

The Association of Hair Coloring During Pregnancy with Pregnancy and Neonate Outcomes: A Cross-Sectional Study

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Research article

Keywords: Apgar Score, Hair Dyes, Infant Low Birth Weight, Infant Newborn Diseases, Pregnancy, Preterm Labor

Posted Date: May 8th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-24851/v1>

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Version of Record: A version of this preprint was published on April 1st, 2021. See the published version at <https://doi.org/10.15296/ijwhr.2021.23>.

Abstract

Background: Hair colorant use has spread globally and rapidly in recent years. Concerns have arisen about the safety of hair dyes usage during pregnancy. The primary goal of this study was to examine the association between hair coloring during pregnancy, intrapartum, and neonatal outcomes.

Methods: This explorative cross-sectional study was carried out at Talegani Teaching Hospital of Tabriz University of Medical Sciences from Jan 2017 to Dec 2019. Three trained midwives inquired mothers about the hair coloring history on the admission to the labor room and recorded intrapartum, and neonatal outcomes. Chi-Square test of independence with post hoc tests and Logistic regression analysis were used for data analysis. Odds Ratios with a 95% confidence interval and contributing effect sizes were reported. The significance level was set at $\alpha \leq 0.05$

Results: We studied 2040 women aged 14 to 48 years. Most of the participants (75.24%) dyed their hair during pregnancy, and the majority (62.67%) colored their hair in the third trimester. There was no statistically significant association between hair coloring and neonate 1-minute ($p=0.23$) and 5-minute Apgar score ($p=0.99$). The logistic regression model did not confirm a rise in overall neonatal complications (NC) associated with hair coloring at any time during the pregnancy (OR:0.027 $p<0.001$). Higher rates of Low birth weight (LBW) were seen among those dyed their hair in the preconception period and third trimester compared to the woman who colored their hair in the first and second trimester ($p<0.001$).

Conclusions: We observed associations between hair coloring and LBW, but there were no increased odds for NC. The evidence for recommending hair dye safety during pregnancy is still limited. Perinatal health professionals should advise their patients on possible adverse outcomes and inform them about the uncertainties about hair dyes.

Background

Pregnancy is a determinative period for both mother and fetus. No mother would jeopardize her baby's health at any cost. Nowadays, most women dye their hair at some point in their lives, sometimes as early as 18 years old [1–3]. It is not clear whether hair color would affect the fetus or not. Studies showed a possible association between hair coloring during pregnancy, and low birth weight, neuroblastoma, and leukemia in the offspring [4–7]. There is a report for increased neonatal abnormalities in mothers who used chlorinated solvents and glycol ether for hair dyeing during pregnancy. Still, it was criticized because of the lack of biological plausibility [8]. Prince et al. failed to show the association between dyeing hair three months before pregnancy and during pregnancy with preterm labor or LBW in black women [9]. Various studies raised concerns about the association of the effect of glycol ethers and oxygenated solvents which are used in cosmetic products with neurocognitive abnormalities and potential developmental effects on the male genital system [10, 11], and, so far, studies have failed to prove the adverse association [12].

Despite limited evidence on the adverse effects of the hair coloring during pregnancy, with a justification of "minimal systemic absorption on healthy skin", hair dyes are considered to be safe during pregnancy [13, 14]. However, there is no convincing evidence aimed to examine the relations between hair coloring during pregnancy and other unwanted outcomes. According to our clinical experience, most Iranian women believe that hair coloring during pregnancy would affect the child; however, if they want to dye their hair, they would do it at the end of the third trimester. According to this observation, the main goal of this study was to examine the association between

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Methods

This is an explorative cross-sectional study; therefore, we did not use a formal sample size calculation and evaluated all participants' data. The study was carried out at Talegani Teaching Hospital of Tabriz University of Medical Sciences from Jan 2017 to Dec 2019. The Ethics Committee of Tabriz University of Medical Sciences approved this study. All pregnant women who admitted to the labor room were eligible for participation in the study. To minimize the confounding factors, we excluded mothers with a medical history of diabetes, thyroid gland dysfunction, cardiopulmonary and renal disease, autoimmune disease, hematological abnormalities, psychotic disorders, confirmed infectious diseases, and history of drug abuse. Hairdressers and beauty salon workers were also excluded. Three trained midwives described the study to the mothers during admission. After consenting to participation, mothers were asked about their hair coloring history; before conception and during pregnancy. Demographic information and pregnancy complications and neonatal outcomes were extracted from the patients' and neonates' hospital files and recorded into the data collection form. The information included prepartum complications such as premature rupture of membrane (PROPM), preterm labor, abruptio placenta, etc. The date of delivery, delivery method (vaginal, cesarean section), and delivery operator (OB/GYN specialist/ midwife), gestational age at delivery, were also documented. Recorded Neonatal outcomes were neonatal birth weight in grams, neonatal Apgar scores, congenital malformations, and neonatal complications (NC), including asphyxia, respiratory distress syndrome (RDS) meconium aspiration syndrome, sepsis, neonatal hemorrhage, hydrops, kernicterus, and hypoglycemia. Data gathered for coloring history consisted of the following: whether they dyed their hair or not, the time of coloring, the product of color (domestic product or foreign), numbers of standard color tube used as an indicator for the amount of the color they used, the frequency of the hair coloring and the style of coloring and the choice of color (spectrum of dark or fair colors). We defined the time of coloring as preconception (3 months before conception) and pregnancy trimesters. We reported the dye material used as tube units (half of a tube*2 rounds of use = 1 tube). We categorized Apgar scores in two groups. Scores of 8 and 9 and 10 were considered favorable, and scores 7 and less were considered unfavorable.

Statistical analysis

Continuous variables were presented as means \pm standard deviations. Categorical variables were presented as frequency and percentages. Chi-Square test of independence with post hoc tests used for testing associations between categorical variables. We used the Logistic regression analysis to predict neonatal complications (NC) with hair coloring history variables. Contributing effect sizes of associations and odds Ratio with a 95% confidence interval and. The significance level was set at $\alpha \leq 0.05$, representing 95% confidence. We reported post hoc p-values after Bonferroni correction.

Results

We studied 2040 women aged 14 to 48, with a mean age of 26.56 years old. Most women (93.69%) were on their first (19.46%), second (18.58%), or third (7.84%) pregnancies. Among all participants, 464 (22.75%) were from rural areas, and the rest (77.25%) were urbanites. The proportion of congenital malformation was low (0.78%), and the records showed that only 42 (2.06%) of neonates experienced NCs. Detailed information about the maternal demographic information, prepartum events, NCs, and type of delivery is available in Appendix.

In total number of mothers who dyed their hair during pregnancy (75.24%), the majority (62.67%) colored their hair in the third trimester. There was no statistically significant association between hair coloring and neonate 1-minute ($p = 0.23$) and 5-minute Apgar score ($p = 0.99$). In subgroup analysis, Chi-square test of independence with post hoc tests showed that the neonates of the women who dyed their hair in the preconception period had more unfavorable 1-minute Apgar scores ($p < 0.0001$)

Chi-square test of independence results of comparison for overall NCs and birth weight categories according to hair coloring indices are displayed in Table 1 and Table 2.

Table 1

Comparisons of the Frequency of Neonatal Complications According to Coloring Characteristics

Characteristics	Overall sample	Complication	No complication	Chi-square tests of independence
Period of coloring				
No coloring	505(24.75%)	22(52.38%)	483(24.17%)	$\chi^2(4) = 85.10$ $p < 0.001$ $\phi = 0.20$ ^a n = 2040
Pre-pregnancy	159(7.79%)	16 (38.10%)	143(7.16%)	
First trimester	343(16.81%)	1(2.38%)	342 (17.12%)	
Second trimester	71(3.48%)	0(0.00%)	71(3.55%)	
Third trimester	962(47.16%)	3(7.14%)	959(48.00%)	
Product of color				
No Coloring	505(24.75%)	22(52.38%)	483(24.17%)	$\chi^2(3) = 18.73$ $p < 0.001$ $\phi = 0.09$ ^b n = 2040
Domestic product	1023(50.15%)	14(33.33%)	1009(50.50%)	
Foreign Product	311(15.25%)	2(4.76%)	309(15.47%)	
Unknown	201(9.85%)	4(9.52%)	197(9.86%)	
Numbers of standard color tube used				
No Coloring	505(24.75%)	22(52.38%)	483(24.17%)	$\chi^2(4) = 33.67$ $p < 0.001$ $\phi = 0.12$ ^b n = 2040
0. 5 Tube	362(17.75%)	6(14.29%)	356(17.82%)	
One Tube	973(47.70%)	5(11.90%)	986(48.45%)	
Two Tubes	176(8.63%)	9(21.43%)	167(8.36%)	
Four Tubes	24(1.18%)	0.0(%)	24(1.20%)	
Style Of coloring				
No Coloring	505(24.75%)	22(52.38%)	483(24.17%)	$\chi^2(4) = 27.96$ $p < 0.001$ $\phi = 0.11$ ^b n = 2040
Bleaching	36(1.76%)	3(7.14%)	33(1.65%)	
Simple coloring	1180(57.84%)	16(38.10%)	1164(58.26%)	
Salt and pepper	319(15.64%)	1(2.38%)	318(15.92%)	
Color of dye				
Bright	428(27.88%)	1(5.00%)	427(28.18%)	$\chi^2(1) = 5.27$ $p = 0.02$ $\phi = 0.05$ ^b n = 1535
Dark	1107 (72.12%)	19(95.00%)	1088(71.82%)	
Dark Or Bright	0(0%)	0(0%)	0(0%)	
ϕ =effect size (phi coefficient or Cramer's V). a: A significant difference with an effect size \geq Cohen's definition of "Medium".b: A significant difference with an effect size \geq Cohen's definition of "small."				

Table 2
Comparisons of the Newborn's Weight Categories According to Coloring Characteristics

Characteristics	Overall sample	VLBW	LBW	NBW*	HBW	Chi-square tests of independence
Period of coloring						
No coloring	505(24.75%)	1(11.11%)	35(23.18%)	447(24.53%)	22 (37.93%)	$\chi^2(12) = 77.39$ $p < 0.001$ $\phi = 0.19$ ^a n = 2040
Pre-pregnancy	159(7.79%)	5(55.56%)	24(15.89%)	121(6.64%)	9(15.52%)	
First trimester	343(16.81%)	3(33.33%)	38(25.17%)	296 (16.25%)	6(10.34%)	
Second trimester	71(3.48%)	0(0.00%)	5(3.31%)	66 (3.62%)	0(0.00%)	
Third trimester	962(47.16%)	0(0.00%)	49(32.45%)	892 (48.96%)	21(36.21%)	
Product of dye						
No Coloring	505(24.75%)	1(11.11%)	35(23.18%)	447(24.53%)	22(37.93%)	$\chi^2(9) = 18.89$ $p = 0.026$ $\phi = 0.09$ ^a n = 2040
Domestic product	1023(50.15%)	5(55.56%)	73(48.34%)	926(50.82%)	19(32.76%)	
Foreign Product	311(15.25%)	0(0.00%)	29(19.21%)	274(15.04%)	8(13.79%)	
Unknown	201(9.85%)	3(33.33%)	14(9.27%)	175(9.60%)	9(15.52%)	
Amount of standard color tube used						
No Coloring	505(24.75%)	1(11.11%)	35(23.18%)	447(24.53%)	22(37.93%)	$\chi^2(12) = 24.86$ $p = 0.016$ $\phi = 0.11$ ^a n = 2040
0.5 Tube	362(17.75%)	1(11.11%)	21(13.91%)	328(18.00%)	12(20.69%)	
One Tube	973(47.70%)	7(77.78%)	68(45.03%)	880(48.30%)	18(31.03%)	
Two Tubes	176(8.63%)	0(0.00%)	24(15.89%)	146(8.01%)	6(8.63%)	
Four Tubes	24(1.18%)	0(0.00%)	3(1.99%)	21(1.15%)	0(0.00%)	
Color of dye						
Bright	428(27.88%)	4(50.00%)	24(20.69%)	393(28.58%)	7(19.44%)	$\chi^2(3) = 6.54$ $p = 0.088$ $\phi = 0.06$ ^b n = 2040
Dark	1107(72.12%)	4(50.00%)	92(79.31%)	982(71.42%)	29(80.56%)	
Dark or Bright	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	
Hair Coloring Style						
No Coloring	505(24.75%)	1(11.11%)	35(23.18%)	447(24.53%)	22(37.93%)	$\chi^2(9) = 46.28$ $p < 0.001$ $\phi = 0.15$ ^a n = 2040
Bleaching	36(1.76%)	2(22.22%)	3(1.99%)	28(1.54%)	3(5.17%)	

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Characteristics	Overall sample	VLBW	LBW	NBW*	HBW	Chi-square tests of independence
Simple coloring	1180(57.84%)	5(55.56%)	104(68.87%)	1046(57.41%)	25(43.10%)	
Salt and pepper	319(15.64%)	1(11.11%)	9(5.96%)	301(16.52%)	8(13.79%)	
ϕ =effect size (phi coefficient or Cramer's V). a: A significant difference with an effect size \geq Cohen's definition of "small".b: not statistically significant. NBW (normal birth weight)						

NCs were more prevalent in the women, who had never dyed their hair before conception, than in others. ($p < 0.001$). Therefore, we ran a subgroup analysis with post hoc chi-square test to examine the differences in NCs in the participants who dyed their hair preconception or during pregnancy. Test results revealed that the recorded NCs were higher in women who dyed their hair in the preconception period in comparison to pregnancy trimesters ($p < 0.001$)¹. Similarly, the post-hoc chi-square test showed that using approximately two tubes of coloring material was significantly associated with higher rates of neonatal adverse outcomes ($p = 0.002$).

When comparing NCs in the categories of "dye production" and "style of hair coloring", NCs were recorded more frequently in mothers who did not color their hair ($p < 0.001$). However, the prevalence of NCs was statistically similar in different categories of dye product and the style of hair coloring ($p > 0.006$).

We performed logistic regression analysis to ascertain the effects of the period of using hair color, the product of the dye, the amount of the hair dye used, and the style of hair coloring on the likelihood that neonates experience adverse outcomes. The logistic regression model was statistically significant ($\chi^2(11) = 82.71, p < .001$). The model explained 21.9% (Nagelkerke R^2) of the variance in neonatal adverse outcomes and correctly classified 98.1% of cases. Neonates born to women who dyed their hair in the preconception period were less likely to exhibit NCs than babies of the women who did not use hair dye and the women who dyed their hair during pregnancy trimesters (OR:0.027 CI95%:0.007–0.108, $p < 0.001$). The likelihood of adverse neonate outcomes was not associated with other hair coloring variables ($p > 0.1$).

A Chi-Square test of independence revealed that birth weight categories were significantly associated with the hair coloring period ($p < 0.001$). Post-hoc comparisons of rates of LBW by the period of hair coloring revealed that higher rates of LBW were seen among those dyed their hair in the preconception period and third trimester ($p < 0.001$). The LBW prevalence was statistically similar among those who colored their hair in the first and second trimester and those who did not color their hair ($p > 0.002$). Very low birth weight (VLBW) and high birth weight (HBW) prevalence were statistically similar among all groups ($p > 0.002$).

Although the Chi-Square test of independence showed significant associations between birth weight categories and the production of the dye, hair coloring style, and the amount of color used, post-hoc tests exposed that rates of VLBW, LBW, and HBW were statistically similar among all groups (Table 2).

Chi-square test of independence depicted a higher prevalence of the abruptio placenta ($p < 0.001$) and PROM ($p < 0.001$) in the women who dyed their hair during pregnancy trimesters. On the other hand, preterm labor recorded at higher rates in the women

who used hair coloring ($\chi^2(4) = 43.94, p < 0.001, \phi = 0.14$). Subgroup comparison with post hoc chi-square test revealed that women who dyed their hair on the third-trimester experienced statistically significant higher rates of preterm labor ($p < 0.0001$).

Discussion

Hair colorant use has increased globally and rapidly in recent years. Scientists have investigated the relationships between hair colorants and skin problems and cancers [15]. Concerns were raised about the safety of cosmetics usage during pregnancy; some women consider beauty products as a risk when they are expecting a child [16, 17]. However, improving and constant changes in the cosmetic industry and the limited evidence on the pregnancy-related effects of the hair dyes influences recommendations on cosmetic use during pregnancy. Even with the probability of toxic effects of cosmetics, to maintain beauty, women frequently color their hair during pregnancy [3, 17]. In our study, 75.24% of participants dyed their hair, and mostly, they did it in the third trimester. However, our results did not support our hypothesis on the association between late-pregnancy hair coloring with the Apgar scores. Despite the statistically significant finding of an association between preconception hair coloring and unfavorable Apgar scores, drawing a clinical inference is not biologically plausible.

Overall, neonatal complications were more frequent in the women who did not color their hair, and the binary logistic regression model did not confirm a rise in overall neonatal complications associated with hair coloring at any time during the pregnancy (OR:0.027). Neither the product nor the amount of the dye used was associated with overall neonatal complications. The rate of specific complications was low, and it limited the statistical power of our study in the investigation of hair coloring and particular complications.

Our results showed that LBW is more frequent in women who dyed their hair in the preconception period or third trimester. Jiang et al. also showed an association between pre-pregnancy hair dye use and increased risk of LBW [4]. Other studies investigated LBW in the hairdressers who have occupational exposure to the hair dye chemicals. However, the results were inconclusive [18]. We may assume that women who dye their hair in the third trimester would belong to the group of women who use hair colors frequently to enhance self-image on the due date [3, 17]. Hence, these women are more exposed to the chemicals in the hair dye. This higher exposure might be associated with the LBW neonates, as Herdt-Losavio et al. reported a slightly increased risk of LBW in cosmetologists [19]. On the other hand, Chua-Gocheoet reported that the chemicals in the hair dyes would not reach the placenta substantial enough to cause harm unless there is a wound or abscess in the scalp skin. They also concluded that they should not be concerned about the occasional use of hair colors during pregnancy [14]

Preterm labor occurred more frequently in the cases of mothers who dyed their hair in the third trimester. Since we did not control for factors that confound the association, we need more evidence considering the chemical substances in the hair dyes, detailed time of hair coloring, and other factors associated with preterm labor to reach to any conclusion.

The strength of the evidence is not sufficient to recommend for the safety of the hair colors in pregnancy (SOR:C) [20]. All the perinatal health professionals need to advise women about the benefits and risks of using cosmetics during pregnancy and provide valid information and informative considerations [16].

Conclusion

This study provided further evidence of an association between exposure to hair dyes and LBW. The odds for NC was not increased. Dyeing hair for a healthy pregnancy is questionable, and pregnant patients are better to avoid all hair coloring products until definitive information is obtained.

Abbreviations

NVD (normal vaginal delivery)
C/S (cesarean section)
CPD (Cephalopelvic disproportion)
PROPM (premature rupture of membrane)
NC (neonatal complications)
OB/GYN (obstetrics/ gynecologist)
NBW (normal birth weight)
LBW (low birth weight)
VLBW (very low birth weight)
HBW (high birth weight)
RDS (respiratory distress syndrome)
OR (odds ratio)
 χ^2 (Chi-square)
SOR(Strength Of Recommendation)

Declarations

Ethics approval and consent to participate

Ethics Approval has been issued on 8-27-2018 from the National Ethics Committee in Biomedical Research of Tabriz University of Medical Sciences (Committee's reference number: IR.TBZMED.REC.1397.464). The project was found to be in accordance with the ethical principles and the national norms and standards for conducting Medical Research in Iran. Informed consent was obtained from all eligible patients before including them in the study

Consent for publication

Consent for publication of the results was obtained from all eligible patients before including them in the study

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request

Competing interests

The authors declare that they have no competing interests

Funding

This study was funded by a grant from the Women's Reproductive Health Research Centre, Tabriz University of Medical Sciences.

Authors' contributions

Manizheh Sayyah-Melli and Maryamalsadat Kazemi Shishavan were responsible for the main idea and the design of the study. Manizheh Sayyah-Melli supervised the study and contributed to the writing of the first draft, and approved the final version to be submitted. Maryamalsadat Kazemi Shishavan was involved in the planning of the project, analyzed statistics, and writing of the first draft of the manuscript. Mohammad Reza Rashidi was involved in the preparation of the project, Parvin Mostafa-Gharebaghi, Morteza Ghojazadeh, Vahideh Rahmani, and Zohreh Tahmasebi assisted with the implementation of the project at all stages and critically revised the manuscript draft for the relevant content. All authors read and approved the final manuscript.

Acknowledgments

The authors would like to acknowledge Fariba Nikan MSc, and Asieh Ghasempoor MSc, who contributed to collecting data and thanks to all participants for making this study possible

Appendix

Demographic information summary on			
Age		Mean (SD)	Min-Max
		26.56 (5.82)	14-48
Gravida		Frequency	Percent
	1	397	19.46
	2	379	18.58
	3	160	7.84
	4	47	2.30
	5	10	.49
	6	4	.20
	7	1	.05
	8	1	.05
	9	397	19.46
Parity			
	0	434	21.27
	1	407	19.95
	2	121	5.93
	3	30	1.47
	4	3	.15
	5	3	.15
	7	1	.05
Literacy			
	Illiterate	159	7.8
	Reading and Writing	1200	58.8
	Diploma or Bachelor	583	28.6
	Masters or Higher	98	4.8
Job			
	Housewife	2005	98.28
	Employee	25	1.23
	Home business owner	4	0.20
Residence			
	Urban	1576	77.25
	Rural	464	22.74

Delivery information summary			
		Frequency	Percent
Mode of delivery	Normal vaginal delivery (NVD)	904	44.3
	Cesarean section (C/S)	1135	55.6
	Vacuum Delivery	1	.0
Operator	OB/GYN	1996	97.8
	Midwife	44	2.2
C/S indications			
	Arrest disorders	81	3.97
	Breech presentation	221	10.83
	Fetal bradycardia	240	11.76
	Cephalopelvic disproportion (CPD)	88	4.31
	Prior CS	215	10.54
	Meconium Staining	40	1.96
	Elective	242	11.86
	Face presentation	8	.39
Apgar Score 1	8-9-10	2016	98.82
		24	1.17
Apgar score 5	8-9-10	2040	100.00
		0	0.00

Neonatal and Prepartum Events		Frequency	Percent
Neonatal Complications	Asphyxia	12	.59
	Respiratory distress syndrome	13	.64
	Aspiration	9	.44
	Neonatal hemorrhage	2	.10
	Kernicterus	6	.29
	Meconium staining	27	1.32
	Small for gestational age	13	0.63
	Large for gestational age	2	0.09
	Fetus malpresentation	240	11.76
	Polyhydramnios	0	0
Oligohydramnios	7	0.34	
Prepartum Events			
	Placenta Previa	0	0.0
	Abruptio placentae	10	0.49
	Premature rupture of membrane (PROM)	43	2.10
	Preterm labor	342	16.74
	Post-term labor	2	0.09

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