CHAPTER 7

SUMMARY AND CONCLUSION

Vitamin D deficiency is still pandemic as seen in the previous literature that it observed in almost all the countries in the world. There might be many causes due to lack of awareness about vitamin D deficiency and it has become an important public health issue. Cod liver oil, oily fish, cow’s milk (which have least amount of vitamin D) and mushrooms exposed to ultraviolet-B radiation are the only natural source. Requirement of fortifying foods with 25(OH) D may be long-lasting and more crucial since excess sun-exposure which is a major source of this nutrient and related to skin cancer and daily lifestyle changes that decrease outdoor exposure of sun for all age groups including children. The tradition of deficiency of vitamin D rises the risk of major chronic illnesses like heart disease, diabetes, stroke, cancer, asthma, infectious diseases and autoimmune diseases etc in whole population of the world. The possible causes of vitamin D deficiency in Indians, of its wide spread might be due to:

a) Low dietary intake and high fiber diet intake that decreases 25(OH) D levels in blood,

b) The traditional habit of parda and burka in rural woman resident and specially in Muslim communities and indoor resident which decrease the exposure of sunlight,

c) Pollution and window glasses also decrease the arrival of specific sunlight wavelength to the human skin.

It happens when almost area of India, getting abundant sun ray, so it is really alarming for Indian population. The Council of Medical Research in India (ICMR) has not given any particular approval regarding daily requirement of 25-hydroxy-D excluding the particular recommendation on medical ground i.e. only 400 IU of vitamin D per day. Indian Council of Medical Research recommends only outdoor activities during sun-shine for normal healthy children and adults so-that they could receive proper amount of vitamin D.
To decrease the prevalence of deficiency of vitamin D among Indians, it is necessary to work together with the private health sector; semi-government and government have to coordinate, keeping in view the following facts:

1. First of all it is very important to organize, educational programs to increase the population in touch with, about the deficiency of vitamin D and its future consequences and causes.
2. Secondly, vitamin D supplementation should be made available at affordable cost for the poor and abundantly available for general population.
3. Third, prophylaxis programmed might be organized for 25-hydroxy-vitamin D supplementation for all age groups including infants, toddlers, adolescents, lactating and pregnant females and elderly populations.
4. Fourth, health schemes might be scheduled for fortification with vitamin D nutrient of foods like milk, children’s cereals and liquid drinks.
5. Fifth, it is very necessary that the Indian Council of Medical Research should revise the recommendation daily requirement of vitamin D to achieve the adequate level within normal reference range.
6. Sixth, in Indian education system, daily physical activity of about 30 minutes in sun with open face, hand and foot should be done compulsory as a part of school activities as per finding of present thesis work that vitamin D deficiency was prevalent among all age groups in Haryana.

The deficiency of vitamin D in previous studies is found alarmingly high and has long term severe consequences. Educational programs, food fortification, public health policies and awareness plans may be on the priority for minimizing the inadequacy of vitamin D.

The summary of my results is:-

The mean age and standard deviation of the entire subjects was 39.51 ± 10.97 years. Mean ± standard deviation of vitamin D, calcium, phosphorous, alkaline phosphatase, estrogen, progesterone and testosterone were found to be 29.55 ± 8.60, 8.42 ± 1.10, 3.74 ± 0.66, 60.01 ± 27.58, 61.45 ± 32.70, 0.53 ± 0.22 and 2.84 ± 2.84 respectively as shown in table number 5.3.Similarly, in the table number 5.4 (in all males) and 5.5 (in all females), mean &SD of all the parameters was observed as below:
• **In males:** In all males of study subjects, the mean ± standard deviation with respect to age was 40.39 ± 11.66 years. Mean ± standard deviation of vitamin D, calcium, phosphorous, alkaline phosphatase, estrogen, progesterone and testosterone were found to be 32.00 ± 8.50, 8.75 ± 0.92, 3.93 ± 0.59, 60.34 ± 31.24, 50.62 ± 17.40, 0.49 ± 0.16 and 5.33 ± 1.92 respectively.

• **In females:** In all females of study subjects, the mean ± standard deviation with respect to age was 38.63 ± 10.22 years. Mean ± standard deviation of vitamin D, calcium, phosphorous, alkaline phosphatase, estrogen, progesterone and testosterone were found to be 27.11 ± 8.02, 8.09 ± 1.17, 3.55 ± 0.67, 59.67 ± 23.53, 72.27 ± 40.13, 0.57 ± 0.26 and 0.35 ± 0.32 respectively.

• **In present study,** all the subjects were distributed into four different groups of age they were 20-30 years, 31-40 years, 41-50 years & 51-60 years as shown in the tables 5.6-5.9. The mean ± standard deviation of study subjects in these groups were as below:

• **In age group 20-30 years:** The mean & standard deviation of age was 25.86 ± 2.57 years, and the mean ± standard deviation of vitamin D, calcium, phosphorous, alkaline phosphatase, estrogen, progesterone & testosterone in this age group were found to be 29.53 ± 9.65 ng/ml, 8.48 ± 1.40 mg/dl, 3.83 ± 0.68 mg/dl, 44.39 ± 18.00 IU/L, 74.72 ± 39.27 pg/ml, 0.60 ± 0.21 ng/ml and 3.26 ± 3.34 ng/ml respectively.

• **In age group 31-40 years:** The mean & standard deviation of age was 34.20 ± 2.68 years, and the mean ± standard deviation of vitamin D, calcium, phosphorous, alkaline phosphatase, estrogen, progesterone and testosterone in this age group were found to be 33.58 ± 10.54 ng/ml, 8.88 ± 0.86 mg/dl, 4.07 ± 0.65 mg/dl, 44.84 ± 16.07 IU/L, 71.30 ± 36.29 pg/ml, 0.58 ± 0.20 ng/ml and 3.62 ± 3.30 ng/ml respectively.

• **In age group 41-50 years:** The mean & standard deviation of age was 43.80 ± 2.43 years, and the mean ± standard deviation of vitamin D, calcium, phosphorous, alkaline phosphatase, estrogen, progesterone and testosterone in this age group were found to be 29.30 ± 5.65 ng/ml, 8.23 ± 1.09 mg/dl, 3.72 ± 0.61 mg/dl, 60.78 ± 19.51 IU/L, 57.49 ± 25.62 pg/ml, 0.53 ± 0.28 ng/ml and 2.45 ± 2.38 ng/ml respectively.
• **In age group 51-60 years:** The mean & standard deviation of age was 54.18 ±
3.49 years, and the mean ± standard deviation of vitamin D, calcium,
phosphorous, alkaline phosphatase, estrogen, progesterone and testosterone in
this age group were found to be 25.80 ± 5.74 ng/ml, 8.08 ± 0.81 mg/dl, 3.33 ±
0.46 mg/dl, 90.02 ± 26.91 IU/L, 42.28 ± 12.59 pg/ml, 0.42 ± 0.13 ng/ml and
2.02 ± 1.88 ng/ml respectively.

• **On the basis of vitamin D category:**
In the present study, 85 subjects were found with normal reference range of
vitamin D and 115 were found with abnormal reference range and when we see
the mean of calcium in subjects with normal reference range of vitamin D
(N=85), it was 8.77 with standard deviation 0.98 and in subjects with abnormal
reference range of vitamin D (N=115) it was 8.16 with standard deviation 1.11,
the difference in mean 0.62 with 95% confidence [lower (0.32) and upper (0.92)]
was found highly statistically significant (p=000).
The mean difference in other parameters phosphorus, alkaline phosphatase,
estrogen, progesterone and testosterone was 0.32, -24.05, 16.11, 0.10 and 2.73
respectively, which were also found statistically significant (p≤0.002).

• **On the basis of calcium category:**
Among all the subjects67 subjects were found with normal reference range of
calcium and 133 were found with abnormal reference range and when we see the
mean of vitamin D in subjects with normal reference range of calcium (N=67), it
was 32.61 with standard deviation 9.72 and in subjects with abnormal reference
range of vitamin D (N=133) it was 28.01 with standard deviation 7.56, the
difference in mean 4.60 with 95% confidence [lower (2.14) and upper (7.06)] was
found highly statistically significant (p=0.000).
The mean difference in other parameters phosphorus, alkaline phosphatase,
estrogen, progesterone and testosterone was 0.42, -12.92, 0.47, 0.01 and
2.01 respectively, which were found highly significant with phosphorous, alkaline
phosphatase and testosterone (p≤0.002) and statistically non significant with estrogen
and progesterone (p>0.05).
On the basis of phosphorus category:
Among all the subjects, 186 subjects were found with normal reference range of phosphorus and 14 were found with abnormal reference range and when we see the mean of vitamin D in subjects with normal reference range of phosphorus (N=186), it was 29.86 with standard deviation 8.64 and in subjects with abnormal reference range of phosphorus (N=14), it was 25.49 with standard deviation 7.00, the difference in mean 4.37 with 95% confidence [lower (-.30) and upper (9.04)] was found statistically non significant (p>0.05).

The mean difference in other parameters calcium, alkaline phosphatase, estrogen, progesterone and testosterone was 0.63, -0.93, 1.33, -0.14 and 1.86 respectively, which were found statistically significant with calcium, progesterone and testosterone (p<0.05) and statistically non significant with estrogen and alkaline phosphatase (p>0.05).

On the basis of alkaline phosphatase category:
Alkaline phosphatase have wide reference range (36-113 IU/L), among 200 study subjects, 196 subjects were found with normal reference range of alkaline phosphatase and 4 were found with abnormal reference range, and when we see the mean of vitamin D in subjects with normal reference range of alkaline phosphatase (N=196), it was 29.69 with standard deviation 8.62 and in subjects with abnormal reference range of phosphorus (N=4), it was 22.78 with standard deviation 3.49, the difference in mean 6.92 with 95% confidence [lower (-1.62) and upper (15.45)] was found statistically non significant (p>0.05).

The mean difference in other parameters calcium, phosphorus, estrogen, progesterone and testosterone was 0.38, 0.06, 21.17, 0.13, 0.55 respectively, the means of all parameters were found statistically not significant different (p>0.05).

On the basis of testosterone category:
Among all the subjects, 195 subjects were found with normal reference range of testosterone and 5 were found with abnormal reference range and when we see the mean of vitamin D in subjects with normal reference range of testosterone (N=195), it was 29.58 with standard deviation 8.64 and in subjects with abnormal reference range of phosphorus (N=5) it was 28.54 with standard deviation 7.49, the difference
in mean 1.04 with 95% confidence [lower (-6.66) and upper (8.47)] was found statistically non significant (p>0.05).

The mean difference in other parameters calcium, phosphorus, alkaline phosphatase, estrogen and progesterone was 0.16, -0.29, 4.42, 1.75 and -0.41 respectively, which were found highly statistically significant with progesterone (p=0.000) only and statistically non significant with calcium, phosphorus, alkaline phosphatase and estrogen (p>0.05).

- The association between the gender and all the study parameters was observed and found that a highly significant association between vitamin D (p=0.000), calcium (p=0.000), phosphorus (p=0.006) levels with gender was existed whereas the association between alkaline phosphatase, progesterone and testosterone levels with gender of study subjects were found statistically not significant (p>0.05) but the association between estrogen and gender could not be calculated because there were no cases of estrogen in abnormal category as shown in table number 5.15 to 5.21.

- Also the association of vitamin D (p=0.000), calcium (p=0.000) and alkaline phosphatase (p=0.007) levels were found statistically significant with respect to age as the deficiency of vitamin D and calcium is growing with age and the association with phosphorous (p=0.959), progesterone (p=0.389) and testosterone (p=0.136) was not found statistically significant with respect to age of study subjects whereas the association between estrogen with respect to age could not be computed as there was no case of abnormal level of estrogen as shown in table number 5.22 to 5.28.

“ANOVA” was applied to compare the means in different age groups in table numbers 5.29 to 5.37.

- In table 5.29 (a), the difference of means of vitamin D of all study subjects was found statistically highly significant (p=0.00) across the age groups. Further multiple comparisons were done in table 5.29 (b). The difference of vitamin D was found statistically highly significant (p=0.00) between age groups 31-40 years and 51-60 years.

- In table 5.30 (a) it is shown that the difference among the means of vitamin D of study subjects (n=85) with normal reference range was found statistically
significant at the level (p=0.018) across all (four) age groups. Further multiple comparisons were done in table 5.30 (b). The difference of vitamin D was found significant among age groups (20-30 years & 41-50 years), further (31-40 years & 41-50 years) with corresponding probabilities (p=0.050& p=0.029) respectively.

- As shown in the table 5.31 (a) that the difference among the means of vitamin D of study subjects (n=115) with abnormal reference range were found statistically not significant (p=0.075) across all the age groups.

- As shown in the table 5.32 (a) that the difference among the means of calcium of study subjects were found significant (p=0.001) across the age groups. Further multiple comparisons were done in table 5.32 (b). The difference of calcium was found statistically significant among age groups 31-40 years and 41-50 further 31-40 years and 51-60 years with corresponding probabilities 0.016 and 0.001 respectively.

- As shown in the table 5.33 (a) that the difference among the means of phosphorous of study subjects were found highly statistically significant at the level (p=0.000) across the age groups. Further multiple comparisons were done in table 33 (b). The difference of phosphorus was found significant among age groups 20-30 years and 51-60 years, 31-40 years and 41-50 years further 41-50 years and 51-60 years& vice-versa with further age groups.

- As shown in table 5.34 (a) that the difference among the means of alkaline phosphatase differed statistically significant at the level (p=0.000). Further multiple comparison was made in the table 5.34 (b) where in all possible pairs of age groups except (20-30 years and 31-40 years) were found statistically highly significant (p≤0.001).

- As shown in the table 5.35 (a) that the difference among the means of estrogen levels were found to be statistically highly significant among the age groups at the level (p=0.000). Table 5.35 (b) illustrates the multiple comparisons in which estrogen was found statistically significant within the age groups [(20-30 year & 41-50 years), (20-30 year & 51-60 years)], [(31-40 years and 51-60 years), (41-50 years & 20-30 years)] and [(51-60 year and 20-30 years), (51-60 year and 31-40 years)].
• As shown in the table 5.36 (a) that the difference among means of progesterone is highly statistically significant (p=0.000). Multiple comparisons were done in the table 5.36 (b) in which the differences among progesterone were found statistically significant in the age groups (20-30 year and 51-60 years), (31-40 years and 51-60 years) & (41-50 years & 51-60 years) with the probability p≤0.05.

• As shown in the table 5.37 (a) that the difference among the means of testosterone of study subjects were found statistically significant (p=0.018). Multiple comparisons were done in the table 5.37 (b) in which the differences among testosterone were found statistically significant in the age groups (31-40 years and 51-60 years).

• As shown in the table 5.38 that the correlation among various parameters taken into study with respect to age was found statistically significant at the level p≤0.05. The correlation coefficients (r) of vitamin D with calcium, phosphorus, alkaline phosphatase, estrogen, progesterone and testosterone were found statistically significant with probability (p≤0.05).

• As shown in the table 5.39 that the variations among alkaline phosphatase, estrogen and progesterone with respect to age were found statistically significant (p≤0.05) among healthy subjects(N=85) which has normal level of vitamin D. Correlation coefficients of vitamin D with phosphorus, estrogen and progesterone were also found significant statistically at the level (p≤0.05).

• As per table 5.40 that the correlation coefficients (r) among various parameters taken under study for vitamin D deficient subjects found that vitamin D does not vary significantly with variation in age (p=0.38). The variations among phosphorus, alkaline phosphatase, estrogen and progesterone with respect to age, were observed statistically significant at the level (p≤0.05). The levels of 25(OH)D have significant variation (p≤0.05) with respect to variations in the levels of calcium, phosphorus, alkaline phosphatase and estrogen.

• As shown in the table 5.41 that the correlation coefficient (r) among various parameters taken under study in vitamin D deficient male subjects, the variations among calcium, phosphorus, alkaline phosphatase, estrogen, progesterone and testosterone with respect to vitamin D were observed statistically not significant (p>0.05) whereas the correlation coefficient between (calcium and
phosphorous), (alkaline phosphatase and testosterone) was found statistically significant with the probability (p=0.001) & (p=0.005) respectively.

• As shown in the table 5.42 that the correlation coefficients (r) among various parameters taken under study for vitamin D deficient female subjects, the variations among calcium, phosphorus, progesterone and testosterone with respect to vitamin D were observed statistically not significant (p>0.05) whereas the correlation coefficients among alkaline phosphatase and estrogen with respect to vitamin D was found statistically significant with probability (p≤0.001). The correlation coefficients (r) between (phosphorus, alkaline phosphatase with calcium), (alkaline phosphatase, estrogen with phosphorus) and (alkaline phosphatase, progesterone with estrogen) were found statistically significant with probability (p≤0.05).

• As shown in the table 5.43 that the levels of vitamin D vary significantly with the variations in the levels of alkaline phosphatase, progesterone and testosterone among the study subjects of age group 20-30 years. The level of calcium also varies significantly (p≤0.05) with respect to the variations in the levels of phosphorous, progesterone & testosterone. The correlation coefficient between phosphorous & testosterone was significant (p≤0.05).

• As shown in the table 5.44 that the level of 25-hydroxy-vitamin D varies significantly with respect to the variations in the levels of alkaline phosphatase, estrogen and progesterone in the age group 31-40 years. Calcium also varies significantly with respect to variation in alkaline phosphatase. The correlation coefficient between phosphorous and vitamin D was found significant (p≤0.05).

• As shown in the table 5.45 that the level of 25-hydroxy-vitamin D varies significantly with respect to variations in the levels of calcium, alkaline phosphatase and estrogen. Calcium also varies significantly (p≤0.05) with respect to variation in the level of vitamin D, serum phosphorus & serum ALP in age group 41-50 years.

• As shown in the table 5.46 that the level of 25-hydroxy-vitamin D varies significantly with respect to variations in the levels of calcium, phosphorous and testosterone in the age group 51-60 years. Calcium also varies significantly (p≤0.05) with respect to variation in the level of vitamin D, phosphorus and
testosterone. The correlation coefficient among phosphorous, vitamin D, calcium, alkaline phosphatase and testosterone was found significant (p<0.05).

- As shown in the table 5.47 that the correlation coefficients (r) of vitamin D with calcium, phosphorous, alkaline phosphatase, estrogen & testosterone were found statistically significant (p<0.05) among male study subjects. The variation in the level of calcium was also found significant with respect to the variations in the levels of phosphorous and alkaline phosphatase (p<0.05). The correlation coefficients of phosphorous with alkaline phosphatase, progesterone and testosterone were also found significant.

- As shown in the table 5.48 that the correlation coefficients (r) of vitamin D with calcium, alkaline phosphatase, and estrogen were found statistically significant (p<0.05) among female study subjects. The variation in the level of calcium was also found significant with respect to the variations in the levels of phosphorous and alkaline phosphatase (p<0.05). The correlation coefficients of phosphorous with alkaline phosphatase and estrogen were found significant.

- As shown in the table 5.49 that the correlation coefficient (r) was found significant with respect to age with alkaline phosphatase and estrogen (p<0.05) among study subjects with normal reference range of calcium. The correlation coefficients with respect to vitamin D with phosphorous, alkaline phosphatase, estrogen, progesterone and testosterone were found significant (p<0.05). The correlation coefficients among calcium with phosphorous & testosterone were also found significant.

- As shown in the table 5.50 that the correlation coefficient (r) was found significant with respect to age with vitamin D, phosphorus, alkaline phosphatase, estrogen and progesterone (p<0.05) among study subjects with abnormal reference range of calcium. The correlation coefficients of vitamin D with phosphorous, alkaline phosphatase, estrogen, progesterone and testosterone were found significant (p<0.05). The correlation coefficients among calcium, vitamin D, phosphorous, alkaline phosphatase and testosterone were also found significant.

- As shown in the table 5.51 that the correlation coefficient (r) was found significant with respect to age with vitamin D, phosphorus, alkaline phosphatase, estrogen and progesterone (p<0.05), among study subjects with normal reference
range of phosphorus. The correlation coefficients with respect to vitamin D with calcium, phosphorous, alkaline phosphatase, estrogen, progesterone and testosterone were found significant ($p \leq 0.05$). The correlation coefficients with respect to calcium with vitamin D, phosphorus, alkaline phosphatase and testosterone were also found significant.

- As shown in the table 5.52 that the correlation coefficient ($r$) was found significant with respect to age with estrogen ($p \leq 0.05$), among study subjects with abnormal reference range of phosphorus. The correlation coefficients with respect to vitamin D with alkaline phosphatase and testosterone were found significant ($p \leq 0.05$).

- Food habit among all the subjects were also analyzed and observed that the association of 25(OH) D levels were found statistically significant ($p<0.05$) with milk ($p=0.00$) consumption, cereal with milk ($p=0.001$), cheese on pizza / toast ($p=0.00$), bread ($p=0.000$), fish ($p=0.045$), consumption of meat ($p=0.027$), consumption of yoghurt ($p=0.001$), consumption of butter ($p=0.00$) and consumption of cheese ($p=0.000$) of all study subjects as per table number 5.54, 5.56-5.58, 5.60, 5.61, 5.64-5.66 respectively.

- Furthermore, the association of 25(OH) D levels was found statistically not significant ($p>0.05$) with the consumption of tea / coffee ($p=0.394$), consumption of eggs ($p=0.180$), consumption of cereal ($p=0.494$) and consumption of pudding ($p=0.430$) of all study subjects as per table number 5.55, 5.59, 5.62 and 5.63 respectively with of all study subjects.

- In addition to the food habit sun light exposure, urban / rural living status and skin color of all the subjects were also analyzed and found that the association of vitamin D levels were found statistically significant ($p=0.000$) with sun light exposure and urban / rural background on the basis of their skin color (brown, light brown and dark brown) were also found statistically significant ($p=0.000$) with skin color of all study subjects with normal and abnormal reference range of vitamin D.

**In conclusion:**

It was found that there is elevated prevalence of vitamin D deficiency among the local population of north-east Haryana across different demographic
characteristics. Subjects with chances of a higher exposure to sunlight, such as rural, have relatively lower prevalence of this deficiency so there is a need of public awareness regarding dietary rectifications and lifestyle changes, to provide opportunities for greater exposure to sunlight. Many countries have the policy of food fortification with vitamin D. Such a strategy could also help improving the scenario in India. In this region it is necessary to find the factors that are responsible for higher prevalence. I would also like to add that with such high proportions of apparently healthy persons showing the defined levels of 25(OH)D deficiency in Haryana where, the sun rays are adequately, there may be a need to re-assess the definitions of optimal and deficient levels.

Vitamin D is of much important for the health of human beings & maintaining the adequate levels of 25(OH)D helps in preventing a lot of diseases. Radical guidelines may be avoided by everyone such as avoiding the sun exposure during the day and simultaneously use sunscreen at day time including all age groups because, there is no general rule. The doctor should keep in mind the general condition of the patient for prescribing the treatment and the disease status if any. Some people may be sensitive to sun exposure such as transplant patients with a pre-disposition to develop skin cancer or the patients on immunosuppressive medicine. Some patients having risk factors for deficiency of vitamin D can sunbathe, such people suffer from liver disease, renal failure, lactose intolerance, intestinal mal-absorption and cystic fibrosis, and some other groups of people may use some medications which decrease the level of 25(OH)D such as anti retrovirals, glucocorticoids and anti-fungal drugs. Thus, over all the best treatment would be one of the best in which, doctor examines the patient & take his medical history and based on the risk-factors, prescribes what is the most appropriate for the patient in that situation with the advice of sun exposure for at-least 10-30 minutes per day between 10 AM to 2 PM.

It is apparent that the deficiency of vitamin D has high prevalence in the population of Haryana and the intervention should be taken to be sure that Haryanavasi would receive the proper amount of vitamin D to maintain the optimal health. It is concluded from the present study that it is advisable to increase present dietary recommendation of vitamin D among all population.