderate increase in Vitamin D_2 intake could be attained through the suggestion of dietary modification among Muslim women in between the age of 30 to 39 years.

Impact of digital health intervention and dietary modification on food intake of the Muslim women (40 -45years)

Table LI depicts the impact of digital health intervention and dietary modification on food intake of the Muslim women (40-45years).

Table LI

Impact of Digital Health Intervention and Dietary Modification on Food Intake of the Muslim Women (40 -45years)

(N = 53)

Food groups	Group I(n = 18)				Group II (n = 18)				Group III (n = 17)			
	Before	After	Df	't' value	Before	After	Df	't' value	Before	After	Df	't' value
Cereals(g)	343.6 ± 39.9	333.7± 40.3	10.9	2.38**	320.6±53.9	311.7± 47.9	8.9	0.97NS	340.4± 43.3	345.3± 28.5	-4.89	0.54NS
Pulses (g)	44.28± 20.5	50.03± 18.04	-5.75	0.62NS	58.73±35.1	56.9±23.9	1.83	0.20NS	43.32± 16.1	33.0± 14.5	10.3	1.68NS
Green leafy vegetables (g)	18.04± 7.44	17.17 ± 6.65	0.88	0.45NS	14.11±9.8	17.13± 8.7	-3.02	0.88NS	20.3± 11.0	19.2± 10.0	1.15	0.35NS
Other vegetables(g)	22.01± 20. 83	21.86± 15.1	0.14	0.02NS	30.12± 26.08	38.02± 16.4	-7.9	0.89NS	35.23± 28.6	20.2±14.9	15.0	1.69NS
Milk and milk products(g)	269.5± 88.9	195.0± 110.0	74.5	2.41**	205.5±78.9	227.4± 71.9	-21.9	1.29NS	249.7± 119.5	217.2± 104.1	32.55	0.78NS
Flesh foods(g)	75.5±42.7	82.8± 28.9	-7.3	0.57NS	73.4±52.36	78.51± 29.8	-5.11	0.37NS	83.0± 34.2	102.9± 45.8	-19.9	1.30NS
Fats and oil (g/ml)	17.14± 5.5	13.33± 6.46	3.81	2.06NS	14.58± 5.83	11.13± 3.1	3.45	2.69**	14.4± 7.3	14.2±5.7	0.24	0.11NS

*Significant at 1%; Significant at 5 %; NS – Not significant; Df - difference

Among the Muslim women in the age group of 40 to 45 years, all the food intake was deficient except cereals and flesh foods, similar to the observation in the other two age groups In Group I a significant reduction in cereal intake and milk and milk products was observed. This was due to a reduction in coffee and tea intake observed during the dietary survey among women of this age group. In Group II, there was an increase in green leafy vegetable, milk and milk products and other vegetable intakes detectable from the difference in consumption before and after the intervention compared to the other two groups. The increase in fat intake was significant but much below RDA (ICMR, 2010). The results showed that dietary modification had a moderate effect in increasing the consumption of certain foods among Muslim women in the age group of 40 to 45 years.

Impact of digital health intervention and dietary modification on nutrient intake of the Muslim women (40 -45years)

Table LII depicts the impact of digital health intervention and dietary modification on nutrient intake of Muslim women (40-45years).

Table LII

Impact of Digital Health Intervention and Dietary Modification on Nutrient Intake of the Muslim Women (40 -45years)

(N =53)

Nutrients	Group I (n = 18)				Group II (n = 18)				Group III (n = 17)			
	Before	**After**	**Df**	**'t' value**	**Before**	**After**	**Df**	**'t' value**	**Before**	**After**	**Df**	**'t' value**
Energy (kcal)	2226.5± 228.6	2143.4± 189.7	83.06	1.26^{NS}	2185.6 ± 323.1	2052,7± 235.7	132.9	1.99^{NS}#	2182.1± 201.6	2131.1± 178.1	50.92	0.76^{NS}
Protein (g)	117.0± 19.9	110.2± 21.9	6.78	1.06^{NS}	87.19± 27.05	123.9±19. 76	-36.8	5.02*	96.35± 25.38	106.1± 9.84	-9.77	1.83^{NS}
Fat (g)	53.63± 7.01	53.32± 10.16	0.31	0.09^{NS}	52.13± 15.9	49.2± 8.01	2.94	0.70^{NS}	52.7±9.2	52.69± 9.65	0.00	0.00^{NS}
Calcium(mg)	905.1±28 6.6	777.78±1 47.8	127.4	1.76^{NS}	798.8 ±119.7	847.0± 132.6	-48.2	1.35^{NS}	828.1±2 37.6	857.53± 427.1	29.41	0.27^{NS}
Iron(mg)	17.56±4. 3	18.96± 3.8	1.43	1.01^{NS}	19.5 ± 5.72	18.03± 2.94	1.48	0.98^{NS}	18.69± 6.4	17.72± 6.29	0.97	0.44^{NS}
Vitamin D2(mcg)	41.65± 17.35	43.68±17. 3	-2.03	0.38^{NS}	43.4± 17.0	51.9± 14.8	-8.57	2.04^{NS}	42.69± 13.8	40.23 ±15.8	2.46	0.48^{NS}
Vitamin D3(mcg)	0.74± 0.51	1.01± 0.75	-0.26	1.17^{NS}	1.01± 1.04	2.40± 5.7	-1.39	1.18^{NS}	0.78± 0.7	1.35± 1.31	-0.57	1.57^{NS}
25 (OH) Vitamin D(mcg)	0.07± 0.15	0.10± 0.16	-0.03	0.48^{NS}	0.08± 0.13	0.09± 0.13	-0.02	0.44^{NS}	0.07± 0.14	0.10± 0.13	-0.02	0.46^{NS}
Total Vitamin D (mcg)	42.47± 17.4	44.78± 17.28	-2.32	0.44^{NS}	44.45± 17.07	54.42± 14.17	-9.98	2.32**	43.6± 13.9	41.68± 16.14	1.86	0.36^{NS}

*Significant at 1%; Significant at 5 %; NS – Not significant; # - Nearly significant;Df - difference

The nutrient intake among the Muslim women between the age of 40 to 45 years showed a significant increase in energy intake which could be attributed to an increase in fats and oil intake observed in the food intake Table LI. There was also a considerable increase in total Vitamin D intake in Group II, which was significant at 5 per cent compared to the other two groups.Hence, a significant difference in Vitamin D intake could be brought about among Muslim women between the age of 40 to 45 years through dietary modification.

From the above results, it is evident that in Group II there were considerable differences in consumption of green leafy vegetables and other vegetables, but the quantity of consumption after the intervention was much lower in comparison with the food recommendations(RDA). Further, there was no significant increase in consumption of milk and milk products, pulses which are also rich sources of Vitamin D and calcium was noticeable. Among the nutrients, an increase in protein, fat and Vitamin D_2 was observed while the increase in calcium consumption was below daily requirement even after intervention. Siddiqui (2007) noticed a similar low calcium intake among Muslim girls. From the observation, during the survey, an increase in the inclusion of Mushrooms, organ meat, fish, ragi and soya were observed, which might be the reason for the increase in Vitamin D intake noticed in the present study.

The finding of that digital health intervention could bring about a significant increase in overall knowledge and practice among Muslim women of all age groups compared to telephonic counselling. The attitude towards Vitamin D was good even before intervention. A significant increase in knowledge and attitude could bring about only an average increase in practice. Thus, only the sustainability of the practices would determine its effectiveness. The dietary changes between groups suggested better intake of green leafy vegetables and other vegetables (20 -39 years) and pulses (30 -39 years) among the Muslim women in Group II, but the post increase values were lower than daily requirements. Among the nutrients, a considerable increase in Vitamin D_2 in the age group of 30 to 45years was achievable with dietary modification compared to digital education. But the Vitamin D_2 is less bioavailable compared to Vitamin $D_{.3.}$ Overall dietary modification suggested showed difference butwas not found to be considerably effective. The effectiveness might be enhanced by increasing the period of dietary modification. It may be observed from the study that there was difference in Vitamin D intake in both Group I and Group II but the difference was significant in Group

IIsuggesting one to one dietary modification to have better effect in improving the intake. The interactive sessions during dietary modification were the women could ask questions and obtain clarity over the topic might be the reason for better improvement observed through dietary modification.Hence, a holistic approach using digital health intervention and dietary modification for a longer period focusing on the combination of sunlight exposure at home, increased dietary intake via natural sources and fortified foods particularly rich in Vitamin D_3 and improved physical activities would benefit the population under study.

Feedback of digital health intervention and telephonic counselling

Feedback on digital health intervention and telephonic counselling is given in Table LIII.

Table LIII

Feedback of Digital Health Intervention and Telephonic Counselling

Sources	**Feedback**	**Percentage(%)**
Digital education class (rating)	Excellent	85.4
	Good	13.8
	Satisfactory	0.8
Comments (Google form)	No comments	70.8
	Appreciated	15.4
	Clear explanation	1.4
	Informative	5.2
YouTube Videos (channel)	Views	100
	Likes	40.9
	Appreciated	5.2
	Informative	2.9
	Useful	1.4
Feedback in the WhatsAppgroup		
YouTube Videos	Appreciated	42.6
	Informative	13.1
	Useful	2.9
Motion graphic videos	Appreciated	35
	Informative	4.3
Memes	Appreciated	19.7
Telephonic counselling	Appreciated	36
	Informative	4.2

Feedback of the study participants on the digital health intervention and telephonic counselling were collected from different sources such as the Google form used for evaluation, the YouTube channel, WhatsApp group and after telephonic counselling. From the feedback, it was obvious that the majority (85.4%)of the Muslim

women rated the digital intervention as excellent. Seventy one per cent did not comment in the Google form and among the women who commented 15.4 per cent appreciated the classes, 1.4 per cent found the explanations clear and 5.2 per cent found it informative. In the YouTube channel, all the participants had viewed the channel, of which 40.8 per cent liked the channel. 5.2 per cent appreciated, 2.9 per cent found it informative and 1.4 per cent found it useful. Feedback from the Whatsapp group on the YouTube videos 42.6 per cent appreciated the videos, 13.1 per cent found it useful. Regarding the motion graphic videos and memes, 35 per cent and 19.7 per cent appreciated them. The feedback obtained on the telephonic counselling showed 36 per cent appreciations and4.2 per cent found it informative.