INTRODUCTION

Loss of hair generally referred to as alopecia is a major concern affecting both sexes of any age. Mostly, women visit a dermatologist for hair loss, due to its effect on their cosmetic appeal. Diffuse hair loss is due to the hampering of any one of the phases of hair cycle: anagen (the active growth phase), catagen (phase of involution), or telogen (the resting stage). Most people have about 100,000 scalp hair among which 10%–15% are in telogen phase. Loss of 100–150 telogen hair is considered normal, but hair loss in anagen phase is abnormal. Diffuse hair loss is triggered by many factors such as physiological stress, emotional stress, various medical conditions, and dietary deficiencies. Deficiency of Vitamin D might be correlated with diffuse hair loss.

Synthesis of Vitamin D takes place in the epidermal keratinocytes under the influence of ultraviolet (UV)-B light (290–315 nm) or obtained from diet or dietary supplements. Endocrine system of Vitamin D directly or indirectly regulates approximately 3% of human genome. Till now, Vitamin D was believed to regulate only calcium and bone metabolism, but recent studies have shown its association with many other physiological functions.

ABSTRACT

Introduction and Aims: Hair fall is a common problem faced by many younger people, which has variety of risk factors. Vitamin D₃ has emerged as a molecule with key role to play in various disorders. This study was done to assess its role in diffuse hair fall among student population. Materials and Methods: This was a case–control study including young adults presenting with complaints of hair fall (>100 a day) as cases, with age-matched healthy controls. Vitamin D₃ levels were measured in all the patients. Data analysis was done using Statistical Package for Social Sciences version 11.5 software and significance was tested using Chi-square test and binary logistic regression analysis. Results: A total of 44 participants were enrolled; 22 in each arm. The mean age of the study population was 20.89 years (standard deviation: 1.49). The median value of Vitamin D was 6.80 (interquartile range - 5.350–16.63) for the study population. Overall, 81.8% cases had Vitamin D deficiency compared to 45.5% of controls and this difference was statistically significant ($P = 0.007$). Furthermore, females had a statistically significant difference in Vitamin D levels between cases and controls. Higher level of full sleeve cloth usage, sunscreen lotion application, and lesser sun exposures were seen among cases although these differences were not statistically significant. The levels of Vitamin D₃ were not significantly different among Indians, nonresident Indians, and foreigners. None of the cases had normal Vitamin D values whereas 4.5% controls fell in the normal category. Conclusions: Female patients with diffuse hair fall were found to have significantly low Vitamin D₃ levels among student population.

Key words: Alopecia, hair fall, Vitamin D₃
effects such as immune regulation and protection against radiation from UV light, infections, cancer, and oxidative stress. Vitamin D deficiency is defined as serum 25(OH)D concentration <20–25 nmol/l and insufficiency is defined as a serum 25(OH)D2 concentration between 25 and 75 nmol/l.

Vitamin D is a hair follicle differentiation promoter without having much effect on its proliferation. Correlation of Vitamin D levels has been seen among patients with hereditary Vitamin D receptor (VDR) deficiency with alopecia. Previous studies show that VDR is necessary for an essential stage of hair follicle development that appears to be independent of 1,25(OH)2D3. Furthermore, calcitriol was found to be effective in treating chemotherapy-induced alopecia in animal models. This study was carried out to test the association between levels of Vitamin D and hair fall among college going population.

MATERIALS AND METHODS

After obtaining clearance from the Institutional Ethics Committee (IEC), this case–control study was carried out between June and August 2015 in selected tertiary care teaching hospitals in a city in South India, among the young adults seeking health care for hair fall and controls without hair fall. The sample size was calculated using OpenEpi statistical software; based on a previous case–control study, with 80% power and 95% confidence interval (CI) and 10% nonresponse error, final sample size was 44 students (22 in each arm). After obtaining approval from the IEC and hospital authorities, the study hospitals were visited for data collection. Convenient sampling strategy was adopted for selecting the study participants. Those students with complaints of hair fall of more than 100 strands per day (self-rated) were included as cases and equal number of age-matched healthy individuals was included as controls. Individuals who had taken Vitamin D supplements within 1 year were excluded from the study. Cases to be included in the study were screened for anemia, serum ferritin levels, and thyroid profile; and those having abnormal values were excluded from the study. A written informed consent was obtained from each of them. The data were collected through a self-administered questionnaire which consisted of three sections: Section A included laboratory reports specifying Vitamin D levels; Section B included the questions regarding the factors effecting hair loss, and Section C included sociodemographic details. After filling up the questionnaire, their Vitamin D levels were assessed by collecting blood samples (both cases and controls) by venepuncture of the large antecubital veins. The samples were analyzed using the enzyme-linked immunosorbent assay kit (manufactured by CAL BIOTECH, USA) for the Vitamin D levels. Data collected were analyzed using statistical software Statistical Package for Social Sciences version 11.5 (SPSS Inc). Descriptive statistics were used for expressing the results. The association of sociodemographic characteristics with hair loss and Vitamin D levels was analyzed using Chi-square test and binary logistic regression. Unadjusted and adjusted odds ratios (ORs) were generated with 95% CI. The P < 0.05 was considered as statistically significant.

RESULTS

The study population consisted of 44 college going students, out of which 22 each were cases and controls. The mean age of the study population was 20.89 years (standard deviation: 1.49), the age distribution was similar across the cases and controls. Among the study population, 16 (36%) were males and 28 (64%) were females. The major portion of study population was Indians 35 (79%), 6 (14%) were nonresident Indians (NRIs), and 3 (7%) were foreigners.

Comparison of Vitamin D levels on the basis of sociodemographic details has been depicted in Table 1.

Table 1: Comparison of baseline characteristics among cases and controls (n=44)

| Baseline characteristics | Median (IQR) | P   |
|-------------------------|-------------|-----|
| **Males**               |             |     |
| Cases                   | 7.04 (5.76-9.56) | 1.000 |
| Controls                | 7.31 (5.57-15.95) |     |
| **Females**             |             |     |
| Cases                   | 5.49 (4.01-6.39) | 0.006* |
| Controls                | 17.43 (8.64-21.44) |     |
| **Indian**              |             |     |
| Cases                   | 6.04 (4.76-8.59) | 0.123 |
| Controls                | 15.55 (6.60-20.93) |     |
| **NRIs**                |             |     |
| Cases                   | 4.38 (3.72-6.36) | 1.000 |
| Controls                | 12.72 (12.72-21.72) |     |
| **Foreigners**          |             |     |
| Cases                   | 21.46 (21.46-21.46) | 0.333 |
| Controls                | 9.46 (4.06-9.46) |     |

*P value significant below 0.05 level. IQR – Interquartile range; NRIs – Nonresident Indians
21.46 in cases versus 9.46 in controls \((P = 0.33)\), but their differences were not statistically significant whereas in females, 5.49 in cases versus 17.43 in controls with an overall statistically significant difference was observed.

Perceptions of the study population toward hair fall have been depicted in Table 2. The most common reasons for hair fall among study population were water and climate change by 36 (81.8%) people, stress by 35 (79.5%) people, and dietary factors by 29 (65.9%) people. Among the study population, stress was opined by 77.3% cases and 81.8% controls and cosmetics was opined by 9.1% cases and 18.2% controls; however, their difference was not significant. Statistical significance was observed in 86.4% cases and 45.5% controls who opined dietary factors to be responsible for hair fall \((P = 0.01)\).

Regarding the sun exposure, more number of cases (55.6%) had sun exposure <0.5 h compared to the controls, whereas 51.5% of controls had adequate sun exposure of >0.5 h. The differences across the groups were not found to be statistically significant \((P = 1.00)\). More number of cases (57.1%) applied the sunscreen compared to the controls and full sleeves/fully covered clothes were mostly worn by cases (62.5%) compared to controls thus blocking the absorption of Vitamin D. The comparison of practices related to sun protection among cases and controls is shown in Table 3.

Vitamin D levels have been compared among the cases and controls in Table 4. Among the study population, 81.8% cases had Vitamin D deficiency compared to 45.5% of controls. Half of the controls (50%) were in the Vitamin D insufficiency category. None of the cases had normal Vitamin D values, whereas 4.5% controls fell in the normal category. These differences were found to be statistically significant \((P = 0.025)\). On comparing the median Vitamin D values among cases and controls, their difference was found to be statistically significant \((P = 0.007)\). The overall median value of Vitamin D was 6.80 (interquartile range - 5.350–16.63) for the study population.

Further, the association between the hair fall and other factors was tested by unadjusted and the adjusted ORs using the binary logistic regression model. It was found that the level of vitamin D3 in blood had statistically significant association with hair fall \((P = 0.013)\), wherein the unadjusted OR was 5.4 (95% CI: 1.37–21.26) and when adjusted for all the other variables under consideration, adjusted OR was 6.849 (95% CI: 1.49–33.33). This meant that those participants with deficient levels of Vitamin D3 in their blood, (which was lower as compared to those with insufficient levels) had higher chances of hair fall (i.e., being the cases). As described in Table 5, the other factors were not found to be statistically significant with respect to their association with hair fall among the participants. However, the lesser the exposure to sun light by virtue of clothing, sun screen lotion application or reduced direct skin contact with the sunlight, the extent of hair fall was higher.

**Table 2: Perceptions toward hair fall among the study population \((n=44)\)**

| Characteristics     | Cases, n (%) | Control, n (%) | Total, n (%) | \(P\) |
|---------------------|--------------|----------------|--------------|------|
| Stress              |              |                |              |      |
| Yes                 | 17 (77.3)    | 18 (81.8)      | 35 (79.5)    | 1.00 |
| No                  | 5 (22.7)     | 4 (18.2)       | 9 (20.5)     |      |
| Cosmetics           |              |                |              |      |
| Yes                 | 2 (09.1)     | 7 (31.8)       | 9 (20.5)     | 0.13 |
| No                  | 20 (19.9)    | 15 (68.2)      | 35 (79.5)    |      |
| Dietary factors     |              |                |              |      |
| Yes                 | 19 (86.4)    | 10 (45.5)      | 29 (65.9)    | 0.01*|
| No                  | 3 (13.6)     | 12 (54.5)      | 15 (34.9)    |      |
| Health issues       |              |                |              |      |
| Yes                 | 7 (31.8)     | 7 (31.8)       | 14 (31.8)    | 1.00 |
| No                  | 15 (68.2)    | 15 (68.2)      | 30 (68.2)    |      |
| Water/climate change|              |                |              |      |
| Yes                 | 18 (81.8)    | 18 (81.8)      | 36 (81.8)    | 1.00 |
| No                  | 4 (18.2)     | 4 (18.2)       | 8 (18.2)     |      |
| Genetics            |              |                |              |      |
| Yes                 | 7 (31.8)     | 7 (31.8)       | 14 (31.8)    | 1.00 |
| No                  | 15 (68.2)    | 15 (68.2)      | 30 (68.2)    |      |

*\(P\) value significant below 0.05 level

**Table 3: Group-wise comparison of practices related to sun protection**

| Characteristics | Cases, n (%) | Control, n (%) | \(P\) |
|-----------------|--------------|----------------|------|
| Sun exposure    |              |                |      |
| <0.5            | 5 (55.6)     | 4 (44.4)       | 1.000|
| 0.5-2           | 16 (48.5)    | 17 (51.5)      |      |
| >2              | 1 (50.0)     | 1 (50.0)       |      |
| Sunscreen       |              |                |      |
| Yes             | 4 (57.1)     | 3 (42.9)       | 1.000|
| No              | 18 (48.6)    | 19 (51.4)      |      |
| Clothing        |              |                |      |
| Full sleeves    | 5 (62.5)     | 3 (37.5)       | 0.470|
| Half sleeves    | 17 (50.0)    | 17 (50.0)      |      |
| Sleeveless      | 0            | 2 (100)        |      |

**DISCUSSION**

Our study population consisted of equal number of cases...
(having hair fall of more than 100 strands per day) and controls, respectively. The median value of Vitamin D among the cases came out to be significantly lower than the controls ($P = 0.007$). This was similar to a study on alopecia areata an autoimmune disease causing inflammation all around the anagen hair follicles where the cases having AA had significantly lower values of Vitamin D than controls ($P < 0.001$).[16,17] However, a study done on telogen effluvium (TE) showed findings contrary to our study, who found those with hair fall due to TE had higher level of Vitamin D. However, they attributed this high Vitamin D levels to the excess exposure to sunlight among that population.[18] Thus, level of hair fall and Vitamin D levels share complex association and are affected by several factors.

According to our study, the difference in the median Vitamin D levels among the male cases and controls was not significant ($P = 1.000$) which is in accordance with the study done on male pattern baldness showing no significant

| Characteristics | Cases, n (%) | Controls, n (%) | $P$ |
|-----------------|-------------|-----------------|----|
| Vitamin D level classification | | | |
| Deficient | 18 (81.8) | 10 (45.5) | 0.025* |
| Insufficient | 4 (18.2) | 11 (50.0) | |
| Normal | 0 | 1 (4.5) | |

Vitamin D levels, median (IQR)

| Characteristics | Cases | Controls | $P$ |
|-----------------|-------|----------|----|
| Average exposure to sunlight (h/day) | 6.04 (4.45-8.03) | 13.79 (6.35-19.96) | 0.007* |
| Regular use of sunscreen lotions | 0.711 (0.14-3.63) | 0.687 (0.07-6.63) | 0.744 |
| Common type of dress worn | 0.711 (0.14-3.63) | 0.687 (0.07-6.63) | 0.744 |
| Levels of Vitamin D3 in blood | 5.400 (1.37-21.26) | 6.849 (1.49-33.33) | 0.033* |

*P value significant below 0.05 level. IQR – Interquartile range

Table 4: Comparison of Vitamin D levels among the study population (n=44)

Table 5: Association between the factors and hair fall - univariate and multivariate analysis using binary logistic regression model (n=44)

In our study, the median value of Vitamin D among the females was significantly lower for the cases as comparison to the controls ($P = 0.006$) which is in agreement with another study, in which the Vitamin D levels in females with chronic TE or female pattern hair loss came out to be significantly lower among cases as compared to the controls for both the conditions ($P < 0.001$).[19] About 81.8% and 79.51% students in the study population consider water/climate change and stress, respectively, as the major factors influencing the hair fall. However, in the available literature, such comparisons about perceptions toward reasons for hair fall are limited. Studies have proven that many lifestyle factors including stress are major physiological factors contributed to hair fall among human beings.[3]

In our study, the results were inconsistent among the cases and controls when the practices related to the sun exposure, sunscreen application, and type of clothing were asked which was also the case with a study, in which the correlation between sun exposure, sunscreen application, and Vitamin D levels came out to be insignificant ($P = 0.50$).[19]

A review done by Amor et al. cited a need for evidence-based data for recommendation of Vitamin D supplementation.[8] Our study showed that Vitamin D levels among most of the cases fell in the Vitamin D
There are no conflicts of interest.

Conflicts of interest

There are no conflicts of interest.

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