



General Public Knowledge, Attitudes, and Practices Regarding Hair Dye Usage and Its Adverse Effects in the Northern Emirates of the United Arab Emirates

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ABSTRACT

Objectives: This study aimed to assess the general population's knowledge, attitudes, and practices regarding hair dye (HD) usage and its adverse effects in the Northern Emirates of the United Arab Emirates.

Materials and Methods: A cross-sectional study was conducted over 3 months in the general population of Ras Al Khaimah. Information was collected by administering a pre-validated self-administered questionnaire related to HDs. Data collected were analyzed using descriptive statistics and binary logistic regression to correlate HD use with various sociodemographic variables. Results with a p -value less than 0.05 were considered statistically significant.

Results: In total, 333 of the 405 distributed questionnaires completed the study, with a response rate of 82.20%. Most (52.85%) participants used natural HDs, and most (30.59%) admitted that their motivation to use HD was to remove gray hair. Of the total sample, nearly 75% agreed that they had never performed an allergic test before using the HD, and almost 70% believed that providing advice regarding the HD would be beneficial. Sex ($p < 0.0001$), age (in years) ($p = 0.032$), and occupation ($p = 0.042$) were associated with the frequency of HD use, which was statistically significant.

Conclusion: In the present study, HD was common among students, employees, and middle-aged students. Approaches such as educational awareness programs with special attention to the safe and effective use of HDs may help individuals select appropriate HDs and avoid preventable adverse effects.

Keywords: Hair dye, health knowledge, adverse effects, surveys and questionnaires

INTRODUCTION

Healthy and beautiful hair enhances personality, physical appearance, and beauty. Maintaining good, healthy, and stylish hair has gained much importance presently and significantly among adolescents, exerting a profound effect on their outlook.¹ In today's modern world, the use of hair dye (HD) products is widely accepted, irrespective of gender, age, educational status, or social status to conceal gray hairs or just for changing fashion trends.²

Temporary, semi-permanent, and permanent HDs are the different types of HDs used to modify hair color to achieve a beautiful and youthful appearance. HDs consisting of natural and synthetic agents provide hair with good shape, attractive and elegant appearance, and long-lasting color. The periodic use of HDs or coloring products has become routine for many individuals, devoting considerable time and financial expenditure to achieving soft, silky, and shiny hair.^{1,3}

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The assumption that HDs are safe and will not cause damage to human health, and the increase in hair coloring trend have raised concerns about their safety, as some synthetic agents contain toxic substances known to be detrimental to their well-being.⁴ Studies have reported that cosmetics, including hair products, are associated with various known and unknown adverse reactions ranging from mild local reactions to more severe systemic life-threatening reactions jeopardizing a person's life in danger.³⁻⁶ Keeping in view the numerous health hazards associated with HD, adequate knowledge and accurate information about HD composition, its use, and adverse effects are important in reducing the prevalence of HD-associated complications among users.

It has been reported that the use of paraphenylenediamine (PPD), a synthetic aromatic amine, is the leading cause of contact dermatitis among HD users. In addition, hyperpigmentation, leukoderma, hair loss, chemical burns, skin malignancy, and systemic diseases are some of the adverse effects of HD preparations.^{2,4}

However, there is a paucity of studies describing the adverse effects of HDs among HD users. To the best of our knowledge, no previous study has attempted to assess the level of knowledge, attitudes, and practices regarding HD use among users in the Northern Emirates of the United Arab Emirates. Considering this, the present study aimed to assess knowledge, attitudes, and practices regarding HD and its adverse effects among HD users.

MATERIALS AND METHODS

Study design and settings

This cross-sectional, self-administered questionnaire-based study was conducted in the Emirate of Ras Al Khaimah from February 2022 to July 2022. Ethical approval was obtained from the institutional research ethics committee and from the Ras Al Khaimah Research Ethics Committee before the initiation of the study (approval number: MOHAP/REC/2022/7-2022-UG-P, date: 21.02.2022). Subjects of either gender aged 18 years and above who had used HD (natural/synthetic) at least once in their lifetime were included after obtaining informed consent.

Study procedure

The sample size was calculated using the Rao soft calculator.⁷ Assuming that the estimated urban population of Ras Al Khaimah is nearly one lakh, and the prevalence rate of HDs used in the Gulf Cooperation Council based on earlier studies is 30%. The minimum sample size is 330 respondents with a 5% margin of error, 95% confidence interval, and 50% response distribution. A convenient sampling technique was used to enroll participants in the study. Information was collected from the general population and employees of our university through a questionnaire developed by the researcher *via* Google Forms provided through emails. In addition, subjects who visited the hair and beauty salons were contacted, and information was collected by providing a hard copy of the questionnaire. For the questions sent through the Google survey form, the informed

consent form page will be opened, and only after consenting to answer the questions by marking a voluntary checkbox will the respondents be directed to the main survey instrument.

Participants were informed that the study was voluntary, and we assured them of the anonymity and confidentiality of their responses. Sufficient time (approximately one week) and an email reminder were provided to each participant to complete and submit the questionnaire. The investigator re-checked every submitted response to ensure the collected data's quality and to avoid any incomplete information in the questionnaire. Questions that could reveal the personal identity of the study subject were not included in the tool.

Questionnaire development and scoring

A self-administered or interviewer-assisted survey on knowledge, attitude, and practice related to HD use was prepared by referring to previous literature and similar studies and modified as per study requirements.^{5,6,8,9} The questionnaire's content validity was evaluated by three experts in the field, who assessed the relevance, clarity, and comprehensiveness of the items to ensure accurate representation of key aspects of knowledge, attitudes, and practices concerning HD use. The questionnaire was improved as a result of their input, proving its pre-validity. A convenience sample of ten people was used for a pilot test to evaluate the instrument's reliability. Cronbach's alpha was used to determine internal consistency, and a value of > 0.7 indicated satisfactory reliability. We acknowledge the significance of concept and criterion validity and recommend that they be investigated in future research using methods like factor analysis or correlations with existing measures, even though formal tests for these validities were not carried out in this study. Multiple-choice items were evaluated according to the total number of correct answers chosen, and the questionnaire was scored using a binary approach (1 for correct/positive responses, 0 for incorrect/negative ones). The questionnaire's reliability and clarity for the intended audience were validated by the pilot study.

There are two sections and sixteen questions in the survey instrument. The demographic data of the respondents, such as age, gender, nationality, marital status, and employment, is gathered in the first part. Questions about the type of HD, usage frequency, side effects, and motivations for using HDs are included in the second section. These questions were answered with the following responses: "yes", "no", and "I do not know". When appropriate, several questions were made to let respondents choose more than one answer. Descriptive analysis of the information gathered from these answers was done to find patterns in HD use-related knowledge, attitudes, and behaviours.

Statistical analysis

Participants' responses to the questions were coded, entered into an Excel spreadsheet, and analyzed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Descriptive statistics were employed to assess the mean and standard deviation for continuous variables and the percentages and frequencies

for categorical variables to narrate demographic factors. The chi-square test was used to test the association between the frequency of HD use and demographic variables. Binary logistic regression was used to relate HD use to various sociodemographic variables. A value of $p < 0.05$ was considered statistically significant.

RESULTS

The questionnaire was distributed among 405 participants. In total, 333 subjects (82.20%) fully completed and returned the questionnaire. Among the remaining 72 participants, 57 did not respond to the e-mails, and 15 responses were partially completed and not considered for the analysis. Among the 333 participants who completed the study, 99 completed the questionnaire *via* Google Forms, and the remaining 234 completed face-to-face interviews.

Sociodemographic characteristics of the study participants

Of the total study population, female (68.5%) predominance was noted over males, and the study population's median age was 30.0 (in years). Most of the study participants were in the age group 21-40 years. The majority of the study participants were non-Arab (74.2%), and nearly half of the study subjects were unmarried (48.9%) and none were classified as "divorced". More than one-third of the participants were working employees (39.9%), and almost half were students (47.4%) (Table 1). An analysis of the responses to the questions related to knowledge, attitude, and practice among the HD users revealed that only 8.4% responded that they had experienced allergic reactions related to HD preparations. When asked about performing an allergic test before using HD, 72.97% answered that they had never previously performed an allergic test before using HD.

Regarding the ingredients in HD, only one-third (34.53%) of the participants read the list. Among the total participants, only 45.64% agreed that they seek advice or suggestions before buying HD. Almost 70% of users indicated that providing educational advice regarding HD would benefit them. Less than 10% of the study participants stated that available HD preparations in the market are safe and can be used in all age groups. Most of the study participants acknowledged that they were unaware of the hazardous chemicals/toxic ingredients of HDs, did not get enough information when buying HD products, and neither consulted nor received pharmacist advice (Table 2).

Concerning the types of HD preferred by the study participants, more than half (52.85%) preferred the use of natural dye,

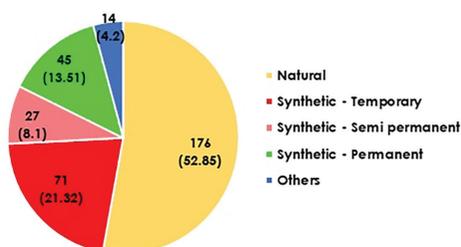


Figure 1. Different types of hair dyes used by the study participants (n= 333)

while 42.93 preferred synthetic dyes of different types, and the remaining 4.20% answered others consisting of egg, hibiscus, and other natural substances (Figure 1).

Adverse effects of HDs

Fewer adverse effects such as fizzy hair (n= 6; 11.53%), rashes over the face and forehead (n= 14; 26.92%), headache (n= 10; 19.23%), hair fall (n= 6; 11.53%), and itching (n=16; 32%) associated with HDs use were reported among the study participants (Figure 2).

The reason for HD use varied considerably among the participants. Most respondents (30.59%) reported that HD helped them get rid of gray hair, while 18.76% believed it made them look more beautiful (Figure 3).

Regarding the source of information about HDs, most (30%) of the study subjects reported using the Internet, whereas 26.19% chose advertisement as the major source of information related to HD (Figure 4).

Table 1. Sociodemographic characteristics of the study populations (n= 333)

Variables	Frequency	Percentage
Sex		
Female	228	68.5
Male	105	31.5
Median age	30.0 (range: 17-76) (in years)	
Age group (in years)		
< 20	26	7.8
21-40	179	53.8
41-60	84	25.2
> 61	44	13.2
Nationality		
Arabs	86	25.8
Non-Arabs	247	74.2
Marital status		
Married	146	43.8
Unmarried	163	48.9
Divorced	24	7.2
Education		
School level	37	11.1
Graduate level	136	40.8
Postgraduate and above	160	48.0
Occupation		
Working	133	39.9
Not working	28	8.4
Student	158	47.4
Home maker	14	4.2

Associations between sociodemographic variables and HD ing practices

Participants with female ($p < 0.0001$), aged between 21 and 40 years ($p = 0.032$) and employees ($p = 0.042$) are inclined to use HD more frequently than other age groups, which was found to be statistically significant (Table 3). The frequency of HD use was higher among highly educated participants, the difference was not statistically significant ($p = 0.052$).

The correlation between sociodemographic characteristics and frequency of HD use using binary logistic regression analysis after adjusting for all other variables showed that sex [odds ratio (OR) = 0.068, 95% confidence interval (CI) (0.024 – 1.199), $p < 0.0001$], marital status [odds ratio (OR) = 0.242, 95% confidence interval (CI) (0.098 – 0.602), $p = 0.002$], and employment [odds ratio (OR) = 1.737, 95% confidence interval (CI) (1.058 – 2.851), $p = 0.029$] were significantly associated with HD use. In the adjusted model, age (in years), nationality, and education were not significantly associated with the frequency of HD use.

DISCUSSION

Hair care has gained considerable importance, and HD use has increased globally to enhance youth and beauty. Additionally, significant growth and rapid development in the cosmetic industry and the limited evidence on safety profiles related to

HDs influence guidance on the safe and effective use of HD preparations.^{5,6} The present study assesses the knowledge, attitude, and practice regarding HDs and their adverse effects among HD users.

The study results point out that more than half of the study participants were female, indicating their predominance in using HDs at least once to have a smart and young look in the work field. The increased percentage is insignificant considering that the prevalence of HD use among females in earlier studies ranged from 60% to 90%.¹⁰⁻¹² A previous study conducted in Riyadh, Saudi Arabia reported that 82.6% of their female participants had used HD at some point.¹³ In the present study, the median age at first use of HD was 29.5 years, expressing HD is common among teenagers and young adults, echoing previous studies, which reported that the median age at first HD ing ranged between 22-36 years, respectively.¹²⁻¹⁴

Concerning the different types of HDs used by the study participants, > 50% preferred natural (henna) dye, indicating its popularity in the community. It must be noted that henna dye is traditional in Islamic countries and has religious and social significance. The growing popularity that natural dyes provide the best normal results without any chemical ingredients and the increased concern that synthetic dyes are likely to cause

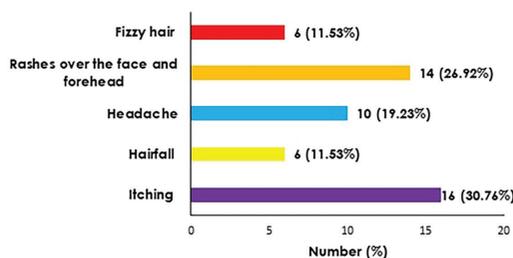


Figure 2. Adverse effects reported by the study participants associated with hair dyes (n= 52)

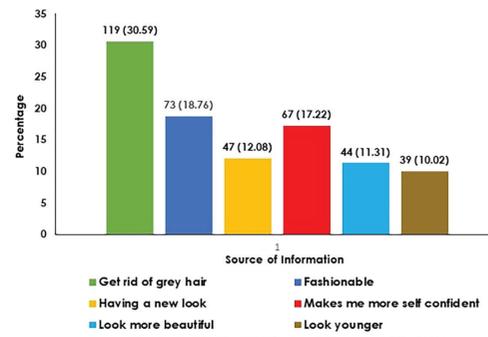


Figure 3. Motivation behind the use of hair dyes

Table 2. Results of a questionnaire on HD-related knowledge, attitude, and practice

Sl no.	Questions	n= 333 (%)		
		Yes (%)	No (%)	I don't know (%)
1	Have you ever experienced any allergic reactions with the use of any HD?	28 (8.40)	237 (71.17)	68 (20.42)
2	Have you ever performed an allergy test before using a HD?	51 (15.31)	243 (72.97)	39 (11.71)
3	Do you usually read/check the list of ingredients present in HDs?	115 (34.53)	124 (37.23)	94 (28.22)
4	Do you seek any advice or suggestions before buying your HD?	152 (45.64)	43 (12.91)	138 (41.44)
5	Do you think educational advice on HD would be beneficial for you?	233 (69.96)	30 (9.0)	70 (21.02)
6	Do you think that all the available HDs in the market are safe?	29 (8.70)	139 (41.74)	165 (49.54)
7	Is it safe to use all available HDs in all age groups?	20 (6.0)	240 (72.07)	73 (21.92)
8	Are you aware of any hazardous chemicals and toxins present in HDs?	99 (29.72)	207 (62.16)	27 (8.10)
9	Did you ever consult or receive pharmacist advice when buying your HD?	91 (27.32)	148 (44.44)	94 (28.22)
10	Do you think you get enough information when buying a product?	71 (21.32)	145 (43.54)	117 (35.13)

Sl no.: Serial number, HD: Hair dye

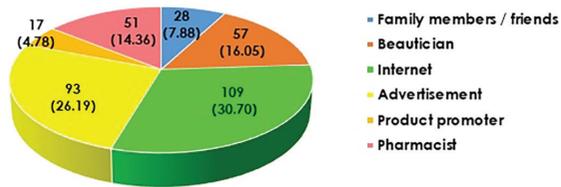


Figure 4. Source of information about hair dyes

Table 3. Association between frequency of HD use and sociodemographic characteristics

Characteristics	Frequency of HD use (per year)			p value
	Once	2-5 times	> 5 times	
Gender				
Female	142	68	18	0.0001*
Male	55	19	31	
Age group (in years)				
< 20	12	6	8	0.032*
21-40	108	51	20	
41-60	55	14	15	
> 61	22	16	6	
Nationality				
Non-Arabs	142	66	39	0.526
Arabs	55	21	10	
Marital status				
Married	76	40	30	0.075
Unmarried	105	41	17	
Divorced	16	6	2	
Education				
School level	19	11	01	0.052
Graduate	76	32	28	
Postgraduate and above	102	44	14	
Occupation				
Working	75	35	23	0.042 ^e
Not working	2	6	0	
Student	88	44	26	
Home maker	12	2	0	

*p value < 0.05 is statistically significant, *Chi-square test, ^eFischer's exact test

serious adverse effects could also be why we prefer natural dyes. Regarding safety, fewer adverse effects related to HDs were reported, shadowing the previous study results.^{12,15} This emphasizes the need for performing an allergy test before using any HD products to improve safety and prevent possible side

effects in the future. The most common reason for using HDs was to cover gray hair, which enhanced their self-confidence. In the modern world, the desire to be youthful is most common, and people prefer to conceal their gray hair at an early age, which is supported by the study responses and their desire to be more beautiful, fashionable, and stand out as young people. The above findings correlate with those of earlier studies, which reported that HD's principal purpose was to cover the gray hair and have a youthful appearance.^{9,13,14}

Regarding the source of information about HDs, most of the study participants expressed that the internet, social media, and newspaper advertisements were the primary sources of information for understanding HD preparation. This section discusses fast-growing online information technology, including the internet and media, which has opened the way for consumers to reach out quickly and can be an effective platform for consumers to learn more about HD products. However, sometimes, making sense of overwhelming information from an online platform becomes difficult, which can be misleading or lead to negative health outcomes.^{11,13,14}

Nearly two-thirds of the study sample reported that they never experienced any adverse effects associated with HD use, and almost the same revealed that they never performed an allergy test before using HD. Appropriate advice must be reinforced in HD users as sometimes mild-moderate adverse effects are underreported because of self-diagnosis and self-medication, which are more common in cosmetics products.^{6,16} It is important to highlight that severe reactions can sometimes cause permanent disability or life-threatening. Only less than half of the study sample declared that they usually read or checked the ingredients before using HD or sought advice while buying HD. A study in Saudi Arabia reported that more than half of the women who developed adverse effects from cosmetics did not seek medical advice or consult a pharmacist.⁵

More than 60% of the study population reported that they were unaware of the hazardous chemicals/toxic ingredients present in HD. Understanding the ingredients in HDs, adhering to the instructions for proper use, and seeking medical advice from healthcare professionals will help ensure the safe and effective use of HDs. Misuse or overuse of HDs is likely to damage hair. Furthermore, few published studies have documented conflicting findings that some compositions in permanent HDs are linked with the development of certain malignancies, but the evidence was weak and could not prove causality.^{10,17,18}

Additional studies on the carcinogenic potential of HDs should be conducted to resolve public concerns. Many participants expressed that HDs available in the market are unsafe and not recommended for use in all age groups. This is particularly important in pregnancy and young children. Concerns regarding safety during pregnancy have been raised, which is a matter of active debate. Studies evaluating the association between HD use in pregnancy and neonatal outcomes have concluded that the strength of evidence is limited to moving the needle on recommendations for the safety of HDs during pregnancy and might cause neonatal health problems.^{19,20}

The presence of toxic ingredients such as PPD, the most potent and key ingredient in HD formulations, raises an important public health concern. Exposure to these products can induce local and systemic toxic effects when applied topically and/or ingested orally, and the outcome depends mainly on the dose taken. Acute (short-term) exposure to high levels of p-phenylenediamine may cause angioedema leading to dysphasia and respiratory distress, rhabdomyolysis, intravascular hemolysis, acute renal failure, and hepatic necrosis, whereas chronic (long-term) exposure in humans results in Eczematous contact dermatitis. Studies have demonstrated that children are susceptible to PPD allergy, and their use might increase the risk of carcinoma and infertility problems in the future.²¹⁻²³

The different types of HD use and motivation justify the increased frequency of HD use observed in the present study. Participants aged between 21 and 40 years and employed individuals tended to use HDs more frequently, which was statistically significant. This observation highlights that individuals aged between 21 and 40 years are either job seekers or employees who would like to continue to maintain a fresh look, believe that it will add shine and dimension to hair, make it more beautiful, and perceive it as an integral part of self-expression and fashion.

Study limitations

First, the study relied on self-reporting information provided by HD users through survey questionnaires in which the data obtained reflected the respondents' personal opinions. However, self-reporting is a common and practical method of collecting data. The information provided may not mirror real-life practice because some respondents may be unwilling to reveal practice deficiencies. The possibility of recall bias cannot be excluded entirely. Secondly, We recognise that only individuals from the northern emirates of the United Arab Emirates were included in the study sample, which could limit the results' applicability to the whole population of the United Arab Emirates. Future research with a sample that is more geographically diverse would improve the findings' representativeness.

CONCLUSIONS

The present study highlights the extensive use of HDs by individuals aged 21-40 years, emphasizing the importance given to their esthetic value. The focus should be on providing appropriate information to HD users regarding the safe use and chemical ingredients of HD products. Performing a patch test before HD use and adhering to usage instructions may help choose safer HD products and avoid possible adverse reactions. The conflicting results regarding the safe use of HDs in pregnancy warrant further investigation with more accurate data on neonatal health issues in the future.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the institutional research ethics committee and from the Ras Al Khaimah Research Ethics Committee before the initiation of the study (approval number: MOHAP/REC/2022/7-2022-UG-P, date: 21.02.2022).

Informed Consent: Subjects of either gender aged 18 years and above who had used HD (natural/synthetic) at least once in their lifetime were included after obtaining informed consent.

Authorship Contributions

Concept: J.S., S.B.S., Design: J.S., S.B.S., S.S., Data Collection or Processing: S.S., S.A., Analysis or Interpretation: J.S., S.B.S., Literature Search: J.S., S.B.S., S.S., Writing: J.S., S.B.S., S.A.

Conflict of Interest: The authors have no conflicts of interest to declare.

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REFERENCES

- Lunge SB, Doshi BR, Pande S, Vyshak BM. Comparative study of knowledge, attitude, and practices of hair care among the final year MBBS students versus final year engineering students. *Int J Trichology*. 2020;12:43-47.
- Kusagur MS, Asifa N, SugaReddy. Trends in hair care and cleansing: a knowledge, attitude, and practice study. *Clin Dermatol Rev*. 2017;1:56-60.
- Jayaganesh S, Sudhir S, Jainendra M, Bachan SR, Asif Ali M. Mechanism of hair dyeing and their safety aspects: a review. *Asian J Appl Sci*. 2017;10:190-196.
- Palaniappan V, Karthikeyan K, Anusuya S. Dermatological adverse effects of hair dye use: A narrative review. *Indian J Dermatol Venereol Leprol*. 2023:1-17.
- Kotby FA, Beayari SMF, Abdulrhman Alsalmi K, Sulaimani AA, Bakheet Alharbi A, Samir A Al-Abdrabbuh D. Knowledge and practice of women toward the adverse effects of cosmetics in Saudi Arabia. *IJMDC*. 2020;4:113-117.
- Dehvari M, Ghaneian MT, Morowatisharifabad MA, Karimi M, Jasemizad T. Knowledge, attitudes and practice of women about adverse effects of cosmetics in Yazd city, Iran. *Health Scope*. 2018;7:e68257.
- Raosoftware® calculator. <http://www.raosoftware.com/samplesize.html> [accessed: 17th Jan 2022].
- Shawana A, Afzal M, Hussain M. Knowledge, attitude and practices university BSN nursing students about undesirable effects of cosmetics in Lahore city. *Glob Sci J*. 2020;8:1331-1338.
- Joshi MV, Nilkanth JV, Rasane SR. Knowledge, practice and adverse reactions amongst Hair dye users-a cross-sectional study. *Int J Ayurvedic Med*. 2021;12:645-648.
- Zhang Y, Birmann BM, Han J, Rosner BA, Tamimi RM, Wang Y, Eliassen AH. Personal use of permanent hair dyes and cancer risk and mortality in US women: prospective cohort study. *BMJ*. 2020;370:m2942.
- Heikkinen S, Pitkaniemi J, Sarkeala T, Malila N, Koskenvuo M. Does hair dye use increase the risk of breast cancer? A population-based case-control study of Finnish women. *PLoS One*. 2015;10:e0135190.
- Dhafiri MA, Al Furaikh B, Aljasir A, Alowfi A, Alquraishi A, Alhussain N, Alotaibi A, Alanazi A. Practice and impact of hair dyeing; a local study. *Int J Innov Res Med Sci*. 2022;7:764-770.
- AlGhamdi KM, Moussa NA. Knowledge and practices of, and attitudes towards, the use of hair dyes among females visiting a teaching hospital in Riyadh, Saudi Arabia. *Ann Saudi Med*. 2011;31:613-619.

14. Patel D, Narayana S, Krishnaswamy B. Trends in use of hair dye: a cross-sectional study. *Int J Trichology*. 2013;5:140-143.
15. Jyrwa S, Sebastian J, Shastry V. Cosmetovigilance in a tertiary care hospital: A prospective observational study. *J Cosmet Dermatol*. 2021;20:804-811.
16. He L, Michailidou F, Gahlon HL, Zeng W. Hair dye ingredients and potential health risks from exposure to hair dyeing. *Chem Res Toxicol*. 2022;35:901-915.
17. Eberle CE, Sandler DP, Taylor KW, White AJ. Hair dye and chemical straightener use and breast cancer risk in a large U.S. population of black and white women. *Int J Cancer*. 2019.
18. Cancer. Do hair dyes increase cancer risk? Harvard Health Publishing. <https://www.health.harvard.edu/blog/do-hair-dyes-increase-cancer-risk-2021012021767>
19. Shishavan MK, Sayyah-Melli MR, Rashidi MR, Gharabaghi PM, Ghojazadeh M, Rahmani V. The association of hair coloring during pregnancy with pregnancy and neonatal outcomes: a cross-sectional study. *IJWHR*. 2021;9:130-135.
20. Gupta M. A study of knowledge, attitude, and practices regarding hair dye use among the general population. *Our Dermatol Online*. 2017;9:15-18.
21. Jayanthi CR, Divyashree RN, Vijayalakshmi, Dharani S, Soumya R. A cross-sectional study of hair dye use among doctors and nurses working at a tertiary care centre. *Int J Res Pharmacol Pharmacother*. 2021;7:85-96.
22. Salami M, Pourahmad J, Zarei MH. Toxicity of para-phenylenediamine (PPD;1, 4 diaminobenzene) on isolated human lymphocytes: The key role of intracellular calcium enhancement in PPD-induced apoptosis. *Toxicol Ind Health*. 2023;39:388-397.
23. Banerjee P, Ulker OC. Combinative *ex vivo* studies and *in silico* models ProTox-II for investigating the toxicity of chemicals used mainly in cosmetic products. *Toxicol Mech Methods*. 2022;32:542-548.