

Analysis of various factors responsible for hair loss and awareness level in Delhi and the National Capital Region of India

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The aim of this study was to assess the prevalence, causes and awareness about various factors related to hair loss in subjects of Delhi and the National Capital Region of India. A survey-based study was conducted with 380 participants. Total dissolved solids level of water samples used for hair wash was also analysed. Majority of subjects (96.5%) were affected with hair loss. High percentage of subjects were unaware about the role of diet (94%), iron content (77.65%), hormonal level (89.92%) and genetic factors (93.19%) with respect to hair loss. Persistent, long-term hair loss is an indicator of some disturbance in physiological or environmental factors. Therefore, it is imperative to generate awareness among the population at regular intervals.

Keywords: Genetic factors, hair loss, hormones, iron deficiency, total dissolved solids.

HAIR loss or alopecia is one of the most common distressing disorders experienced by people of all age groups characterized by sudden or gradual decline in hair density from the head and other bodily parts. Earlier a high percentage of individuals used to experience hair loss by the age of fifty. However, recently due to lifestyle changes and other factors, many start to see the first sign of hair loss in their adolescence. This widespread nature of hair loss is caused by several factors, which vary among individuals and could be temporary or long-lasting. Factors associated with sudden hair loss are illness, medications, dietary habits or childbirth, while gradual hair loss is usually associated with severe distress, workload and depression. The pathophysiological factors involved in hair loss are genetic disorders, endocrine abnormalities, drug intake, nutritional deficiencies, fungal infections and auto-immune disorders¹. Most people are unaware that hormonal imbalance and iron deficiency are the most common causes of hair loss^{2,3}. However, the extent to which these contribute to hair loss is still unclear. Exposure to increasing levels of air pollution, including particulate matter, dust, smoke, sulphur dioxide, nitrogen dioxide, ammonia and polycyclic aromatic hydrocarbons (PAHs) causes 'sensitive scalp

syndrome' leading to hair loss⁴. Stress caused by excessive use of hair dryers, hair dyes, hot curlers, hair-straightening products, and chemical-laden cosmetics causes decline in the general health of hair (brittle, dry and thin hair) and ultimately hair loss⁵.

Among the various internal and external factors contributing to hair loss, the quality of water used for hair washing is important in determining the degree of hair loss. Long-term use of water having high levels of positively charged minerals like magnesium, silica, iron and calcium weakens the hair follicles, roots and shafts, leading to dryness, thinning and hair loss⁶.

Therefore, it is important to study the various factors associated with hair loss at regular intervals and generate awareness, as this problem is affecting a high percentage of individuals across the globe. Thus, the present study was undertaken to assess the same from different regions of Delhi and the National Capital Region (NCR) of India using questionnaire-based survey.

The study was conducted with 380 (70% female, 30% male) randomly selected subjects belonging to different age groups (10–80 years), residing in Delhi and NCR during June to September 2018. Thirteen samples were excluded from the further study who answered the first question negative and the final study was conducted with 367 samples. All the participants were assured of confidentiality. Only willing participants were included in the study after receiving a written consent.

A uniform questionnaire was designed with 34 close-ended questions for obtaining information about the occupational status, lifestyle stress, dietary habits, general health, hormonal level and various other factors which directly or indirectly contribute to hair loss among the subjects. The level of awareness with respect to hair loss and its causes was also determined through the study.

Water samples (tap water/groundwater) used for hair washing were collected for measuring total dissolved solids (TDS) level using a TDS metre.

Data collected were compiled, and analysed using percentage statistics. Among the 380 subjects surveyed, 96.58% ($n = 367$) showed high prevalence of hair loss irrespective of their place of residence, gender and occupation (Table 1). Data collected showed that subjects residing in Faridabad and Gurugram experienced marginally low percentage of hair loss ($87.96\% \pm 5.815\%$, $n = 108$) compared to those residing in Delhi (100% , $n = 207$) and Noida and Ghaziabad (100% , $n = 65$). It was observed that compared to non-working subjects ($94.88\% \pm 2.80\%$, $n = 241$), the percentage of working subjects (job or business) experiencing hair loss was high (100% , $n = 126$). Further, maximum number of subjects experienced first signs of hair loss at an early age, viz. 10–20 years (35.69% , $n = 131$) and 20–30 years (48.77% , $n = 179$).

Among the 367 subjects, a high percentage (67.58% , $n = 248$) was suffering from gradual hair loss (Table 2).

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Table 1. Socio-demographic conditions and their association with hair loss (figures in parentheses indicate percentage)

Parameters	Delhi	Faridabad and Gurugram	Noida and Ghaziabad	Total
Sample size	<i>n</i> = 207	<i>n</i> = 108	<i>n</i> = 65	<i>n</i> = 380
Gender				
Male	67 (32.36)	25 (23.14)	22 (33.84)	114 (30)
Female	140 (67.63)	83 (76.85)	43 (66.15)	266 (70)
Occupational status				
Working, affected	64 (30.91)	35 (32.40)	27 (41.54)	126 (100 = 126/126)
Working, not affected	–	–	–	–
Non-working, affected	143 (69.08)	63 (58.33)	38 (58.46)	241 (94.88 = 241/254)
Non-working, not affected	–	13 (12.04)	–	13 (5.12 = 13/254)
Subjects affected by hair loss	207 (100)	95 (87.96)	65 (100)	367 (96.57)
Age (years) at which hair loss started				
10–20	94 (45.41)	8 (8.42)	29 (44.61)	131 (35.69)
21–30	78 (37.68)	77 (81.05)	24 (36.92)	179 (48.77)
31–40	27 (13.04)	10 (10.52)	9 (13.84)	46 (12.53)
41–50	0 (0)	0 (0)	3 (4.61)	3 (0.82)
51–60	–	–	–	–
61–70	–	–	–	–
71–80	8 (3.86)	–	–	8 (2.18)
<i>n</i>	207	95	65	367

Table 2. Pattern of hair loss (figures in parentheses indicate percentage)

Parameters	Delhi (<i>n</i> = 207)	Faridabad and Gurugram (<i>n</i> = 95)	Noida and Ghaziabad (<i>n</i> = 65)	Total (<i>n</i> = 367)
How rapid was hair loss at the start?				
Gradual	134 (64.73)	78 (82.10)	36 (55.38)	248 (67.58)
Sudden	59 (28.50)	17 (17.89)	29 (44.61)	105 (28.61)
Do not know	14 (6.76)	–	–	14 (3.81)
Are your hair				
Breaking off	103 (49.75)	24 (25.26)	35 (53.84)	162 (44.14)
Coming out with root attached	103 (49.75)	71 (74.73)	30 (46.15)	204 (55.59)
Both	1 (0.48)	0	0	1 (0.29)
Does the problem get aggravated in specific weather				
Yes	97 (46.85)	49 (51.57)	34 (52.30)	180 (49.05)
No	104 (50.24)	46 (48.42)	31 (47.69)	181 (49.32)
Do not know	6 (2.89)	0 (0)	0 (0)	6 (1.63)

More than half (55.58%, *n* = 204) of the subjects reported that their hair came out with root attached, a condition detrimental to the regrowth of new hair. However, it was reported that in almost half (49.32%, *n* = 181) of the subjects, the severity of hair loss was not associated with changing weather and remained persistent throughout the year.

It is indispensable to underline the role of chemical treatment in terms of shampoo used and proper diet with respect to hair loss. With this objective, subjects were questioned to check their awareness level and importance of appropriate shampoo depending on hair type and its impact on hair loss. It was found that only 46.86% (*n* = 172) participants changed shampoo after experiencing hair loss and a significant number among them (50%, *n* = 86) was relieved (Table 3). An overwhelming majority

(70.57%, *n* = 259) of subjects surveyed had never chemically coloured their hair. Similarly, 75.74% (*n* = 278) surveyed subjects had never applied heat treatment to their hair (Table 4).

With regard to proper diet and nutrition, majority of participants (93.73%, *n* = 344) were not following any particular diet and only 5.99% (*n* = 22) of the participants began to take special diet in terms of higher protein intake (pulses and meat) and green vegetables for relief. When they were cross-questioned regarding decline in hair loss after intake of special diet, only 31.81% (*n* = 7) gave positive response (Table 3).

When participants were asked about physical appearance of hair, 32.42% (*n* = 119) responded that they had thin and rough hair while 22.61% had rough and thick hair (*n* = 83) (Table 5). To interpret the impact of water

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Table 3. Awareness regarding role of personal care and diet in relation to hair loss (figures in parentheses indicate percentage)

Parameters	Delhi	Faridabad and Gurugram	Noida and Ghaziabad	Total
Have you changed shampoo after the start of hair loss?				
Yes	84 (40.57)	57 (60)	31 (47.69)	172 (46.86)
No	123 (59.42)	38 (40)	34 (52.30)	195 (53.13)
<i>n</i>	207	95	65	367
If yes, did it help control hair loss?				
Yes	61 (72.61)	18 (31.57)	7 (22.58)	86 (50)
No	23 (27.38)	39 (68.42)	24 (77.41)	86 (50)
<i>n</i>	84	57	31	172
Have you been on a diet before the start of hair loss?				
Yes	16 (7.72)	4 (4.21)	3 (4.61)	23 (6.27)
No	191 (92.27)	91 (95.78)	62 (95.38)	344 (93.73)
<i>n</i>	207	95	65	367
Have you started any special diet to control hair loss?				
Yes	13 (6.28)	4 (4.21)	5 (7.69)	22 (6)
No	194 (93.71)	91 (95.78)	60 (92.30)	345 (94)
<i>n</i>	207	95	65	367
If yes, did it help control hair loss?				
Yes	4 (30.76)	2 (50)	1 (20)	7 (31.81)
No	8 (61.53)	2 (50)	4 (80)	14 (63.63)
No idea	1 (7.69)	–	–	1 (4.54)
<i>n</i>	13	4	5	22

Table 4. Awareness regarding various adornment factors on hair (figures in parentheses indicate percentage)

Parameters	Delhi (<i>n</i> = 207)	Faridabad and Gurugram (<i>n</i> = 95)	Noida and Ghaziabad (<i>n</i> = 65)	Total (<i>n</i> = 367)
How often is your hair chemically treated for colouring/straightening?				
Never	143 (69.08)	61 (64.21)	55 (84.61)	259 (70.57)
Weekly	6 (2.89)	6 (6.31)	7 (10.76)	19 (5.18)
Monthly	58 (28.01)	28 (29.47)	3 (4.61)	89 (24.25)
How often is your hair heat treated for curling/blow drying/straightening?				
Never	155 (74.87)	73 (76.84)	51 (78.46)	278 (75.74)
Weekly	13 (6.28)	8 (8.42)	5 (7.69)	26 (7.08)
Monthly	39 (18.84)	14 (14.73)	9 (13.84)	62 (16.89)

quality used for hair washing the subjects were questioned about the type of water used. It was found that a majority of subjects used tap water for hair washing (92.64%, *n* = 340). Besides the fact that a high percentage of subjects (85.01, *n* = 312) were aware about the role of water in hair loss, only one subject attempted to switch the water used for hair washing. Further, TDS level of water was measured and it was concluded that 267 samples had TDS level below 500 ppm while for 71 samples it was higher than 900 ppm. According to the US Environmental Protection Agency (EPA), the permissible limit for TDS is 500 ppm.

Hair loss is associated with various factors, and abnormality or disturbance in any of these factors causes the disorder. It is important to assess the awareness level of studied subjects regarding these factors, as a cure is possible only when an underlying factor is known (Table 6). With this aim, subjects were questioned whether their

iron and hormonal levels had been checked. Only 22.34% (*n* = 82) and 10.08% (*n* = 37) subjects opted for quantitative analysis of iron and hormonal levels in the blood respectively. It was observed that subjects from Faridabad and Gurugram were more cautious about hair loss and opted for laboratory test. It was analysed that a significantly low (6.81%, *n* = 25) number of subjects were aware about the fact that hair loss could be a result of genetic factors.

It is interesting to note that all 367 subjects had some problem with the scalp, as 69.75% (*n* = 256) participants were suffering with clinical conditions like burning or itching of the scalp, while the remaining 39.50% (*n* = 145) of the subjects had dandruff or flakes on the scalp (Table 7). Only 14.44% (*n* = 53) of the subjects were concerned about hair loss and consulted a medical practitioner.

Hair loss affects both males and females, leading to decline in hair density and in some cases, baldness.

Table 5. Physical appearance of hair and its co-relation with hardness of water (figures in parentheses indicate percentage)

Parameters	Delhi (n = 208)	Faridabad and Gurugram (n = 95)	Noida and Ghaziabad (n = 65)	Total (n = 367)
Texture of hair				
Thick	7 (3.38)	4 (4.21)	4 (6.15)	15 (4.08)
Rough and thin	62 (29.95)	28 (29.47)	29 (44.61)	119 (32.42)
Silk and thick	35 (16.90)	33 (34.73)	1 (1.53)	69 (18.80)
Rough and thick	53 (25.60)	9 (9.47)	21 (32.30)	83 (22.61)
Silk and thin	50 (24.15)	21 (22.10)	10 (15.38)	81 (22.07)
What is the source of water for hair-washing?				
Tap water	189 (91.30)	93 (97.89)	58 (89.23)	340 (92.64)
Groundwater	18 (8.69)	2 (2.10)	7 (10.76)	27 (7.36)
Do you think that hardness of water affects hair loss directly?				
Yes	181 (87.43)	70 (73.68)	61 (93.84)	312 (85.01)
No	26 (12.56)	25 (26.31)	4 (6.15)	55 (14.99)
Have you switched water source to counter hair loss?				
Yes	0 (0)	1 (1.06)	0 (0)	1
No	207 (100)	94 (98.94)	65 (100)	366
If yes, did it help?				
Yes	0	0	0	0
No	0	1 (100)	0	0
Total dissolved solids level of water used for hair washing				
Below 100	41 (19.80)	12 (12.63)	0 (0)	53 (14.44)
100–300	120 (57.97)	44 (46.31)	0 (0)	164 (44.69)
300–500	32 (15.45)	17 (17.89)	1 (1.53)	50 (13.62)
500–700	7 (3.38)	16 (16.84)	0 (0)	23 (6.27)
700–900	1 (0.48)	0 (0)	5 (7.69)	6 (1.63)
Above 900	6 (2.89)	6 (6.31)	59 (90.76)	71 (19.35)

Table 6. Awareness level of subjects with respect to various causative factors of hair loss (figures in parentheses indicate percentage)

Parameters	Delhi	Faridabad and Gurugram	Noida and Ghaziabad	Total
Have you ever checked your iron content?				
Yes	37 (17.87)	40 (42.10)	5 (7.69)	82 (22.34)
No	170 (82.12)	55 (57.89)	60 (92.30)	285 (77.66)
<i>n</i>	207	95	65	367
If yes, whether the iron levels were within range?				
Yes	23 (62.16)	32 (80)	2 (40)	57 (69.51)
No	14 (37.83)	8 (20)	3 (60)	25 (30.49)
<i>n</i>	37	40	5	82
Have your hormone levels ever been checked to evaluate hair loss?				
Yes	17 (8.21)	15 (15.78)	5 (7.69)	37 (10.08)
No	190 (91.78)	80 (84.21)	60 (92.30)	330 (89.92)
<i>n</i>	207	95	65	367
If yes, whether the hormone levels were within range?				
Yes	10 (58.82)	10 (66.66)	2 (40)	22 (59.45)
No	7 (41.17)	5 (33.33)	3 (60)	15 (40.54)
<i>n</i>	17	15	5	37
Do you think that it is a genetic disorder?				
Yes	17 (8.21)	4 (4.21)	4 (6.15)	25 (6.81)
No	190 (91.78)	91 (95.78)	61 (93.84)	342 (93.19)
<i>n</i>	207	95	65	367
If yes, from whom have you probably inherited it?				
Father	12 (70.58)	3 (75)	1 (25)	16 (64)
Mother	5 (29.41)	0 (0)	2 (50)	7 (28)
Both	0	1 (25)	1 (25)	2 (8)
<i>n</i>	17	4	4	25

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Table 7. Associated clinical condition and medication for hair loss (figures in parentheses indicate percentage)

Parameters	Delhi (n = 207)	Faridabad and Gurugram (n = 95)	Noida and Ghaziabad (n = 65)	Total (n = 367)
Is there any clinical condition associated with scalp?				
Itching/burning	163 (78.74)	39 (41.05)	54 (83.07)	256 (69.76)
Nothing	44 (21.25)	56 (58.94)	11 (16.92)	111 (30.25)
Do you have dandruff or flaking in your scalp?				
Yes	81 (39.13)	36 (37.89)	28 (43.07)	145 (39.51)
No	126 (60.86)	59 (62.10)	37 (56.92)	222 (60.49)
Is there any medication you are taking for relief?				
Yes	34 (16.42)	15 (15.78)	4 (6.15)	53 (14.44)
No	173 (83.57)	80 (84.21)	61 (93.84)	314 (85.56)
If yes, is there any decrease in hair loss?				
Yes	7 (20.58)	6 (40)	0 (0)	13 (24.53)
No	27 (79.41)	9 (60)	4 (100)	40 (75.47)

Various factors causing hair loss are both internal (from enzymes to hormones) as well as external⁷. Earlier hair loss was considered to be an age-related phenomenon. However, at present a high percentage of subjects are experiencing hair loss at an early age between 10 and 20 years (35.69%, $n = 131$) and 20 and 30 years (48.77%, $n = 179$). This depicts that hair loss is related to other factors as well. Keeping this in view, further questions were framed to decipher and analyse the various factors contributing to early start of hair loss. It has been reported that there is high prevalence of abrupt and short-term hairloss during extreme weather conditions, but gradual hair loss (49.05%, $n = 180$) throughout the year (49.32%, $n = 181$) indicates that it is not likely to be a physiological cycle, but a result of external or internal disturbances. Frequent use of shampoos containing synthetic ingredients not only make the hair dry and dull, but also has other side effects in terms of increased hair fall because of the presence of alkanolamides used as a surfactant. It is interesting to note that the maximum number of participants who got relief after changing their shampoo ($n = 61$) were from Delhi. In cities, hardness of water is the major cause of hair loss. It contains high amounts of magnesium, silica and calcium, which leads to breakage, dryness and thinning of hair. Hard water also results in dandruff and destroys hair follicles and is therefore detrimental to the regrowth of new hair⁶. In the present study, the impact of high dissolved solids on hair loss could not be ascertained as only 100 subjects (27.25%) were using water with TDS level above 500 ppm.

Table 6 shows that majority of subjects were unaware of the role of special diet, iron content, hormonal levels and genetic factors with respect to hair loss. It has been reported that only 6% of the subjects were aware about the role of special diet and proper nutrition. Iron deficiency is the world's most common nutritional deficiency and is a well-known cause of hair loss⁸. It has been studied that iron works as a cofactor for ribonucleotide reductase, the rate-limiting enzyme for DNA synthesis. Hair follicles are one of the most rapidly dividing cells in our body and ribonucleotide reductase helps in the divi-

sion and growth of hair follicles². In addition, multiple genes have been identified in human hair follicles regulated by iron^{9,10}.

In males and females, hair loss is androgen- and estrogen-dependent respectively^{3,11}. Dihydrotestosterone (DHT), a more potent form of testosterone in males is synthesized from testosterone by a specific enzyme, 5-alpha reductase. While both testosterone and DHT are known to have a weakening effect on hair follicles, there appears to be something unique about the conversion process of testosterone to DHT that is related to hair thinning. This is why some drugs that are marketed for hair loss block the conversion of testosterone to DHT. In females, hair loss is one of the most common symptom of polycystic ovary syndrome (PCOS). It has been reported that most of the women who have PCOS also suffer from with androgenic alopecia^{12,13}. The data collected in the present study depict a low level of awareness among the subjects regarding hormonal level as only 37 subjects had their hormonal levels checked. Along with nutrition and hormonal level, genetic factor is one of the most important internal factors contributing to hair loss. It has been reported that the genetic machinery controls the metabolism of hormones and active substances required for hair growth and proliferation of hair follicles. However, only 6.81% ($n = 25$) subjects considered this as a plausible cause for hair loss.

According to statistical analysis of data, 69.76% subjects reported itching/burning of scalp, which could be identified as 'sensitive scalp syndrome' resulting from exposure to increasing levels of air pollution, including particulate matter, dust, smoke, nickel, lead, arsenic, sulphur dioxide, nitrogen dioxide, ammonia and PAHs which settle on the scalp and hair. This could be the reason why non-working people are also experiencing hair loss, as the indoor environment contains volatile organic compounds released from various sources which deposit on the scalp. The pollutants transepidermally migrate to the dermis, thus leading to oxidative stress and hair loss. With such a high prevalence of hair loss, only 14.44% subjects consulted a medical practitioner.

Thus, the present study shows that the younger population is most affected by hair loss. Lifestyle related stress and pollution are the major factors responsible for hair loss, along with hardness of water which leads to scalp-related problems like dandruff and flaking. Majority of the population was unaware of the contribution of special diet, iron content, hormonal levels and genetic features to hair loss. It is imperative to generate awareness among the population regarding the causative factors, as persistent and long-term hair loss is an indicator of some physiological or environmental disturbances.

Conflict of interest: The authors declare no conflict of interest.

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A comparative study of physical properties of yarns and fabrics produced from fresh and recycled fibres

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Recycling is the process of producing new products with additional qualities from old materials which are no more in use. Furthermore, the decreasing natural resources forced researchers to produce new synthetic products from waste products using new technologies. This study compares the physical properties of yarns and fabrics produced using blends of fresh and recycled fibres/fabrics of wool, acrylic and polyester; these were used to manufacture fabrics through weaving technique. Physical properties of yarns, i.e. tensile strength, twist per inch of fabrics, i.e. tensile strength, elongation and bending length were measured and statistically analysed. The results showed that the physical properties of recycled yarns and fabrics were comparable to control/fresh yarns and fabrics. The strength of recycled yarns and fabrics was little different than control products. Thus, recycled yarns and fabrics can be used for the production of woollen apparels with suitable properties like smooth texture, appeal, etc.

Keywords: Fabrics, physical properties, recycling, yarns.

INDIA is the second largest producer of textiles and garments in the world and according to a report by Technopak Advisors the Indian textiles and apparel industry is expected to grow to about US\$ 223 billion by 2021. The Indian textile industry is the oldest industry providing employment and earning foreign exchange for the country (<http://info.shine.com/industry/textiles/17.html>). As consumers are becoming more fashion-oriented, every year millions of garments are discarded because they are either worn out, damaged, outgrown or gone out of fashion. As a result, several textile and clothing items are disposed-off into the trash and end up in municipal landfills. Throwing away clothes is not only wasteful but also harmful for society and creates pollution problems.

For proper waste management and to generate minimum amount of waste, the waste hierarchy has taken many forms over the past decade; ‘Reduce, Reuse and Recycle’ are the three Rs in the waste hierarchy. Reduce is design for minimum use of energy, minimize or eliminate waste material. Reuse refers to the use an item more than once without reprocessing, which saves time, money,

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