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Vitamin D status: A case study of Surat city

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Abstract---Vitamin D3, also known as cholecalciferol, is very important for overall health. Our body produces vitamin D3 naturally, whenever we get exposure to the sun. Therefore, people who are not in the habit of going out in the sun may have a deficiency of vitamin D3. The climate of Surat city is moderate with average temperatures of 37 degrees, 32 degrees and 23 degrees Celsius in summer, monsoon and winter, respectively, yet deficiency of vitamin D3 prevails in the population of the city. Vitamin D3 is a fat-soluble vitamin which helps the body to absorb calcium and phosphorus and is essential for building robust bone health. The studies available in the present literature are longitudinal in nature and most have small sample sizes. Therefore, in this paper, an attempt was made to give an idea of a picture regarding the level of vitamin D3 in the population of Surat city. Some of the major findings are: D3 level is found statistically significantly different age-wise as well as gender-wise. The prediction is that, assuming all other factors will remain fairly similar, then approximately 63.85% to 90.46% of the population of Surat city will have vitamin D3 deficiency. Children have less deficiencies than late adolescent and adults as well as senior citizens in Surat city.

Keywords---Vitamin D3 -25(OH) D serum level, nonparametric limits, age-wise differences, gender-wise differences, Indian laboratories limits, IoM limits, US endocrine limits.

Introduction

Vitamin D3, also known as cholecalciferol, is very important for overall human health [1]. Our body produces vitamin D3 naturally, whenever we get exposure to the sun. Therefore, people who are not in the habit of going out in the sun may have a deficiency of vitamin D3 [1]. The climate of Surat city has moderate temperatures with an average of 37 degrees, 32 degrees and 23 degrees Celsius in summer, monsoon and winter, respectively, yet deficiency of vitamin D3 prevails in the population of Surat city. Vitamin D3 is a fat-soluble vitamin which helps the body to absorb calcium and phosphorus and is essential for building robust bone health [2]. The studies available in the present literature are longitudinal in nature and most have small sample sizes.

Aparna *et.al* [3] discussed the diagnostic cut offs of level of serum Vitamin D used by US Endocrine Society and as mentioned in their article, the serum level <20 ng/ml is considered as vitamin D Deficiency, serum level 21-29 is considered as insufficiency, serum level >30 ng/ml is considered as sufficiency and serum level >150 ng/ml is considered as toxicity. Hillstrom *et. al* [4] mentioned in his article IoM Vitamin D recommendations that the serum level <12 ng/ml is considered as vitamin D Deficiency, serum level 12-20 is considered as insufficiency(inadequate), serum level >20 ng/ml is considered as sufficiency(adequate) and serum level >50 ng/ml is considered as toxicity (potential adverse effect). Gupta *et. al* [5] studied vitamin D deficiency among north Indian athletes and considered the serum level <20 ng/ml as deficient, serum level 20-30 as insufficient, serum level >30 ng/ml as sufficient. Sinkar et.al [6] studied vitamin D deficiency picture considering 1079 Asian Indians from Indian laboratories considering clinical range <20 ng/ml as deficient, 21-30 ng/ml as insufficient, >30ng/ml as sufficient. They studied age-wise as well as gender-wise deficiency and considered the age groups 0-10, 10-25, 25-50 and age above 50. If we consider reports of current Indian laboratories, for adults, serum level 30-100 ng/ml is mentioned as normal range. There is no unanimous opinion about a normal range of vitamin D amongst experts. The present study is based on a serum level of 25(OH) D using limits reported by Indian laboratories, Institute of Medicine (IoM) limits and limits of US Endocrine society which were recommended in 2014 and are mentioned in table 1 as well as figure 1. The table 1 in our present study also coordinates with normal/sufficient range with diagnostic cut offs of normal range recommended in 2022 by Indian laboratories report normal range (30-100 ng/ml), Institute of Medicine (IoM) limits (20 to 50 ng/ml), and limits of US Endocrine society (30-150 ng/ml). Measurements of Vitamin D levels used in present study are the same as mentioned by Shah et al. [7].

Table 1
Different limits (ng/ml) of 25(OH)

25 (OH) D level	Indian labs	IoM	US Endo. Soc.
Severe deficiency	--	<5	--
Deficient	0-10	5-15	0 – 20
Grey area	--	15 - 20	--

Insufficient	10—30	--	21 – 30
Sufficient	30--100	20 - 50	30 - 150
Toxic	>100	>50	>150

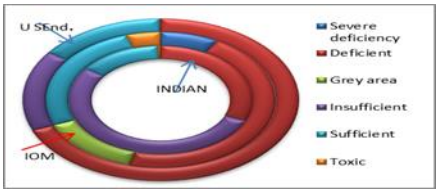

Figure 1. Different limits (ng/ml) of 25(OH) D (in %)

The most important source of vitamin D is exposure of the skin to sunlight, especially to UVB radiation from the sunlight, and less than 10-15% is derived from dietary sources, viz., fatty fish, beef liver, egg yolks, fortified milk, orange ice and fortified cereals. Sunlight produces both UVA and UVB radiation, out of which UVB radiation produces vitamin D in the skin. The production of vitamin D in the skin depends on time of the day, year, latitude, altitude and prevailing weather conditions where the person lives. In comparison to western countries, India has more advantage over UVB radiation. In general, vitamin D is more absorbed by our body between 10 a.m. and 3 p.m. but the experts' advice is to avoid going out in the sun during this time to prevent the skin from cancer. It is also said that people with darker skin have extra melanin that acts as sunscreen to reduce the synthesis of vitamin D and so they need more prolonged exposure to sunlight. People who use sun screen, wear protective clothes, work the whole day in AC rooms, wear burakha and do pardah may prevent production of vitamin D by sunlight in the skin and will have a deficiency of it. This brings the vital question, given all favourable conditions, why is vitamin D deficiency and insufficiency so common in people of Surat city?

The National Academy Press [8] discussed that the recommendations suggested by IoM in 1997 were inadequate. Michael and Tai [9] have concluded in their paper that a reevaluation is required to decide adequate intake of vitamin D for children and adults. In previous literature, Michael & Tai [9] have suggested taking oral supplement of vitamin D as ≥ 800-1000 IU* (≥20000-25000 ng) per day for children and adults when sunlight is unable to produce vitamin D. However, these recommendations are not approved by government officials or pediatric organizations in the United States, Canada or Europe Michael & Tai [9]. Kulie et al. [10] have discussed that supplements of vitamin D reduce mortality of people on dialysis, decrease the risk of various conditions such as cardiovascular disease, diabetes, osteoporosis, falls among the elderly, cancer, multiple sclerosis, Alzheimers, dementia, chronic pain syndrome, rickets with bow legs etc. Kulie et al. [10] have also suggested intake of vitamin D for children, pregnant women, adults and elderly people, but the intake level may vary by patient.

* IU refers to international units, which is equal to 25nanogram of vitamin D per milliliter.

Caulfield et al. [11] have examined the nature of vitanin D with respect to the health and requirement of its supplements using 294 print articles in the UK, USA and Canada over the period of 5 years, i.e. from 2009 to 2014. Using media content analysis, they have concluded that newspapers have supported vitamin D supplements with the statement “adequate vitamin D is necessary for good health.” They have also mentioned that deficiency has been widespread and food intake would not be sufficient. 80% of the articles suggested taking supplements for vitamin D, but none of the articles discussed about the inherent risk of supplements of vitamin D in details. Hollo et al. [12] have discussed that deficient levels of vitamin D are associated with epilepsy, which is the second major neurological disorder, yet very little attention has been paid in comparison to other neurological disorders such as multiple sclerosis, alzheimer, parkinson, autism, schizophrenia and cerebrovascular disorders. There is limited direct role of vitamin D in epilepsy. However, an indirect relation was found both in experimental data as well as in two interventional human studies by Hollo et al. [12]. Yet more studies are required to decide the optimum intake of vitamin D supplements in concern with epilepsy.

Hodgkin et al. [13] mentioned that vitamin D deficiency was rare till the early 1990s. Goswami [14] discussed that there was no systematic study done for Asian Indians residing in India till 2000. Mehlawat et al. [15] have studied vitamin D Deficiency in the Indian population in various age groups on the basis of previous evidence and found Vitamin D deficiency in all age groups including newborns, infants, toddlers, school children, pregnant women and lactating mothers and their neonates and adult males and females, elderly people residing in rural or urban areas. It was evident by Mehlawat et al. [15] that in India, amongst all age groups, Vitamin D deficiency prevailed in the range from 50% to 90%. Shukla *et. al* [16] has discussed age-wise as well as gender-wise vitamin D deficiency in healthy population in their hospital based retrospective survey considering the age groups <20, 21-40, 41-60 and above 60 with serum level <20 ng/ml as deficient, 20-40 ng/ml as insufficient and >40 ng/ml as sufficient. It was observed that healthy Indian population have high prevalence of vitamin D status.

Materials and Methods

The present study is based on data collected from different laboratories (Dr. Prashant K. Naik, Abha laboratory; Dr. H. D. Wankawala, Thyrocare Laboratory; Atul V. Shah, HR- Desai Metropolis Health Services Pvt. Ltd.) of Surat city. This is not survey-based data so there is no any inclusion or exclusion criteria. The data analysis is done using Excel and (Statistical Package for Social Science) SPSS 21.00 version. Future confidence limits for 25(OH)D levels are based on non-parametric test statistics as some of the serum values of 25(OH)D were represented in values of greater than a given (observed) value. So median is the best measurement and, on that basis, to test significant difference amongst categories of age as well as gender, Kruskal Wallis test is applied.

Data collection and data description

We have collected data from different laboratories of Surat city. But before using the findings of this study for any purpose, the following points should be considered.

- The majority of the data is based on the blood test due to some health problems. Very few observations are from the free medical checkup camp.
- For many cases, observations were given as > some given (observed) value. In those cases, for the sake of analysis, we have taken the next integer value as the observed value. Therefore, instead of a mean, we suggest observing a median as the measure and hence, for inference, nonparametric techniques are used.
- In the data set, gender is mentioned as only male and female. So the child category is prepared from males and females whose age is up to 15.
- For all the categories (gender-wise as well as age-wise), common limits of D3 are used.

Analysis

Considering the literature, present study is based on vitamin D status of Surat city on the basis of 1940 observations. The analysis is based on 1940 observations obtained from different laboratories. On the basis of age of the person, it is divided into 3 age categories, as, if "age ≤ 15 years – children (C)", "age 15 years to less than 60 years – Late adolescent and adults (A)" and if "age ≥ 60 years- senior citizens (SC)". Similarly, gender-wise also three categories – male (M), female (F) and children (C) are defined. Then, using different limits of 25 (OH) D level in blood by (a) regular limits used by the Indian laboratories (b) limits suggested by IoM and (c) limits suggested by the US Endocrine Society (table 1), we have compared the respective descriptive and inferential statistics and results are reported thereafter.

Comparisons on the basis of descriptive statistics
Overall comparison

In the given sample of 1940 persons, the percentage of people having different levels of 25 (OH) D according to different specified limits is reported in table 2. From table 2 as well as figure 2a, figure 2b and figure 2c, it is very clear that, considering any limits, almost 68% to 86% of people have a 25(OH) D level below sufficient or, other way, only 12% to 26% of people are found to have sufficient level of 25(OH) D.

Table 2
People having different 25(OH) D levels (in percentage)

25 (OH) D level	Indian	IoM	U S Endocrine society
Severe deficiency	-	1.60	-
Deficient	19.95	48.71	68.30

Grey area	-	17.99	-
Insufficient	66.49	-	18.30
Sufficient	12.27	26.49	13.09
Toxic	1.29	5.21	0.31

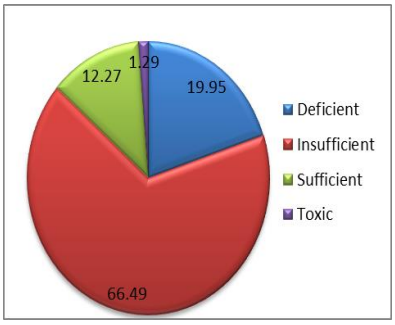

Figure 2a. Different D3 levels according to limits used by Indian labs (in %)

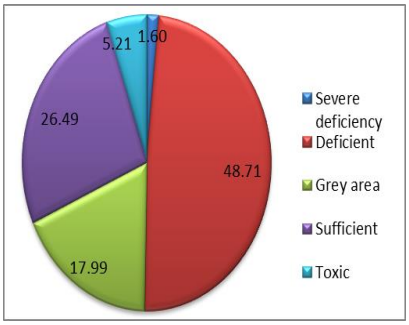

Figure 2b. Different D3 levels according to limits suggested by IOM (in %)

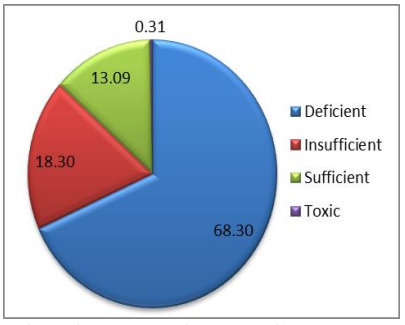

Figure2c: Different D3 levels according to limits suggested by U S Endocrine society (in %)

From the table 3 of percentiles, it becomes easier to observe how many % of people have 25 (OH) D levels below that particular value. It can be observed from table 3 that 86.55% of people have 25 (OH)D level below 30.

Table 3
Descriptive statistics for 25(OH) D level

N	1940		
Median	14.9		
Mode	10.5		
Min	2		
Max	161		
Percentile	%	Value	
	1.8	5	Maximum count for first 1.8% of ordered data
	20.65	10	Maximum count for first 20.65% of ordered data
	50.7	15.0087	Maximum count for first 50.07% of ordered data
	68.57	20	Maximum count for first 68.57% of ordered data
	86.55	30	Maximum count for first 86.55% of ordered data
	94.74	50	Maximum count for first 94.74% of ordered data
	98.7	100.912	Maximum count for first 98.7% of ordered data
	99.66	148.473	Maximum count for first 99.66% of ordered data
	99.67	152.529	Maximum count for first 99.67% of ordered data

Gender wise comparison

It can be seen from table 4 and figure3a, figure3b and figure3c that considering any limits, almost 57.83% to 72.29% of children have 25(OH) D level below sufficient, almost 67.09% to 87.19% of males have 25(OH) D level below sufficient and almost 69.98% to 87.27% of females have 25(OH) D level below sufficient level.

Table 4
Gender wise percentage of people having different 25(OH) D level

25 (OH) D level	Indian			IOM			U S End Soc		
	C	M	F	C	M	F	C	M	F
Severe deficiency	--	--	--	4.82	1.02	1.77	--	--	--
Deficient	18.07	17.41	21.93	38.55	47.50	50.37	57.83	67.09	69.98
Grey area	--	--	--	14.46	18.57	17.84	--	--	--
Insufficient	53.01	69.53	65.33	--	--	--	14.46	20.10	17.29
Sufficient	26.51	11.78	11.52	31.33	28.68	24.54	27.71	12.42	12.45
Toxic	2.41	1.28	1.21	10.84	4.23	5.48	0.00	0.38	0.28

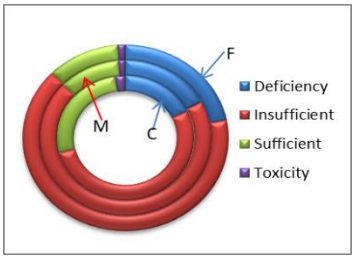

Figure 3a. Gender-wise D3 level according to Indian limits for Surat (in %)

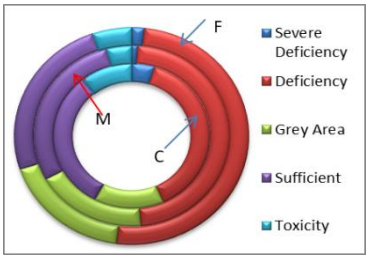

Figure 3b. Gender-wise D3 level according to IOM limits for Surat (in %)

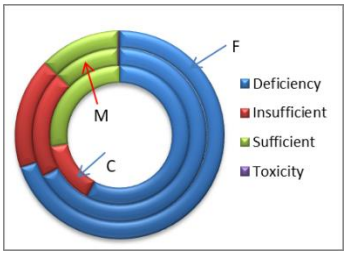

Figure 3c. Gender-wise D3 level according to US Endocrine limits for Surat (in %)

Age wise comparison

It can be seen from table 5 and figure 4a, figure 4b and figure 4c that considering any limits, almost 57.83% to 72.29% of children have 25(OH) D level below sufficient, almost 70.74% to 88.59% of late adolescent and adults have 25(OH) D level below sufficient and almost 60.29% to 81.43% of senior citizens have 25(OH) D level below sufficient level.

Table 5
Age wise percentage of people having different 25(OH) D level

25 (OH) D level	Indian			IOM			U S End Soc		
	C	A	SC	C	A	SC	C	A	SC
Severe deficiency	--	--	--	4.82	1.46	1.43	--	--	--
Deficient	18.07	21.17	15.14	38.55	51.16	40.57	57.83	70.74	60.29
Grey area	--	--	--	14.46	18.12	18.29	--	--	--
Insufficient	53.01	67.29	66.29	--	--	--	14.46	17.85	21.14

Sufficient	26.51	10.55	16.29	31.33	25.28	30.57	27.71	11.35	17.14
Toxic	2.41	1.00	2.29	10.84	3.98	9.14	0.00	0.07	1.43

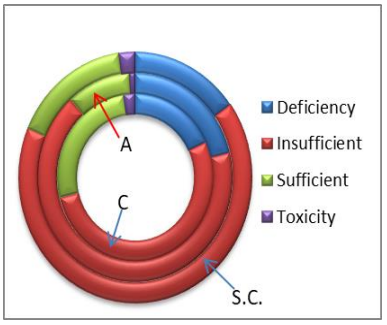

Figure 4a. Age-wise D3 level according to IOM limits for Surat (in %)

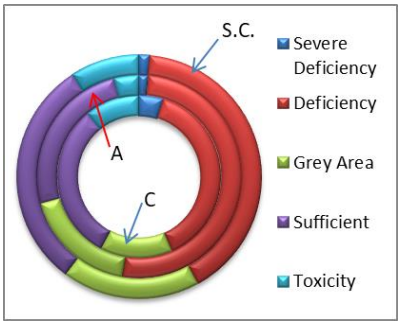

Figure 4b. Age-wise D3 level according to US Endocrine limits for Surat (in %)

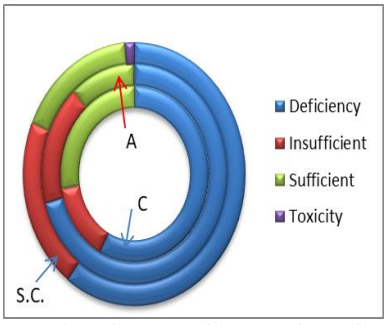

Figure 4c. Age-wise D3 level according Indian limits for Surat (in %)

Comparisons on the basis of inferential statistics

- It can be observed from table 6 that there is statistically significant difference amongst age-wise 25 (OH) D levels for all of the IOM, Indian lab as well as US Endocrine limits.
- It can be observed from table 7 that there is statistically significant difference amongst gender-wise 25 (OH) D levels for IOM, Indian lab as well as US Endocrine limits.

Table 6
Kruskal Wallis Test for 25 (OH) D level (Age-wise Significance testing results)

	Recoded Age	N	Mean Rank	Chi-Square	df	p value
25 (OH) D level	Child	83	1105.05	21.763	2	0
	late adolescent and adults	1507	944.53			
	Senior Citizen	350	1050.42			
	Total	1940				

Table 7
Kruskal Wallis Test for 25 (OH) D level (Gender-wise Significance testing results)

	Gender	N	Mean Rank	Chi-Square	df	p value
25 (OH) D level	Female	1076	947.45	10.582	2	0.005
	Male	781	987.95			
	Child	83	1105.05			
	Total	1940				

Results

For a population with aggregate data of Surat (1940 subjects) using a 95% confidence interval through IoM limits (non-parametric), it is estimated that 63.85% to72.99% of persons will be below sufficient level (table 8). From table 9, it can be depicted that 64.01% to 76.41% of females will be below sufficient level, 60.29% to 74.55% of males will be below sufficient level and 37.1% to 85.65% of children will be below sufficient level of 25 (OH) D. As per the age group analysis from table 10, it can be inferred that 65.72% to 76.06% of late adolescent and adults will be below sufficient level and 50.23% to 71.96% of senior citizens will be below sufficient level of D3.For the population with aggregate data of Surat (1940 subjects) using a 95% confidence interval through Indian lab limits (non-parametric), it is estimated that 82.53% to 90.39% of persons will be below sufficient level (table 8). From table 11, it can be depicted that 81.9% to 92.71% of females will be below sufficient level, 80.98% to 93% of males will be below sufficient level and 52.22% to 92.12% of children will be below sufficient level of D3. As per the age group analysis from table 12, it can be inferred that 83.98% to 92.97% of late adolescent and adults will be below sufficient level and 72.62% to 90.55% of senior citizens will be below sufficient level of D3.

For a population with aggregate data of Surat using a 95% confidence interval through US Endocrine Soc. limits (non-parametric), it is estimated that 82.78% to 90.46% of persons will be below sufficient level (table 8). From table 13, it can be depicted that 82.21% to 92.39% of females will be below sufficient level, 81.01% to 93.47% of males will be below sufficient level and 54.19% to 92.49% of children will have D3 deficiency. As per the age group analysis from table 14, it can be inferred that 84.32% to 92.9% of late adolescent and adults will be below sufficient level and 71.93% to 91.25% of senior citizens will be below sufficient level of D3. It can be seen that in any of the three limits, children have less deficiency than late adolescent and adults and senior citizens.

Table 8
95% Confidence limits for 25 (OH) D level

25 (OH) D level	Indian				IOM				US Endocrine society			
	NP		P		NP		P		NP		P	
	LL	U L	LL	U L	LL	UL	LL	UL	LL	UL	LL	UL
Severe defi.	--	--	--	--	1.09	2.26	1.04	2.16	--	--	--	--
Deficient	18.19	21.80	18.17	21.73	46.46	50.96	46.49	50.94	66.18	70.37	66.23	70.37
Grey area	--	--	--	--	16.30	19.77	16.28	19.70	--	--	--	--
Insufficient	64.34	68.59	64.39	68.60	--	--	--	--	16.60	20.09	16.58	20.02
Sufficient	10.84	13.81	10.81	13.73	24.54	28.52	24.53	28.46	11.62	14.68	11.59	14.59
Toxic	0.84	1.90	0.79	1.79	4.26	6.29	4.22	6.19	0.11	0.67	0.06	0.56

Table 9
Gender-wise 95% Confidence limits for different levels of 25 (OH) D according to IoM

25 (OH) D level	Child				Male				Female			
	NP		P		NP		P		NP		P	
	LL	U L	LL	U L	LL	UL	LL	UL	LL	UL	LL	UL
Severe defi.	1.33	11.88	0.21	9.43	0.44	2.01	0.32	1.73	1.07	2.74	0.98	2.55
Deficient	28.07	49.88	28.08	49.03	43.95	51.07	44.00	51.01	47.34	53.40	47.38	53.36
Grey area	7.70	23.89	6.89	22.02	15.90	21.47	15.84	21.29	15.60	20.27	15.56	20.13
Sufficient	21.59	42.44	21.35	41.30	25.53	31.99	25.51	31.85	21.99	27.22	21.96	27.11
Toxic	5.08	19.59	4.15	17.53	2.93	5.88	2.81	5.64	4.20	7.02	4.12	6.84

Table 10
Age-wise 95% Confidence limits for different levels of 25 (OH) D according to IoM

25 (OH) D level	Child				Late adolescent and Adults				Senior Citizens			
	NP		P		NP		P		NP		P	
	LL	U L	LL	U L	LL	UL	LL	UL	LL	UL	LL	UL
Severe defi.	1.33	11.88	0.21	9.43	0.92	2.2	0.85	2.07	0.47	3.3	0.19	2.67
Deficient	28.07	49.88	28.08	49.03	48.6	53.71	48.64	53.69	35.38	45.92	35.43	45.72
Grey area	7.7	23.89	6.89	22.02	16.2	20.15	16.17	20.06	14.38	22.74	14.24	22.34
Sufficient	21.59	42.44	21.35	41.3	23.1	27.56	23.09	27.48	25.78	35.69	25.74	35.4
Toxic	5.08	19.59	4.15	17.53	3.05	5.1	2.99	4.97	6.34	12.66	6.12	12.16

Table: 11
Gender Wise 95% Confidence limits for different levels of 25 (OH) D according to limits used by Indian labs

25(OH) D level	Child				Male				Female			
	NP		P		NP		P		NP		P	
	LL	U L	LL	U L	LL	UL	LL	UL	LL	UL	LL	UL
Deficient	10.48	28.05	9.79	26.35	14.82	20.26	14.75	20.07	19.49	24.53	19.46	24.41
Insufficient	41.74	64.07	42.27	63.75	66.16	72.74	66.30	72.75	62.41	68.18	62.49	68.18
Sufficient	17.42	37.34	17.01	36.00	9.60	14.25	9.52	14.04	9.68	13.58	9.62	13.43
Toxic	0.29	8.43	0.00	5.71	0.62	2.34	0.49	2.07	0.64	2.06	0.56	1.86

Table 12
Age Wise 95% Confidence limits for different levels of 25 (OH) D according to limits used by Indian labs

	Child				Late adolescent and Adults				Senior Citizens			
	NP		P		NP		P		NP		P	
25(OH) D level	LL	U L	LL	U L	LL	UL	LL	UL	LL	UL	LL	UL
Deficient	10.48	28.05	9.79	26.35	19.13	23.32	19.11	23.23	11.55	19.33	11.39	18.90
Insufficient	41.74	64.07	42.27	63.75	64.85	69.65	64.92	69.65	61.07	71.22	61.33	71.24
Sufficient	17.42	37.34	17.01	36.00	9.04	12.21	9.00	12.10	12.57	20.58	12.42	20.15
Toxic	0.29	8.43	0.00	5.71	0.56	1.64	0.49	1.50	0.99	4.45	0.72	3.85

Table 13
Gender Wise 95% Confidence limits for different levels of 25 (OH) D according to U S Endocrine society

	Child				Male				Female			
	NP		P		NP		P		NP		P	
25(OH) D level	LL	U L	LL	U L	LL	UL	LL	UL	LL	UL	LL	UL
Deficient	46.49	68.60	47.21	68.46	63.67	70.38	63.80	70.39	67.14	72.71	67.24	72.72
Insufficient	7.70	23.89	6.89	22.02	17.34	23.09	17.29	22.91	15.07	19.68	15.03	19.55
Sufficient	18.45	38.62	18.08	37.34	10.19	14.94	10.11	14.73	10.54	14.58	10.48	14.43
Toxic	0.00	4.35	0.00	0.00	0.08	1.12	0.00	0.82	0.06	0.81	0.00	0.59

Table 14
Age Wise 95% Confidence limits for different levels of 25 (OH) D according to U S Endocrine society

25(OH) D level	Child				Late adolescent and Adults				Senior Citizens			
	NP		P		NP		P		NP		P	
	LL	U L	LL	U L	LL	UL	LL	UL	LL	UL	LL	UL
Deficient	46.49	68.6	47.21	68.46	68.37	73.02	68.44	73.03	54.95	65.45	55.16	65.41
Insufficient	7.7	23.89	6.89	22.02	15.95	19.88	15.92	19.78	16.98	25.8	16.87	25.42
Sufficient	18.45	38.62	18.08	37.34	9.79	13.06	9.75	12.95	13.34	21.51	13.19	21.09
Toxic	0	4.35	0	0	0	0.37	0	0.2	0.47	3.3	0.19	2.67

Discussion

Balasubramanian et.al [17] considered serum level<5ng/ml as severe deficient, <15 ng/ml as deficient, >20 ng/ml as sufficient and >50ng/ml as toxic and concluded that 50 – 90% had deficiency and they suggested fortification as well as supplementation for prevention of vitamin D deficiency. Though India is a sunshine sufficient country, there is high prevalence of vitamin D deficiency. There is a strong need to take appropriate and concrete public health action [3]. Singh *et.al* [18] studied vitamin D deficiency in adults of sahara district considering the age group 20-40, 40-60 and 60-80 and concluded that vitamin D deficiency is highly prevalent in the district. Vitamin D deficiency was more observed in females than males. In the present study, age-wise as well as gender-wise deficiency of 25 (OH) D level is found using the data provided by laboratories of Surat. Unfortunately, deficiency of 25 (OH) D level is noted not only in Surat but all over Gujarat and India. Though milk is a good source and pasteurized

milk is available in Surat, most of the people drink boiled milk and it is boiled for a rather long time which causes part of 25 (OH) D level to be destroyed. Abundant sunlight is available in Surat throughout the year round except on rainy days. But a person has to take sunrays on the bare chest and back and limbs. Unfortunately, timings vary--some believe 8-10 a.m. is the best time but others believe 10 a.m. to-12 p.m. is the best time. Even the glass windows in a balcony room filter the rays to manufacture (UAV) is a moot point. So it depends upon the quality and thickness of the glass whether the person is able to absorb 25 (OH) D level when the person is in the office or home during the day. Surat is known as a textile and diamond city and the structure of the textile market and diamond market is such as that the workers do not get enough sunlight. There is no unanimous opinion as the capacity of the patient to absorb Vitamin D is different. Skin colour, pigmentation, the use of sunscreen lotion also affects deficiency of vitamin D. Even fortification of food is required, so that less supplement of vitamins may be required [19]. Even nowadays, there is an increment in the indoor lifestyle which prevents adequate exposure to sunlight and results in vitamin D deficiency. More use of junk food is also one of the responsible factors for vitamin D deficiency.

Conclusion

Vitamin D deficiency is a silent killer of all diseases. Adequate level of Vitamin D may prevent many other diseases as well as boost the body to fight against viral diseases. Vitamin D deficiency is a major problem in the whole world. On the basis of study of sample 1940 observations which is collected from different diagnostic laboratories due to some health issues and it does not have an inclusion or exclusion criteria, it can be depicted that, in Surat city, 68% to 86% of the population have Vitamin D deficiency. This is due to junk food and the indoor lifestyle. The Surat Municipal Corporation needs to educate children from school level about the importance of Vitamin D for better health through conducting seminars in schools and posters in city. Children should be encouraged to play outdoor games so they can have exposure to the sufficient sunlight. Government needs to include vitamin D fortified foods for children in midday meal scheme. Government should aware the people about importance of vitamin D and supplements should be made available at public health center.

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Conflict of interest

The authors declare that there are no conflicts of interest in the course of conducting the research. All the authors had final decision regarding the manuscript and decision to submit the findings for publication.

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