REVIEW

Hair Aging in Different Races and Ethnicities

by MAYRA B. C. MAYMONE, MD, DSc; MELISSA LAUGHTER, PhD; SAMARA POLLOCK, BA; IMAN KHAN, MS, MPH; THAÍS MARQUES, MD; RANA ABDAT, MD, MSc; LYNNE J. GOLDBERG, MD; and NEELAM A. VASHI, MD

Drs. Maymone, Goldberg, and Vashi, Ms. Pollock, and Ms. Khan are with the Department of Dermatology, Boston University School of Medicine in Boston, Massachusetts. Drs. Maymone and Laughter are with the Department of Dermatology, University of Colorado School of Medicine in Denver, Colorado. Dr. Marques is with the Department of Internal Medicine, Metrowest Medical Center in Boston, Massachusetts. Dr. Abdat is with the Department of Dermatology, Tufts Medical Center in Boston, Massachusetts. Dr. Vashi is also with the United States Department of Veteran Affairs, Boston Health Care System in Boston, Massachusetts.

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ABSTRACT

BACKGROUND: Aging is an unavoidable biological process with many influencing factors, accounting for a multitude of visible manifestations on the hair as well as the skin. As the population ages while becoming more diverse, it is increasingly important to better understand the hair aging process. **METHODS:** A literature search was performed to review what is known about changes in hair structure over time, focusing on the differences in hair aging according to ethnic background. **RESULTS:** Sixty-nine publications were selected and information regarding hair structure, aging characteristics, and responses to extrinsic damage together with differences between races and ethnicities was collected. Hair-graying onset varies with race, with the average age for Caucasians being mid-thirties, that for Asians being late thirties, and that for Africans being mid-forties. Caucasians and Asians typically experience damage to the distal hair shaft, while African-Americans see damage occurring closer to the hair root. Postmenopausal changes include decreased anagen hairs in the frontal scalp, lower growth rates, and smaller hair diameters. **CONCLUSION:** There is a paucity of literature examining the characteristics of hair aging across all races. The unique characteristics of hair aging in different ethnicities provides information that will aid in a culturally sensitive approach and recommendations.

KEY WORDS: Hair aging, ethnic hair, differences in hair according with ethnicity, hair aging, graying, hair damage.

Aging is an unavoidable biological process with many influencing factors that results in visible manifestations on all cutaneous appendages, including the hair. The hair follicle is a particularly unique structure that undergoes many changes over time. While skin aging and hair loss are extensively discussed in the dermatology literature, hair aging has not received similar attention. Similar to skin, hair aging comprises both intrinsic aging, which includes the natural physiological changes that occur with time, and extrinsic aging, or changes associated with environmental exposures and physical stress caused by daily grooming. The most well-recognized sign of intrinsic aging is graying of the hair. However, hair aging changes go far beyond color alterations, with many other hair properties. such as diameter, density, shape, growth patterns, and mechanical and tactile aspects affected. Exposure to ultraviolet light and the use of heat can cause extrinsic aging, resulting in dull and pale hair color, loss of natural shine, changes in hair surface texture, and dryness.[1]

Despite a similar chemical composition, the structural properties of hair vary between different ethnicities and, consequently, the aging of hair differs as well. As the population ages and becomes more diverse, it is of greater necessity to understand the hair aging process in different types of hair. We aim to review current literature, highlighting the structural and cultural differences between varying races and ethnicities, focusing on the heterogeneity between Caucasians, Asians, African-Americans, and Hispanics/Latinos.

METHODS

A PubMed, Web of Science, and Google Scholar literature search was performed. The scope of our search included basic science research, randomized controlled trials, observational studies, reviews, commentaries, and textbook chapters published from 1965 to July 2019. A total of 69 publications regarding hair structure and aging in ethnic skin were selected and included according to topic relevance.

FACTORS IN HAIR AGING

Intrinsic factors. Hair graying is commonly associated with increased age. The regulation of melanin production, and thus, hair pigmentation is affected by numerous factors, including hair cycle-dependent variations, sex and racial differences, hormones, genetics, and age-related changes.[2] However, the exact mechanism of how this occurs is not completely understood. In general, hair graying has been attributed to a loss of melanin-producing

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CORRESPONDENCE: Neelam Vashi, MD; Email: nvashi@bu.edu

melanocytes in the hair matrix at the base of the hair follicle. This leads to a decrease in the amount of melanin that is transferred to keratinocytes and, thus, a decrease in the pigmentation of the hair shaft.[3] The reason for the decline in melanocytes with increasing age is thought to be the reduced activity of stem cells. Melanocyte stem cells reside in the hair follicle bulge and serve as a source for hair pigment.[4] It is thought that, as we age, these melanocyte stem cells lose the ability to self-maintain and proliferate to replace old melanocytes.[5] Thus, there are no melanocytes to synthesize melanin, leading to graying hair. Melanogenesis itself creates oxidative stress due to the hydroxylation of tyrosine and oxidation of dopamine to melanin. Previous studies have linked increasing age to a decrease in the expression levels of both tyrosine hydroxylase and catalase in hair follicle melanocytes.[6] Similarly, the activity of the remaining catalase enzymes is decreased, with increasing age of the donor hair.[6,7]

Along with increasing age, there are many other factors that influence the progression of hair graying. The average age of onset of hair graying appears to be mid- to late forties; however, this varies with race, with the average age for Caucasians being mid-thirties, that for Asians being late thirties, and that for Africans being mid-forties. Graying hair is considered premature if it occurs before the ages of 20 years in Caucasians, 25 years in Asians, and 30 years in Africans, respectively.[8] The incidence and age of onset of hair graying appear to be similar for both men and women, although there are differences in the pattern of color change (i.e., beginning in the temporal area in men vs. the frontal area in women).[9] Studies have also shown that certain environmental factors, such as smoking (i.e., the risk is 1.99 times higher in smokers vs. nonsmokers) increase the risk of hair graying.[9] Other extrinsic factors including ultraviolet (UV) exposure and nutrition can accelerate hair graying.[3]

Extrinsic factors. Extrinsic factors, or environmental factors, can have a vast effect on the structure and condition of hair, thus affecting how it ages. Oxidative damage of hair, caused by ultraviolet (UV) light, can result in the degradation and loss of hair proteins and pigment.[17,18] The mechanism behind this damage begins with the absorption of UVB and UVA radiation by amino acids within the hair and the release of free radicals, causing damage to the protein structure of the hair. Free radicals are usually absorbed by melanin; however, the presence of a large amount of free radicals can decrease the melanin production within the hair follicle and increase the degradation of melanin, leading to reduced pigment.[3] Less pigment leads to less protection from UV light, allowing greater oxidative damage.[19] Other environmental factors, such as chemicals and heat, can affect how hair ages. Chemicals, such as those in hair dye and products to permanently straighten the hair, can cause damage to the hair fiber and create breaks within the hair shaft. These chemicals may be less tolerated as the hair ages and becomes less resilient to damage.[11] Among different ethnicities, Caucasians and Asians typically experience damage to the distal hair shaft, while African-Americans tend to experience damage closer to the hair root, possibly caused by harsh chemicals used to relax the hair.[13] Meanwhile, studies have shown that smoking can increase the rate of aging hair, leading to early-onset alopecia and graying.[9] Although the mechanism of how smoking affects hair properties and aging has not been well-studied, it could be related to an increase in oxidative damage, which is a known factor in alopecia and hair graying.[11]

HAIR AGING BY ETHNICITY

Caucasian. *Structural aging.* Caucasian hair consists of a great diversity of morphological shapes and physical properties, ranging from fine to coarse and straight to curly.[20] This diversity in hair structure is thought to stem from the variety of backgrounds from which the Caucasian ethnicity is derived, including European, North African, and Southwest Asian ancestries.[21] Common among all ethnicities, the hair shaft consists of the cuticle, cortex, and medulla.[22] The cuticle is the outermost layer of the hair shaft, composed of keratin in beta sheets to protect the cortex from the environment.[22,23] The cortex surface consists of protein in an alpha helical formation, where cysteine and disulfide bonds contribute to the tensile strength of the cortex and provide important protection against breakage. The medulla is an empty center of the hair fiber that may not always be present, but is found more commonly in aging hair to be enlarged and collapsed, with a central cavity.[7]

Hair's diameter increases until the mean age of 40 years, plateaus in the early forties, and then continues to decrease exponentially thereafter.[25] Caucasian hair has an average diameter of 65µm, which is of intermediate thickness between Asian hair (70µm) and African hair (55µm). It is more cylindrical in shape relative to the more ellipsoid structure of African hair,[24] peaking in thickness between the ages of 42 and 53 years in women, during the perimenopausal period or transition to menopause, suggesting that estrogen levels are involved in hair growth.[25] An increase in hair diameter toward the scalp is observed during pregnancy, while a decrease in the same is observed in nonpregnant individuals. Similarly, Robbins et al[25] discussed that estrogens have a positive influence on hair growth by prolonging the anagen phase and suppressing androgen production.

The density of hair, defined as the number of hair fibers per cm^2, is determined by the hair cycle itself, which consists of anagen, catagen, and telogen phases. The average duration of the anagen phase decreases with aging and more hairs remain in the resting or telogen phase, increasing the amount of hair that is shed.[7] Similar to a decrease in the diameter of aging hair, the hair density decreases with increasing age.[25] The highest density of hair is observed between the ages of 20 to 30 years, with declining density beginning at the age of 35 years and older.

Hair is dynamic, changing from childhood to puberty and adulthood to old age both in terms of diameter and pigmentation.[20] For example, vellus hair follicles on body sites in children grow later into terminal hair, while the vellus follicle remains after the loss of terminal scalp hairs.[26] From childhood to puberty, the surface morphology of hair also changes, with a reduction in the size of the cuticle and increasing pigmentation observed throughout this period.

Kauser et al[6] noted that the hair bulb environment becomes more oxidized with age. Oxidative stress leads to cellular aging and the accumulation of mutations occurs with age, with a higher rate of mutations in those tissues exposed to oxidative processes.[6,27] As melanocytes age, their susceptibility to oxidative stress increases, leading to an overall reduction in the melanocyte number and an increasing amount of gray and white

TABLE 1. Ethnic differences in properties of the hair[68]

PROPERTIES	CAUCASIAN*	AFRICAN	ASIAN	HISPANIC/LATINO
Hair shaft shape	Cylindrical	Ellipsoid/ flattened	Circular	Cylindrical/Circular
Cuticle	Standard	Smaller and less number of layer	More compact and highest number of layers	NA
Breakage	Average	Increased/ Faster	Lesser	Similar to Asian
Diameter/thickness	65µm	55µm	80–120µm	Between Asian and Caucasian
Density[65]	Highest	Less than Caucasian	Less than Caucasian	Less than Caucasian
Growth rate	Average	Lowest	Higher	NA
Eumelanin content	Variable**	Highest	Second highest after African American	NA
Melanosome size/shape	Average	Larger melanosome size and higher melanosome density	Ellipsoidal to a thicker shape with age[69]	NA

NA: Not available
*Serves as a reference for comparison; **Depends on hair color

pigmentation in aging hair.[6,7]

Cultural considerations. Not unique to Caucasians, the hair serves two roles in today's society: protection and cosmesis. Starting from childhood, individuals subject their hair to a variety of chemical and physical treatments in accordance with both societal and cultural expectations of beauty. Particularly among Caucasian men and women, thermal and color treatments eventually become the norm.[25,28] When exposed to thermal treatment with temperatures upwards of 450˚F, both cuticular and cortical damage occur. McMullen et al[20] noted the occurrence of color changes of Piedmont hair (i.e., yellow-colored) to a dark yellow hue when exposed to a summation of a series of short thermal treatments. Hot ironing, flat ironing, and blow-drying hair leads to dehydration, tryptophan degradation, cracking of the cuticle, and denaturing of hair proteins.[20] When exposed to heat, both surface and internal damage ensues, denaturing the alpha helical keratin of the cortex into beta-pleated sheet conformation. Numerous cross-sectional studies have shown that the outside cuticles appear normal and of healthy morphology, while the internal cortical structures contain cavities after cumulative exposure to heat.[20] Bleaching of hair from dark brown to blonde, which is common in the United States, creates the most damage and the largest decrease in tensile strength.[20,29] Bleaching breaks disulfide and hydrogen bonds, causing the fiber to become more extensible, weakening the tensile strength, and creating more stress and strain in each individual fiber.[20] Furthermore, color dyes commonly utilize ammonia to lift the cuticle protection to permit the entry of peroxides and dye into the hair cortex. The process of hair dying causes oxidative damage to the hair fiber, splitting, drying, and dulling the hair after cumulative treatments. As oxidative damage leads to cellular aging, the increase in hair dye will lead to further graying of the hair fiber.[30]

African descent. *Structural aging.* Similar to the diversity of Caucasian hair, African hair belongs to individuals from a variety of geographic locations, most notably from Central, East and West Africa, the Middle East, and the Caribbean.[21] The primary structure and function of hair remain similar among all ethnicities; however, the unique morphologies and intrinsic characteristics of hair fibers allow for a range of differences in both hair type and hair health.

African hair has an average diameter of 55µm—the smallest among all hair subgroups.[24] Furthermore, African hair contains the greatest variability of diameter in a single strand.[24] The cross-sectional shape of the hair fiber varies along its length as well and is ellipsoid and flattened when compared with hair affiliated with other ancestries.[24,31] Regardless of race, the larger the diameter of the hair fiber, the faster the rate of hair growth. Although there are no differences in the hair-growth cycle among Asian, African, and Caucasian hair subgroups, African hair has been found to grow at a slower rate, likely due to its smaller-diameter fibers.[32] Loussouarn et al[33] reported this slower rate of growth, approximating the occurrence of a 5-cm difference in hair length between African and Asian hair in one year. African hair has been shown to break faster than it grows, contributing to the perception of the inability of African hair to grow.[32,34] Although no one particular study has shown evidence of a decrease in the diameter of African hair with age, numerous studies have focused on the changing diameter of aging hair in individuals of Caucasian and Asian ethnicities. If alterations in hormone levels and the relative length of the anagen phase are predominant controlling factors of hair diameter, similar results would be expected in aging African hair.[31]

The average density of scalp hair of African ethnicity is less than that of Caucasian and Asian ethnicities, while the density of African hair decreases with age.[22,33,35] Individuals begin to perceive hair loss after approximately 50 percent of hairs are gone.[36] According to Khumalo et al,[34] shed hair fibers in Caucasian and Asian groups are full-length hair shafts with a telogen club, while, in contrast, shed African hair shafts are often shorter, with no proximal club and evidence of longitudinal fissures, suggesting that breakage is how hair is lost.

Although the hair cuticle consists of keratin in all ethnicities, there are less cuticular layers in that of African hair as compared with Asian and Caucasian hair, increasing the susceptibility to deeper cortical damage.[20,22,24] African hair is intrinsically fragile and thin, as evidenced by the smaller number of cuticular cell layers, smaller diameter, and longitudinal splitting of the hair shaft with minimal stress. In addition, "virgin" African hair, which is hair that has not undergone any chemical or thermal treatment, has less tensile strength than Caucasian and Asian hair.[34] African hair breaks earlier and at a lower stress level than Caucasian and Asian hair,[24] due to the small angles and tight curls

that cause torsions at many regions along the hair's length.[37] Furthermore, knotting of the hair fiber is seen predominately in African hair as there are tight curls and frequent twists, leading to increased breakage and fragility. With regular grooming and combing, the number of breaks, fissures, and knots increase, leading to cumulative physical damage in aging hair.[34]

Regardless of race, graying hair is largely correlated with chronological age.[26] The average age of onset of gray hair in people of African ethnicity is mid-forties, with premature graying if the onset is before the age of 30 years.[26] Previous studies have found that African hair samples contain larger melanosome sizes and higher melanosome density relative to hair samples of Caucasian or Asian ancestry, suggesting a possible reason for the later onset of graying in African hair.[31,38,39] The production of eumelanin declines with age, while the oxidative stress increases, similar to as seen in Caucasian hair.[6,7] Furthermore, Commo et al[38] noted that there is a decrease in dopachrome tautomerase activity, an enzyme involved in the production of eumelanin, in aged melanocytes, with the enzyme undetectable in hair bulbs in individuals older than 45 years of age. Similarly, an intermediate in the production of melanin, dihydroxyindole carboxylic acid, decreases in content in African-American hair from young to old age.[38]

Cultural considerations. Hair is of cultural value for women and men of African ancestry. Multiple haircare products, thermal and chemical treatments, and hairstyling practices are used particularly for African and afro-textured hair. With age, hair is seen to become thinner and the scalp has a lower density of follicles.[22] Certain factors contribute to hair loss and, in people of African ancestry, alopecia is the sixth most common diagnosis made when visiting the dermatologist.[32] Unique hairstyles, such as cornrows, tight hair ties, braiding, and weaves, common in individuals with African hair, create traction on the scalp, yielding traction alopecia.[32,34,40] Furthermore, as African hair exhibits tight coiling, everyday washing, combing, and grooming practices increases knot formation and leads to a high prevalence of fractures along the hair's length.[24,32,34]

It is common for African hair to be treated with heat, colorants, and chemical relaxers in order to attain a more manageable style. In particular, chemical relaxers incorporating sodium, potassium, and guanine hydroxide alter the chemical and morphological properties of the hair shaft, leading to the cleavage of disulfide bonds, the formation of cross-links, and changes in keratin protein conformation.[20,32] Chemical relaxers have been shown to remove lipids from the cuticle, creating a hair fiber that is more porous to water, damaging the cell-membrane complex in the process and decreasing the tensile strength.[20,34] While thermal treatments, including hair straightening and curling, are more common among people with Caucasian hair, similar effects on the degradation of keratin are seen when hair is exposed to repetitive alkaline solutions in relaxer treatments common among individuals of African ancestry.[20]

The perception of hair luster and shine is seen to reduce with age. Hair not only becomes dull when the individual shaft lacks moisture but also when the oil or sebum from the scalp is diminished.[13] Although virgin African hair has high sebum production, which often leads to an oily scalp, African hair actually has drier hair fibers relative to Asian and Caucasian hair.[13,24,37] In addition, it is difficult for sebum to coat the entire length of curly and wavy hair, contributing to the use of daily brushing to promote diffusion of the sebum throughout the hair's length.[22,37] With daily shampooing, the protective layer of sebum that covers the hair is removed, causing the inner shaft to dry and become more prone to friction.[37,41] Similarly, the hair fiber itself is less permeable to water and has a lower radial swelling rate compared to Caucasian and Asian hair fibers.[34] With simple daily practices, hair shine diminishes, creating the perception of aged hair.

Asian descent. *Structural aging.* Asians are a diverse population, yet current literature on hair tends to focus on East Asians, which includes Chinese, Koreans, and Japanese; there is limited information on Southeast Asians. Structurally, Asian hair can be straight or curly[42] with a circular hair shaft. Asian hair has a greater diameter when compared with that of Caucasians or African-Americans and with a similar diameter to Latino hair,[43] ranging from 80 to 120 µm. The increased diameter is attributed to a wider[44] and more compact cuticle, with greater number of cuticle layers.[45] The increased cuticle thickness is thought to confer an increased resistance to external damage such as coloring, mechanical trauma, and ultraviolet radiation.[45] Moreover, the cuticles of Asian hair have a sharp inclination and narrower intervals between scales, which this seems to absorbs stress in a unique manner, providing the extra strength seen in Asian hair.[44]

The reduction in hair diameter is a common feature of hair aging and studies have reported a decrease in diameter after 40 years of age in Japanese women[46] and after 50 years of age in Koreans.[47] The decrease in diameter leads to reduction in tensile strength, making the hair weaker and more prone to breakage.[48] The cuticle is the first structure affected by aging, with the type of damage changing from type L, when the cell membrane is split and the cuticle lifts up, to type E,[49] when the endocuticle is broken, resulting in a wavy surface and ill-defined scale borders that are less resistant to stress.[50] After the cuticle, the second structure affected is the hair matrix and, then, the keratin network.[51]

The normal hair density in Asians varies with the population studied, Ko et al reported the density of hair follicles in Taiwanese to be slightly higher than that in Koreans and similar to that in African-Americans, yet much lower when compared with in Caucasians and Iranians.[35,52–55] In Asian men, the density varies per scalp region, with central occipital areas having the highest density, and increased miniaturization noted over the temporal areas, with West Asians presenting with 14 percent and South Asians with 8.5 percent of miniaturized hairs, respectively.[56] Moreover, West and South Asians have a slightly greater hair density when compared with East and Southeast Asians.[56] With aging, the density begins to decrease around the fourth and fifth decades of life, yet the changes are subtle and do not result in visible hair loss.[46] Alterations in hair curvature with aging adversely influences hair properties including the loss of hair luster, leading to cuticle breakage, frizziness, and a rough/dull appearance that starts around the fourth decade.[47,57,58] Despite the lower hair density relative to Caucasians, Asians have a higher hair growth rate.[59]

Hair pigmentation is known to vary with ancestry and age and the total eumelanin content found on East Asians hair is the second highest after Africans-Americans; however,

TABLE 2. Antiaging and healthy hair strategies[58]

Appropriate grooming habits
Careful hair styling
Correct choice of shampoo, conditioner and leave-in products
Adequate choice of hair coloring
Medical therapies to address any underlying conditions

they appear to have the same "visual" phenotype.[38] A specific polymorphism in the dopachrome tautomerase gene found in Asians is associated with a 20-percent reduction in pigmentation. The most common visible sign of hair aging is graying and, traditionally by the age of 50 years, about 50 percent of the hair of 50 percent of individuals is gray.[8] Recently, a study by Panhard et al[60] reported that onset and rate of graying are influenced by both ethnicity and geographic location of origin. African-American, Thai, and Chinese individuals with darker hair tones have a lower frequency and intensity of graying when compared with those with lighter hair colors (e.g., Caucasians) of similar ages.

Hair lipids are responsible for hair moisture, shine, and integrity, functioning as a barrier against external injury. A study by Ji et al[61] found larger amounts of integral lipids, fatty acids, cholesterol, and wax esters in Asians when compared with in Caucasians and African-Americans. Moreover, this greater hair lipid layer makes the Asians hair less susceptible to UV damage.[61] With age, there is a decrease in lipids around the fourth and fifth decades of life, which appears to be more pronounced in women than in men.[58]

Cultural considerations. Hairstyles in the Asian population are used to identify sex, age, ethnicity, and even social and marital status. In ancient China, girls wore their hair braided until the hair pinning ceremony, an event that marked their passage to adult life and readiness for marriage.[62] Hair color and style continue to influence the perception of age, attractiveness, and health.[63] Fink et al[63] used manipulated computer-generated images to evaluate three hair characteristics (diameter, density, and style) and how they influence women's beauty perceptions. Hair style seemed to play a strong role in the perceptions of health and attractiveness, with darker shades deemed more attractive and healthier than lighter hair tones. Additionally, longer hair was perceived as healthier and hair diameter and density had an impact on perceptions of age, health, and attractiveness.[63]

Common to all races, the use of cosmetic products to bleach or color, perm, or straighten the hair are frequently used; however, how the hair reacts to external damage differs across races. According to Lee et al[54] Asian hair was found to be more resistant to straightening treatments when compared with that of Caucasians and African-Americans, yet did not show similar resistance to coloring or the combination of coloring and straightening. Conversely, a study by Galliano et al[64] reported the Chinese hair cuticle to be more sensitive to chemical products such as hair straightening products. More research is needed to evaluate how different hair origins respond to chemical treatments.

Hispanic or Latino descent. *Structural aging.* Hispanic or Latino populations have a diverse phenotype and genetic background. Their mixed European, Native American, and African ancestry coveys an extensive variation in hair appearance. There is a paucity of literature evaluating the properties of Hispanic hair in comparison with that of other the races/ethnicities. Structurally, Latino hair is similar but slightly smaller than Asian hair,[43] falling between the Asian and Caucasian values for diameter, ellipticity, and curliness measurements.[5]

A quantitative trichoscopic study found that Hispanics have a lower hair density than their Caucasian counterparts but a higher density than individuals of African descent.[65] The highest density was found at the vertex of Hispanics versus the frontal scalp, followed by in the frontal and occipital scalp, respectively.[65] A recent large genomic analysis of a Latino population including people from five countries identified genes associated with hair features, with an apparent high heritability in the Latino population found to be highest for hair color and lowest for graying.[66] Further elucidation of the exact mechanism through which this gene works may be a target for future intervention.[66]

Cultural considerations. Despite the innate differences in hair properties due to ethnicity, hair characteristics may be strongly impacted by daily habits and practices. When evaluating differences in hair damage, measured by tensile properties, a study comparing the hair of Mexican nationals living in Mexico City and the United States found that hair procured from the latter exhibited lesser tensile properties.[5]

Hispanic descents report heat-styling habits similar to those of Caucasians, but a greater use of hair dye and hair keratin straightening treatments.[65] Keratin hair straightening, also known as Brazilian keratin or albumin hair straightening, acetic acid treatment, and hair Botox, are extremely popular in Brazil among those seeking to obtain smooth, shiny hair. However, these chemically treated hairs may become highly sensitive and prone to damage.[65,37] Due to the increased damage caused by external factors from cosmetic procedures; friction damage from combing and brushing; damage from excessive heat from a hair dryer or curling irons; and structural and chemical damage from the chemical treatment of hair or bleaching, coloring, perming, and straightening, the Latino population may show signs of hair aging from weathering earlier. As we understand this population better, both genetically and culturally, we are steps closer to identifying targets for intervention.[67]

CONCLUSION

The role of hair for both protection and cosmesis makes it incredibly important to physical and mental well-being. A thorough understanding of the unique characteristics of hair aging among different races and ethnicities is essential for the appropriate management of mature patients and allows for a culturally sensitive approach to be adopted when making recommendations to prevent hair damage during one's life time.

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