

NARRATIVE REVIEW

Considering the risk of a coloring shampoo with the function of gray hair cover cosmetology and skin barrier: A systematic review

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Abstract

Background and Aims: As the number of demanders who want to easily cover gray hair increases, the demand market is rapidly expanding along with the demand for coloring shampoos that can be dyed while shampooing. Among these coloring shampoo ingredients, it is necessary to differentiate products that are safe and harmless to the human body in consideration of hair loss or skin barrier problems caused by trihydroxybenzene (THB) ingredients. The correct selection criteria were presented by examining the problems, effectiveness, and side effects when used in relation to the skin barrier through previous studies by consideration of the ingredients of the coloring shampoo and the skin barrier of the scalp.

Methods: The analysis of this study looked at previous studies through a systematic literature review through related keywords for coloring shampoo. After reviewing 150–200 related prior papers, a total of 39 review papers were finally selected using the PRISMA flow diagram.

Results: It was confirmed through a literature review that the coloring shampoo containing THB, which is harmful to the human body, has a detrimental effect on the scalp-skin barrier.

Conclusion: This study examined the harmfulness of coloring shampoo on the scalp skin barrier. It was confirmed that frequent coloring shampoo procedures can have various harmful effects on the scalp. Therefore, it is important to reduce side effects caused by the use of harmful ingredients and maintain a healthy scalp condition through analysis of sufficient scalp conditions and consultation with experts. In addition, various studies on the standard standards and age for harmful ingredients are suggested.

KEYWORDS

coloring shampoo, scalp skin barrier, toxin harmful, trihydroxybenzene

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1 | INTRODUCTION

Recently, in the Republic of Korea, coloring shampoo that can dye gray hair while shampooing is creating a craze. There are two types of dyeing: stylish and gray color. It consists of a group of consumers who have a lot of gray hair or gray hair and fashionable dyeing, mainly made up of young women.¹⁻³ Dyeing has long been close to humans to indicate its social position or status, such as Egyptian tattoos, and in the *Joseon Dynasty*, it was engraved like a stigma on the forehead as a warning about the crime.⁴ As we get closer to this case, starting with what is engraved on the human body, now it has been developed to dye hair with ingredients extracted from the henna extract. This is as common as doing a perm to the hair. Dyeing started in ancient Egypt and has continued to develop in earnest. For dyeing, natural dyes, and creams are combined with velour hair agents including oxides. Henna hair dye has recently been discouraged from using it due to its negative effects on the human body.⁵ Originally, henna originated from plants growing in hot regions, and it was crushed in the process of developing it.⁶⁻⁸ These various types of hair dyes are being actively sold to the appropriate consumer group, but their use is discouraged due to side effects. The use of ingredients that have a harmful effect on the human body and cause genetic mutations in the future is a trend that is prohibited. Therefore, even if the ingredients of shampoo and dye are combined, it is necessary to find out whether they are harmless to the human body while performing their roles properly. Also, it is very encouraging to consider the harmful effects of shampoos and dyes that will be used continuously for a long time in the future unless an alternative product for shampoo and dyeing is made.⁹

Therefore, it is necessary to understand the improvement of harmful ingredients to the human body that consumers want and the sufficient national verification of the product.¹⁰ All consumers must check the presentation of these standards. We see the problems ahead rather than worrying about genetic mutations. However, it occurs even after only 20 years have passed, and it becomes a problem that we carry with us for the rest of our lives. In Korea, the responsibility for the use of trihydroxybenzene (THB) components is still deferred only to business operators, and the standard value has not been announced, showing that this is very limited. As in the case of the West, we need very tight standards for factors such as genetic mutations that affect our future generations as well as dense standards.^{11,12}

2 | MATERIALS AND METHODS

2.1 | Search strategy

Although this review was a descriptive literature review, we searched PubMed, Google Scholar, Research Gate, RISS, DB Pia, and Cross Ref. Following the PRISMA guidelines, the following queries were performed using a broad search strategy. Coloring shampoo; scalp skin barrier; toxin harmful; THB toxin, THB The PRISMA flow chart in

Figure 1 shows the number of records identified, included, and excluded along with reasons for exclusion. The current literature (published between 2000 and 2023) related to the process of finding and selecting studies included in this review included specific keywords.

2.2 | Eligibility criteria

This literature review had to meet the eligibility criteria for this literature review as follows: Regarding the research on coloring shampoo for gray hair cover, the effect of THB, the main ingredient, on the human body was considered as a subject. Includes: coloring shampoo; scalp skin barrier; toxin harmful; THB toxin, THB.

2.3 | Screening and data extraction

Because the study period was relatively short, it was used as the transfer criterion. Types of papers included original research papers, review papers, and internet articles. Letters to editors, edits, comments, protocols, points of view, comments, and short communications excluded. There is no restriction on the date of publication. Related articles have been excluded by language. Full text is not accessible. The full text does not include raw text. We considered the main focus of irrelevant topics, papers and reviews not related to the data.

2.4 | Study selection and data extraction

The reference list included in the current study was manually reviewed to identify all articles. Appropriate sources were provided. Among the remaining papers, we reviewed the entire paper and made a decision for inclusion. Documents and exclusion criteria inconsistent with the study topic were excluded. This search identified academic publications between 2000 and 2023. It represents the oldest and most recent documents found during the search process, using the most recent review. Previous studies are enclosed to explain some details, but we have included studies published from 2000 to 2023. This is because the scope of our review is descriptive rather than a systematic revision of publications, which results in testing. Given that the environmental changes of the global pandemic are affecting many countries, the literature suggests that this period will be incomplete. Initially, there was an analysis of every text word contained in the title and summary. Second, additional sources were identified by searching the reference lists of all identified documents. Potentially identified relevant articles were critically reviewed by all authors throughout the text for inclusion. The content is related to our discussion of the story. The main findings highlight the harmful effects of coloring shampoos on humans and their warnings and importance. When using THB ingredients, experts and correct use are recommended, standards

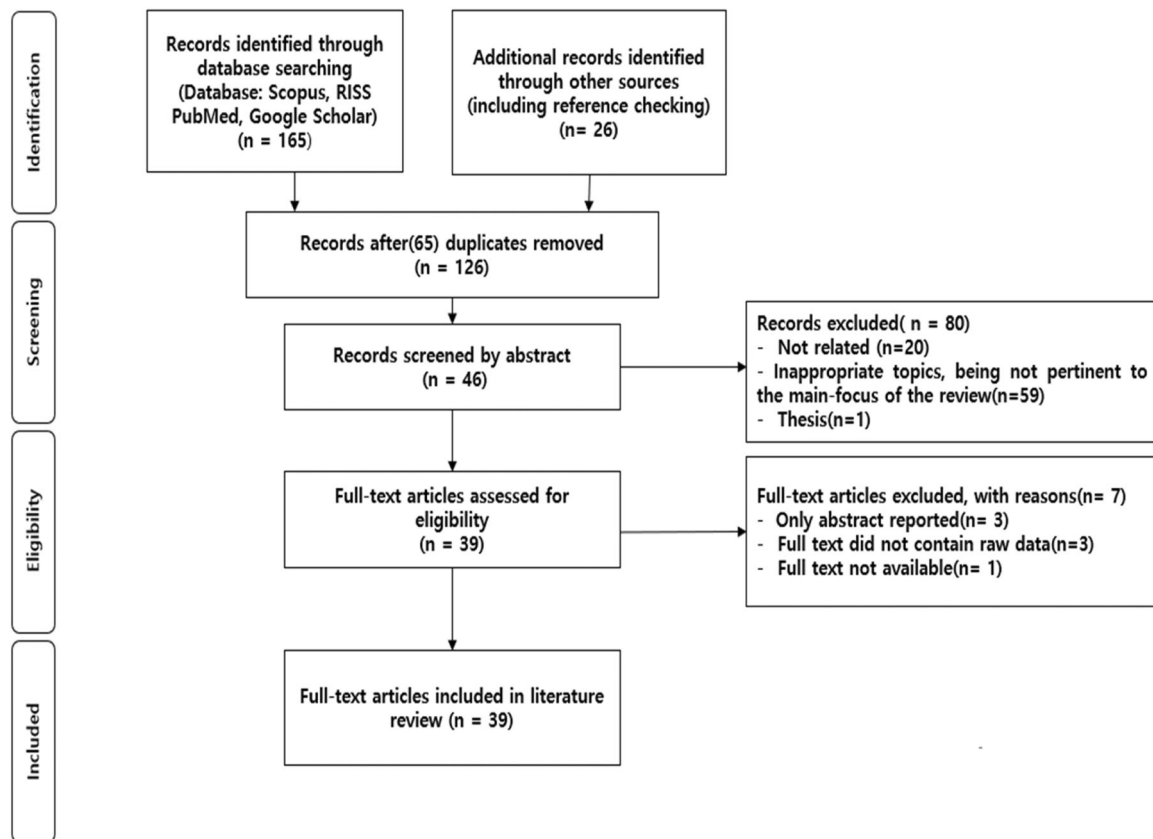


FIGURE 1 PRISMA literature review search results.

are recommended, and messages are expected for growth and development in this field. The main results are summarized in Figure 1.

3 | RESULTS

3.1 | Effects of Dyeing on the human body

The history of dyeing has been passed down through several eras. Dyeing has defined a group of humans in its history, and sometimes defined group discrimination. The effect on the human body has been studied from the manufacturing method made by mixing chemical components to make dyeing colorful.^{4,5} Colors do not come together as a single color, and if you try to have several colors, the colors will bring about a process of mixing with each other. Since dyeing has a permanent aspect unlike general tint, it inevitably causes a lot of damage to the hair to destroy the melanin pigment and permanently settle in the hair.^{13,14} The harmfulness of dyeing to the human body can be divided into four categories and discussed. First, in terms of allergic reactions, hair dyes can contain various ingredients that can cause allergic reactions in some people. Some of the most common allergens include paraphenylenediamine (PPD), toluene-2,5-diamine (TDA), and resorcinol. Allergic reactions to hair dye can range from mild to severe and include symptoms such as itching, redness,

swelling, and even trouble breathing. Second, in terms of carcinogenicity, some hair dyes contain chemicals classified by the International Agency for Research on Cancer (IARC) as possibly carcinogenic to humans. These chemicals include para-toluenediamine (p-TDA), 4-aminobiphenyl (4-ABP), and 2,4-diaminotoluene (2,4-DAT). Studies show that prolonged exposure to these chemicals may increase your risk of bladder cancer, non-Hodgkin's lymphoma, and multiple myeloma. Third, as for hormonal effects, hair dyes can contain chemicals that can disrupt the endocrine system and affect hormone levels in the body. For example, some hair dyes contain phthalates, which have been shown to have estrogenic effects and may increase your risk of breast cancer. Fourth, in terms of hair damage, in the process of dyeing hair, the hair may be damaged and broken, resulting in split ends and dryness. Bleach and high concentrations of hydrogen peroxide can further damage your hair, making it brittle and losing its elasticity.¹⁴ Scalp health from such a process can cause many problems, and when looking at the effects on the human body, it is reported that repeated use of hair dye causes problems such as genetic mutations when pregnant women use or use it in the future.^{15,16} Hair dyeing is divided into natural dyeing and chemical dyeing, and natural dyes are used a lot, but if you want to use trendy colors, you will prefer to use products with oxidizing agents. As a result, consumers want more and more colorful colors, and beauty salons also prefer it to boom. Of course, this is not the case in all cases, but the use of hair dye has a direct effect on the skin, and

above all, it cannot but cause a problem in the user's skin barrier.^{11,17} Although it causes many of these problems, the fact is that as it cannot show medical results, research on the experiment is very lax. We tend to research issues that have to be caused by social issues, but there are many practical issues that cannot be easily resolved because corporate interests are intertwined with social issues.¹⁸⁻²⁰ In addition, consumers are paying the price for the dangerous beauty of using products with no results. The results are presented shown in Table 1.

3.2 | Components and roles of genetic mutation toxicity of components

Table 2 shows that studies on the effects of genetic mutations on the human body have been conducted through several previous studies. In the case of other products, for example, studies on sunscreens have also revealed that there are other statements about the harmfulness of using the minimum amount of such ingredients and that there are regulations that are not harmful to the human body.²¹⁻²³ When dyeing affects the human body and nourishes the scalp health and the skin barrier that protects the skin from external attacks, it can cause fatal skin troubles.^{24,25} This causes necrosis and inflammation of the skin, which breaks down the skin barrier, affecting aesthetically and aesthetically.²⁶

The ingredients of the coloring shampoo are as follows: edelweiss callus culture extract, disodium laureth sulfosuccinate, sodium C 14-16 olefin sulfonate, sodium cocoyl ethionate, kogamidopropyl hydroxysulfonate, butylene glycol, glycerin, lauryl glucoside, 1,2-hexanediol, sorbitol, garlic acid, biotin, pinthenol, niacinamide, radix porcinifolia extract, seaweed extract, ecklonia cava extract, green leaf extract, chlorella bulgari extract, algae extract, sodium chloride, menthol, green tea catechin, tannic acid, caprylyl glycol, PG-3 caprylyl ether, guar hydroxypropyl trimonium chloe, plaquaternium-10, polyvinyl alcohol, charcoal powder, caramel, citric acid. There are climbazole, ethylhexylglycerin, salicylic acid, 1,2,4-trihydroxybenzene, and perfume.⁸ Even in this case, seaweed or algae extracts are the ingredients, but the actual instructions for use describe general instructions for use, that is, red spots and side effects, or side effects of salicylic acid.^{8,25} Pregnant women with diseases such as diabetes, kidney failure, infection, and redness are cautioned to avoid use.^{29,30} There is also a warning to be careful when using shampoo as it may be colored when it gets on clothes or nails. Another thing to look out for here is that the color of shampoo and treatment liquid may change darker due to the nature of polyphenols.^{27,28} This is to bring about the same coloration as dyeing, and reflects that it can affect the human body as well.^{31,32} At the same time, considering the 1,2,4-trihydroxybenzenet ingredient, which has recently been an issue in the coloring shampoo market in Korea, it is for consumers who are concerned about gray hair with a lot of dye-shampoo. It is a solution to the problem, but the problem in long-term use cannot be overlooked.

TABLE 1 Effects of dyeing on the human body.

Author	da Franca, S.D., Michelli, (2015)	Jimenez, F., et al., (2015)	Richardson, S.D., (2008)	Corwell, P.A., (2018)	Draeos, Z.D., (2013)
Journal name	Cosmetics	J Am Acad Dermatol	Anal Chem	Int J Cosmet Sci	Dermatol Clin
Title	Esteves, Victoria; Baby, André; Velasco Maria types of hair dye and their mechanisms of action.	Hair transplantation: basic overview.	Environmental mass spectrometry: emerging contaminants and current issues.	A review of shampoo surfactant technology: consumer benefits, raw materials, and recent developments.	Shampoos, conditioners, and camouflage techniques.
Discussion	Dyes and colors show differences related to hair fiber affinity, water solubility, and light stability. Discussion of hair dye products and their mechanism of action on the skin.	Understanding the causes of female and male hair loss in modern hair restoration surgery and the difference in skin requirements for hair loss surgery.	Effects of new pollutants on the human body through analysis of the environment.	Recent trends to consumers through a technical review of shampoo surfactants.	Shampoo conditioner, which plays an important role in hair, and the dynamics of hair loss.
Reference	[11]	[13]	[15]	[17]	[19]

TABLE 2 Components and roles of genetic mutation toxicity of components.

Author	Perez, V.A., M.A. Strom, and C.T., (2020)	Chiu, C.H., S.H. Huang, and H.M. Wang, (2015)	Rollison DE, H.K., Pinney SM., (2006)	Krishnaswamy S, Sooraj Y, (2009)	Čorak, I., et al., (2022)
Journal name	<i>J Emerg Med</i>	<i>Curr Pharm Biotechnol</i>	<i>J Toxicol Environ Health B Crit Rev</i>	<i>Trauma Shock</i>	<i>Molecules</i>
Title	Lauren, allergic contact dermatitis to a henna tattoo.	A review: hair health, concerns of shampoo ingredients, and scalp nourishing treatments.	Personal hair dye use and cancer: a systematic literature review and evaluation of exposure assessment in studies published since.	Hair dye poisoning and the developing world. Journal of emergencies.	Natural dyeing of modified cotton fabric with cochineal dye.
Discussion	Effects using henna is allergic contact dermatitis to paraphenylenediamine (PPD), a henna dye for temporary tattoos.	The need for shampoo and scalp nutrition management that affects the skin barrier.	A literature study on the problem of cancer occurrence on the human body when personal hair dye is used.	Human effects of many chemicals that can cause paraphenylenediamine in hair dyes that affect hair dye poisoning.	Compared with chemical dyeing, natural dyes are biodegradable, so they are harmless to the environment and explain coloration.
Reference	[8]	[21]	[27]	[28]	[29]

3.3 | Effect of THB gene mutation on the human body by the scalp skin barrier

In Table 3 and Figure 2, it was shown that the gene mutation has various incurable diseases and, in the case of women, even reproductive disorders. THB is a chemical compound that can be found in some cosmetic and personal care products. THB is often used as an ingredient in hair care products, such as shampoos and conditioners, due to its potential benefits for the scalp and hair. The three hydroxyl groups in THB make it a highly hydrophilic molecule, which means that it is attracted to water. This property makes THB an effective moisturizer and emollient, as it helps to retain water in the scalp and hair. THB is also a good humectant, meaning that it helps to prevent moisture loss from the scalp and hair. THB has been shown to have anti-inflammatory and antioxidant properties, which can help to protect the scalp from damage caused by oxidative stress. This is important for maintaining healthy hair growth, as oxidative stress can lead to hair loss and other scalp conditions. In addition, THB has been shown to have a soothing effect on the scalp. This can help to reduce itching and flaking, which are common symptoms of a dry, irritated scalp. By improving the overall health of the scalp, THB can also help to promote healthier, stronger hair growth.³³ It causes various lesion problems, and social problems occur very frequently.^{33,34} These issues are not unique to consumers. Manufacturers developing and producing products need to be aware of the fact that they cause serious problems and know what can cause difficulties. The effect of the skin barrier on the human body is very important. The skin barrier protects our skin from the outside world, boosts our immunity, and we know that in today's epidemic situation, we must do our part more, this is shown in Figure 2.^{35,36}

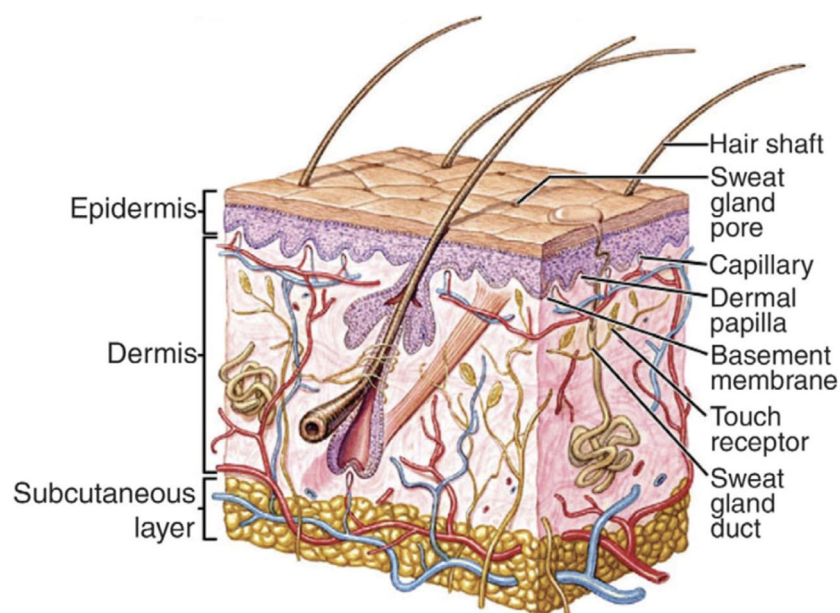
Face-oriented cosmetics are being used all over the body, occupying a deep place in our lives. First, it is a language that was created when cosmetics companies emphasized moisture cosmetics, and it is a very important part to protect the skin from bacteria.³⁴ It is the place where everything that is made up of the scalp is the basis and the life and loss of hair is made. When the skin barrier is broken, it is exposed to all germs, so the toxicity to the human body spreads throughout the body. Especially in the case of the scalp, the severity is greater because it leads to hair loss. It is no exaggeration to say that the scalp, where hair grows and forms its shape, is a field of hair. As the importance of the skin barrier, which is the home of hair, increases, the risk of genetically mutated components is also treated as important in nutrition to the human body. In the meantime, we are exposed to genetically mutated components. This is because these genetically modified ingredients and the mechanism of the skin barrier cannot be free from the effects of alopecia, scalp inflammation, and toxic effects on the overall human body.³⁷

4 | DISCUSSIONS

There are always discussions about ingredients that are harmful to the human body. In addition, as dealt with in many previous studies, products that are frequently used should be treated very carefully. For example, coloring shampoo is a product that combines coloring

TABLE 3 Effect of gene mutation on the human body of the scalp skin barrier.

Author	Towns, A., (2021)	Turati F, P.C., Galeone C, Decarli A, La Vecchia C, (2014)	Adeel, S., et al., (2018)
Journal name	<i>Color Technol</i>	<i>Ann Epidemiol</i>	<i>Handbook of Renewable Materials for Coloration and Finishing</i>
Title	A review of developments in industrial hair colorant actives for oxidative dyes.	Personal hair dye use and bladder cancer: a meta-analysis.	Sustainable application of natural dyes in cosmetic industry.
Discussion	The development of industrial colorants as an active ingredient in commercial products that depend on oxidizing agents for coloration of human hair was reviewed and the effect of this study was studied.	An observational study examining the association between hair dye use and bladder cancer incidence/mortality in PubMed/EMBASE, January 2013, for hair dye and bladder cancer issues.	Problems arising from the development of natural dyes and chemical dyes in the cosmetic industry, their impact on the environment, and countermeasures.
Reference	[33]	[34]	[37]

**FIGURE 2** MacNeil (2008). Biomaterials for tissue engineering of skin.³⁵

shampoo.^{2,22} Kim et al. report the harmful effects on the human body due to the use of dyeing. When dyeing is exposed for a long time, toxic ingredients cause fatal harm such as dermatitis, cancer, and allergies. It addresses the importance of this issue, particularly in relation to the safety of ingredients in hair dyes.¹⁴ For decades, an expert panel's Cosmetic Ingredient Review (CIR) has evaluated the safety of many chemicals used in hair dye. The safety of various chemicals in oxidizing and nonoxidizing hair dyes in hair dyes, the toxicity associated with hair dyeing, and the carcinogenic risk associated with hair dyeing are reviewed. The use of these chemicals as raw materials for hair dye production increases potential toxicity and carcinogenic risk and facilitates the synthesis of contaminants. Personal or professional dyeing increases and predicts cancer risk and positive associations between dye use and cancer incidence have been reported in certain subgroups. Through this, it was found that the inclusion of THB components is very harmful to the human body. Permanent hair dyes, the most commonly used product type, are

problematic because they are formed by oxidation processes involving arylamines. When exposed to such hair dyes for a long time, the harm to the human body is known to have low-grade toxicity that causes allergic contact dermatitis, including the risk of cancer.¹⁴ A study by He and colleagues revealed the toxicity associated with hair dyeing and the carcinogenic risk associated with hair dyeing in oxidative and nonoxidative hair dyes. A warning about 1,2,3-THB, which is the toxicity of the hair dye, and a review of the usage amount was done. Controlling the amount of THB used is emerging as a very important issue even in coloring shampoos containing hair dye ingredients.² In another study by Kunz and his colleagues, focusing on ultraviolet (UV) filters used in sunscreens and UV stabilization of materials, benzophenone-1 (BP1), benzophenone-2 (BP2), 4,4-dihydroxybenzophenone, 4-hydroxybenzophenone, 2,4,4-trihydroxy-benzophenone, was found to have an effect on the estrogen receptor. Like this and coloring shampoos that use THB, this study predicted the response of 1,2,3-THB to estrogen, and

TABLE 4 The harmful effects of toxins on the human body by dyeing.

Author	Kim KH, K.E., Jahan SA., (2016)	He L, M.F., Gahlon HL, Zeng W, (2022)	Kunz, P.Y., (2005)
Journal name	<i>Environ Int</i>	<i>Chem Res Toxicol</i>	<i>Toxicol Sci</i>
Title	The use of personal hair dye and its implications for human health.	Hair dye ingredients and potential health risks from exposure to hair dyeing.	Comparison of in vitro and in vivo estrogenic activity of UV filters in fish.
Discussion	Acute toxicity of the hair dye and its ingredients has been confirmed, mainly causing allergic contact dermatitis, and the importance of the ingredients in relation to the safety of the hair dye ingredients has been discussed.	In accordance with the trend of hair dyeing, it is necessary to understand and cope with skin exposure to chemicals in hair dyeing products and related toxicity and risks.	Estrogen receptor fish-based assay for environmental risk assessment based on combined, complementary and appropriate species-related assay for hormonal activity.
Reference	[14]	[2]	[22]

warns of the risk of breast cancer, as indicated in previous studies.²² It is safe to say that it has double toxicity. But we are using it too easily. In the case of standards for harmful ingredients for genetic mutations, it is not possible to use them until safety is secured in Europe.^{38,39} In the case of the United States, a strong manufacturer's punitive liability system is preferred, and when a problem occurs, the consumer is liable to aggravated punishment. Ironically, all these experiments are based on bacterial experiments, not human experiments. Even in Korea, manufacturers say that they have used expansion that has no problem in bacterial tests. If so, no matter how small the amount is, it does not provide an answer on how to ensure the safety of shampoos that are used every day. In the case of coloring shampoo, if it is the subject of a problem enough to issue a warning to pregnant women, it should display the warning for other ingredients as well. For example, if there is an ingredient for algae, a warning label should be added to people who are allergic to it. At the same time, the manufacturer should know that it is an obligation to inform the consumer in the case of a lesion factor so that they can fully understand that even a small problem can be harmful to the human body even in other cases by the Table 4.

Due to the pandemic, people are talking about immunity too much. Healthy people can be free from certain diseases. However, unhealthy, and immunocompromised people always become sensitive to anxiety and social problems when exposed to this pathological pandemic, which has many adverse effects in real life. The coloring shampoo market in Korea is rapidly expanding. If we look at the question of, is it safe from dye-shampoo gene toxicity? And major consumers should make detailed requests for more cultivating coloring shampoo and continue to inquire about safety so that the harmfulness of the product can be further developed.

5 | CONCLUSIONS

The study examined the harmfulness of coloring shampoo to scalp skin barriers. It has been confirmed that frequent coloring shampoo procedures can have various adverse effects on the scalp. The highlighted main points are warnings about the harmfulness of THB

ingredients in coloring shampoos to the human body, general attention to the human body when using coloring shampoos for covering gray hair, and harmfulness to scalp health. Therefore, when using coloring shampoo, it is important to reduce side effects from the use of harmful ingredients and maintain a healthy scalp condition through sufficient scalp condition analysis and consultation with experts. In addition, various studies according to the standard standards of THB harmful ingredients and age are suggested.

AUTHOR CONTRIBUTIONS

Jooyoung Lee: Conceptualization. Ki Han Kwon: Supervision.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

TRANSPARENCY STATEMENT

The lead author Ki Han Kwon affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

DATA AVAILABILITY STATEMENT

The findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The conducted literature review did not require the agreement of the bioethics committee.

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How to cite this article: Lee J, Kwon KH. Considering the risk of a coloring shampoo with the function of gray hair cover cosmetology and skin barrier: A systematic review. *Health Sci Rep*. 2023;6:e1271. doi:10.1002/hsr2.1271