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Artificial Intelligence in Patient Education for Androgenetic Alopecia: A Comparative Study of ChatGPT, Gemini, and Deepseek R1

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ABSTRACT

Introduction: Androgenetic alopecia (AGA) is a common cause of hair loss worldwide. Accurate patient education may improve treatment adherence and outcomes.

Objective: To compare the accuracy, readability, and user experience of ChatGPT 4.0, Gemini 1.5 Flash, and Deepseek R1 in answering common patient questions about AGA.

Methods: In February 2025, a cross-sectional study was conducted using 12 frequently asked patient questions on AGA, sourced from online platforms. The questions were submitted to ChatGPT 4.0, Gemini 1.5 Flash, and Deepseek R1. Two dermatologists independently assessed responses using a validated 4-point accuracy scale. Readability was measured with the Flesch-Kincaid Grade Level and Flesch Reading Ease Score. User experience was evaluated based on response speed, presence of visual aids, citation usage, and overall satisfaction. Inter-rater reliability was analyzed via Cohen's kappa, and statistical comparisons were made between models.

Results: ChatGPT 4.0 and Gemini 1.5 Flash successfully answered all 12 questions, with most responses rated as "satisfactory with minimal corrections." Deepseek R1 answered only five questions and frequently provided inaccurate content, especially when differentiating between AGA and cicatricial alopecia. It also lacked warnings about potential misinformation. Gemini 1.5 Flash included visual aids and citations, improving interpretability. All models generated responses at a high school reading level. In terms of user experience, ChatGPT 4.0 and Gemini 1.5 Flash outperformed Deepseek R1.

Conclusions: ChatGPT 4.0 and Gemini 1.5 Flash provided accurate, readable, and user-friendly responses on AGA-related questions, making them promising tools for patient education under physician guidance. Deepseek R1's limitations highlight the need for cautious implementation.

Introduction

Hair is an important part of a person's perception of beauty and individual image. Hair loss is therefore a significant problem, not only dermatologically but also psychologically [1]. The most common cause of hair loss in both males and females is androgenetic alopecia (AGA), or male pattern baldness. It is more common in the Caucasian race and has a slightly lower prevalence in individuals of Black and Asian ethnicity [2]. Androgenetic alopecia is a type of alopecia characterised by progressive miniaturisation of genetically predisposed hair follicles under the influence of androgens [3]. There are various topical and systemic treatment options available, but due to the progressive nature of the disease, these treatments must be continued over a long period of time. The lack of information about treatment duration and side effects leads to disappointment, which affects compliance and premature discontinuation. It is therefore important that patients are provided with accurate and appropriate information [4]. Patients often use internet tools to learn about diseases and treatments, and artificial intelligence (AI) tools have recently been added. This situation has also led to publications evaluating the role of AI tools in patient education [5].

ChatGPT 4.o, Google's Gemini Flash 1.5, and DeepSeek R1 represent a new generation of large language models (LLM) that leverage advanced artificial intelligence techniques, specifically deep learning methodologies, to generate responses to natural language prompts that exhibit characteristics reminiscent of human interaction. These models are initially pre-trained on extensive textual data, followed by fine-tuning to facilitate conversational responses to a range of user commands [6-9]. Improved patient interaction can be achieved by integrating AI models into the field of dermatology.

In consideration of the aforementioned factors, this study was designed to compare responses from ChatGPT 4.o, Gemini 1.5 Flash, and DeepSeek R1 to a series of patient inquiries concerning androgenic alopecia.

Methods

A search for "patients' questions about androgenetic alopecia" was conducted using Google (www.google.com). The Frequently Asked Questions sections from various clinics were analyzed. From a list of twenty questions, the 12 most frequently asked were selected by a dermatologist with experience in hair-related conditions who evaluates approximately 800-1000 patients annually.

The selected questions were presented to ChatGPT (version 4.o, the latest free version as of 2 February 2025), Gemini 1.5 Flash, and DeepSeek R1 chatbot in a single session without follow-up or repetition. Two dermatologists independently reviewed all responses using an evidence-based framework. The second reviewer is a dermatologist currently working at a Training and Research Hospital, where he manages tertiary-level patients. He has clinical experience in the management of hair disorders and evaluates approximately 700–800 patients annually.

Responses were evaluated using the Mika et al. rating system, previously utilized in AI-related medical research [10]. This system assigns scores on a four-point scale:

1. Excellent (no clarification required): Complete and aligned with the existing literature
2. Satisfactory (minimal clarification required): Lacking minor details but generally accurate
3. Satisfactory (moderate clarification required): Containing outdated or partially irrelevant information
4. Unsatisfactory (substantial clarification required): Including erroneous or overly generalized information that could lead to misinterpretation

To ensure consistency and reliability in scoring, each response was rated independently by two dermatologists, and inter-rater agreement was calculated.

The readability of the responses was assessed using the Flesch-Kincaid Reading Ease Score (FRES) and Grade Level (FKGL), widely used tools for evaluating text readability [11]. The FRES provides a score between 0 and 100, with higher scores indicating easier readability. For instance, a score of 70–80 corresponds to a 7th-grade reading level, whereas a score of 30–50 corresponds to a college-level reading ability. The FKGL represents the minimum educational background required for comprehension.

As this study solely analyzed publicly available online content without involving human subjects, ethical approval was not required.

Statistical Analysis

The data analysis was conducted using the IBM SPSS Statistics version 25 software package (IBM Corporation, Armonk, NY, USA). The normality of the distribution of continuous variables was assessed using the Shapiro-Wilk test, and descriptive statistics are reported as mean ± standard deviation for continuous variables. Categorical data are expressed as frequency (N) and percentage (%). The Flesch-Kincaid Grade Level (FKGL) and Flesch Reading Ease Score (FRES) for the responses provided by each large language model (LLM)-based AI application (i.e., Chat GPT, Gemini Flash 1.5, DeepSeek R1) were calculated using an online Flesch-Kincaid calculator tool available at the Good Calculators website (https://goodcalculators.com/flesch-kincaid-calculator/). The statistical significance of differences in

FKGL and FRES levels across the applications was evaluated by repeated-measures analysis of variance via Wilks' lambda test. As DeepSeek R1 failed to provide responses to four of the directed questions, the subsequent analysis focused on the subset of fully answered questions. The differences in FKGL and FRES levels between ChatGPT 4.o and Gemini were assessed by a paired samples t-test. Finally, the responses to each user experience question were visualized as bar graphs for ChatGPT, Gemini Flash 1.5, and DeepSeek R1, and descriptive statistics were calculated for the scores obtained from each subdomain. To assess the agreement between the dermatology specialists' evaluations, kappa coefficients and their standard errors were calculated. A p-value of less than 0.05 was considered statistically significant.

Results

The questions and answers of ChatGPT 4.o, Gemini 1.5 Flash, and DeepSeek R1 are shown in Table 1. ChatGPT 4.o and Gemini Flash 1.5 were able to respond to all 12 questions in succession without interruption, while DeepSeek R1 was able to answer only five. When it came to the 6th question, DeepSeek R1 replied, "The server is busy. Please try again later." The same question was asked again five minutes later, but the same response was received. After 10 minutes, the same question was asked again, and the same answer was received. Then, when the 7th question was asked again, "The server is busy. Please try again later," and no response was received. DeepSeek R1 was able to respond to each subsequent question after about 15–20 minutes, but the waiting time gradually increased. It was decided that, considering that waiting for more than 20 minutes to get the answer to a question is incompatible with real-life experience, the answers to the other questions would not be included in the study.

One week later, the same questions were presented to DeepSeek R1 again; however, starting from the second question, the response **"Server busy. Please try again later."** was received, resulting in a slower user experience. When the questions were asked for the third time on 25 February 2025, the same issue persisted, with DeepSeek R1 displaying the **"Server busy. Please try again later."** message from the second question onward.

ChatGPT 4.o's eight responses were rated as "excellent" by Reviewer 1, four responses were rated as "satisfactory requiring minimal clarification;" nine responses were rated as "excellent" by Reviewer 2, and three responses were rated as "satisfactory requiring minimal clarification."

Gemini Flash 1.5's nine responses were rated as "excellent" by Reviewer 1, and three responses were rated as "satisfactory requiring minimal clarification;" nine responses were rated as "excellent" by Reviewer 2, and three response was rated as "satisfactory requiring minimal clarification."

Deepseek R1 could only answer eight questions in total. DeepSeek R1's six responses were rated as "excellent" by Reviewer 1 and Reviewer 2, one response was rated as "satisfactory requiring minimal clarification," and one response was rated as " Unsatisfactory, substantial clarification required" (Table 2).

The ratings given by both evaluators regarding the consistency of ChatGPT 4. o's responses were found to be highly concordant (κ=0.800±0.188, P=0.0001). Similarly, the ratings given by both evaluators regarding the consistency of responses from Gemini Flash 1.5 and DeepSeek R1 were found to be perfectly concordant (κ=1.000±0.000, P=0.000).

The average FKGL levels for the first eight responses between ChatGPT 4.o, Gemini Flash 1.5, and DeepSeek R1 were found to be statistically similar (P=0.666). While no statistically significant difference was observed in terms of average FRES levels between ChatGPT 4.o, Gemini Flash 1.5, and DeepSeek R1 (P=0.053), the Bonferroni-corrected multiple comparison test showed that the average FRES value of ChatGPT 4.o was slightly higher than that of DeepSeek R1 (P=0.047). (Table 3)

The average FKGL levels for twelve responses between ChatGPT 4.o and Gemini Flash 1.5 were found to be statistically similar, corresponding to a $10t^{h}$–11^{th} grade level (P=0.674). Although the average FRES value of ChatGPT 4.o was slightly higher than that of Gemini Flash 1.5, no statistically significant difference was observed in terms of average FRES levels between ChatGPT 4.o and Gemini Flash 1.5 (P=0.059) (Table 4). All of the documents were found to be in a format that was difficult to read.

Figure 1 displays the average responses given by the evaluators for each question that constitutes the user experience of ChatGPT 4.o, Gemini Flash 1.5, and DeepSeek R1, respectively, in bar chart form. It can be seen that ChatGPT 4.o and Gemini Flash 1.5 are in a very good position in terms of user experience. On the other hand, it was found that DeepSeek R1 had a relatively poor user experience, especially in the subcomponents of effectiveness and attractiveness.

Discussion

In the case of chronic dermatological diseases such as AGA, the most common alopecia in the community, providing accurate information and effective patient education is of great importance for the success of treatment processes [12]. With patients increasingly using artificial intelligence to inform themselves about their diseases, the evaluation of both the accuracy of content generated by artificial intelligence and its usability and readability is becoming imperative.

A salient finding of the present study is that while ChatGPT 4.o and Gemini Flash 1.5 were able to respond to all 12 questions quickly and without interruption, DeepSeek

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1.

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
1. Why does hair fall out?	Hair loss can happen for a variety of reasons. Here are some common causes: 1. **Genetics (Androgenetic Alopecia):** This is the most common cause of hair loss and is often referred to as male or female pattern baldness. It typically starts gradually and follows a predictable pattern. In men, this may result in a receding hairline or bald spots, while women may notice thinning along the part line. 2. **Hormonal Changes:** Hormonal fluctuations, such as those occurring during pregnancy, childbirth, menopause, or thyroid imbalances, can lead to temporary or permanent hair loss. 3. **Medical Conditions:** Conditions like alopecia areata (an autoimmune disorder where the body attacks hair follicles), scalp infections (e.g., ringworm), or diseases like lupus and diabetes can cause hair loss. 4. **Nutritional Deficiencies:** Lack of essential nutrients, such as iron, vitamin D, zinc, and proteins, can result in hair shedding or thinning. 5. **Stress:** High levels of stress or trauma can trigger a type of hair loss known as telogen effluvium, where hair prematurely enters the shedding phase. This usually resolves once the stress is managed. 6. **Medications and Treatments:** Some medications, such as those used for cancer (chemotherapy), arthritis, depression, or high blood pressure, can cause hair loss as a side effect. 7. **Physical Trauma or Injury:** Hair can fall out as a result of physical stress to the hair follicles, such as from tight hairstyles (e.g., ponytails or braids) or excessive combing and brushing. 8. **Age:** As people age, hair growth slows down, and hair may become thinner or fall out more easily. If you're experiencing significant hair loss, it may be helpful to consult a healthcare provider or dermatologist to determine the underlying cause and appropriate treatment.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. Hair loss, also known as alopecia, can have various causes. Here are some of the most common reasons why hair might fall out: • **Genetics:** Androgenetic alopecia, often referred to as male or female pattern baldness, is a common cause of hair loss due to genetic. * (An image taken from tuniohairtransplant.com) • **Hormonal changes:** Fluctuations in hormones, such as during pregnancy, childbirth, menopause, or thyroid disorders, can affect the hair growth cycle. *(An image taken from www.zrtlab.com Hormonal changes hair loss • **Medical conditions:** Certain medical conditions like autoimmune diseases (alopecia areata), thyroid problems, and iron deficiency can lead to hair loss. *(An image taken from insparya.es Thyroid problems hair loss) • **Medications and treatments:** Some medications, such as chemotherapy drugs, can cause temporary hair loss as a side effect. • **Stress:** Physical or emotional stress can disrupt the hair growth cycle and lead to increased shedding. *(An image taken from traya.health Stress hair loss) • **Hairstyles and treatments:** Tight hairstyles, excessive heat styling, and harsh chemical treatments can damage hair and cause breakage. • **Nutritional deficiencies:** Lack of essential nutrients like iron, protein, and vitamins can weaken hair follicles. If you're experiencing hair loss, it's important to consult a doctor to determine the underlying cause and discuss treatment options.	Hair loss, or alopecia, can result from a variety of factors, often interacting in complex ways. Here's a structured overview of the primary causes: 1. **Genetic Factors (Androgenetic Alopecia):** • The most common cause, affecting both men (male pattern baldness) and women (female pattern hair loss). It involves sensitivity to dihydrotestosterone (DHT), which shrinks hair follicles over time. 2. **Hormonal Changes:** • **Life Events:** Pregnancy, menopause, or discontinuation of birth control pills can disrupt hormone levels (e.g., estrogen, progesterone), triggering temporary shedding (telogen effluvium). • **Thyroid Disorders:** Both hypothyroidism and hyperthyroidism can lead to hair thinning. 3. **Aging:** • Hair growth slows with age, and follicles may produce thinner, shorter hairs, eventually ceasing production. 4. **Medical Conditions:** • **Autoimmune Diseases:** Alopecia areata (patchy hair loss), lupus, or lichen planus. • **Infections:** Scalp fungal infections (e.g., tinea capitis) or bacterial folliculitis. • **Chronic Illnesses:** Diabetes, lupus, or iron-deficiency anemia. 5. **Nutritional Deficiencies:** • Low levels of iron, zinc, vitamin D, B vitamins (especially biotin), or protein can weaken hair. Rapid weight loss or extreme diets often exacerbate this. 6. **Medications/Treatments:** • Chemotherapy, radiation, antidepressants, blood thinners, and beta-blockers may cause temporary or prolonged shedding. 7. **Physical/Traumatic Stressors:** • **Telogen Effluvium:** Triggered by surgery, illness, or severe stress, pushing hair follicles into a resting phase, followed by shedding months later. • **Traction Alopecia:** Tight hairstyles (e.g., braids, ponytails) that pull on hair roots. • **Damage from Styling:** Heat tools, chemical treatments, or harsh products leading to breakage. 8. **Psychological Factors:** • Trichotillomania, a compulsive urge to pull out hair, often due to stress or anxiety. 9. **Environmental Factors:** • Pollution, toxins, or seasonal changes may contribute to shedding in some individuals. **Key Notes:** • **Temporary vs. Permanent:** Stress-related loss (telogen effluvium) often reverses, while genetic balding is typically permanent without intervention. • **Diagnosis:** A dermatologist can assess via blood tests, scalp biopsies, or trichoscopy. Treatments range from topical minoxidil and oral finasteride to dietary adjustments or stress management. • **When to Seek Help:** Sudden, patchy, or symptomatic hair loss (e.g., itching, pain) warrants medical evaluation. Understanding the hair growth cycle (anagen [growth], catagen [transition], telogen [resting]) helps explain how disruptions lead to shedding. Addressing the root cause is essential for effective management.

2. At what age does androgenetic alopecia begin?	Androgenetic alopecia (AGA), or male pattern hair loss, can begin as early as the late teens to early 20s. On average, many men start noticing signs of hair loss in their 20s or 30s, but it can vary widely depending on genetics. Some men may not experience noticeable hair loss until their 40s or even later. The onset and progression of AGA are influenced by several factors: 1. **Genetics**: If a man has close relatives who experienced early hair loss, he is more likely to start losing hair at a younger age. Family history plays a significant role in determining when and how severely hair loss will occur. 2. **Hormones**: Androgenetic alopecia is linked to the body's sensitivity to androgens, which are male hormones such as testosterone. The conversion of testosterone to dihydrotestosterone (DHT) in the scalp contributes to hair follicle shrinkage and hair loss. Individuals who have higher DHT levels or a genetic predisposition to hair follicles sensitive to DHT are more prone to early hair loss. 3. **Stage of Hair Loss**: AGA often starts with a receding hairline at the temples and/or thinning at the crown of the head. This pattern is usually seen as early as the late teens to 20s. Over time, the hair loss can progress, leading to more extensive bald spots and potential baldness on the top of the head. **Age Ranges for Onset of AGA:** • **Late Teens to Early 20s**: Some men may start noticing hair loss during this time, especially if they have a family history of early hair loss. • **30s**: This is a common age range for the initial stages of male pattern baldness to become more noticeable. • **40s and Beyond**: Hair loss becomes more apparent, and the pattern may become more severe, affecting a larger area of the scalp. Overall, while AGA can start in the late teens to early 20s, the exact age of onset depends on a combination of genetic and hormonal factors.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. Androgenetic alopecia, also known as male or female pattern baldness, can begin at different ages for men and women. • **Men:** It often starts in their late teens or early 20s, but some men may notice signs as early as their late teens. • **Women:** Hair loss is most likely after menopause. The risk of androgenetic alopecia increases with age for both men and women.	Androgenetic alopecia, commonly known as male or female pattern baldness, can begin at different ages depending on genetic predisposition, hormonal factors, and overall health. Here's a breakdown: **Male Pattern Baldness** • **Onset**: Typically begins in the late teens to early 20s, but it can start at any age after puberty. • **Progression**: By age 35, about 66% of men experience some degree of hair loss. By age 50, approximately 85% of men have significantly thinning hair. • **Pattern**: Often starts with a receding hairline or thinning at the crown and progresses over time. **Female Pattern Baldness** • **Onset**: Usually begins later than in men, often after menopause (around age 50 or older), but it can start as early as the 20s or 30s. • **Progression**: Hair thinning is more diffuse, with widening of the part line and overall reduction in hair density. • **Pattern**: Unlike men, women rarely experience a receding hairline but may notice their scalp becoming more visible. **Key Factors Influencing Onset** 1. **Genetics**: A family history of androgenetic alopecia increases the likelihood of early onset. 2. **Hormonal Changes**: Androgens (like dihydrotestosterone or DHT) play a significant role in triggering hair loss. 3. **Lifestyle and Health**: Poor diet, stress, and certain medical conditions can accelerate hair loss. **Early Signs to Watch For** • **Men**: Receding hairline, thinning at the crown, or a change in hair texture. • **Women**: Widening part line, increased hair shedding, or reduced hair volume. **What You Can Do** If you notice early signs of androgenetic alopecia, consult a dermatologist. Early intervention with treatments like minoxidil, finasteride (for men), or hormone therapy (for women) can slow progression and improve outcomes. Lifestyle changes, such as a balanced diet and stress management, can also help maintain hair health.

Table 1 (*Continued*)

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1. *(continued)*

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
3. What causes androgenetic alopecia?	Androgenetic alopecia (AGA), also known as male pattern hair loss or female pattern hair loss, is primarily caused by a combination of **genetic predisposition** and **hormonal influences**, particularly the hormone **dihydrotestosterone (DHT)**. Here's a closer look at the key factors involved: 1. **Genetics:** • **Hereditary Factors**: AGA is highly influenced by genetic inheritance. If your parents or grandparents had male or female pattern baldness, you are more likely to develop it yourself. The genes responsible for AGA can come from either side of the family, though the influence of genes from the mother's side has often been emphasized. • **Specific Genes**: Research has identified several genes related to androgen sensitivity, particularly those affecting the androgen receptor (AR) gene on the X chromosome. This receptor plays a role in how hair follicles respond to androgens like DHT. 2. **Hormones (Androgens):** • **Dihydrotestosterone (DHT)**: The main hormone implicated in AGA is DHT, which is derived from testosterone through the action of an enzyme called **5-alpha reductase**. DHT binds to androgen receptors in hair follicles, leading to their shrinkage (miniaturization). Over time, this miniaturization causes the affected follicles to produce thinner, shorter hairs, and eventually, hair production may stop completely. • **Androgen Sensitivity**: The extent to which DHT affects hair follicles depends on how sensitive they are to the hormone. Men with more sensitive hair follicles may experience more rapid and severe hair loss. 3. **Hair Follicle Sensitivity and Miniaturization:** • Hair follicles on certain parts of the scalp, like the temples and crown, are more susceptible to the effects of DHT. This selective sensitivity leads to the characteristic pattern of AGA, which typically starts with a receding hairline and/or thinning at the crown, progressing to bald spots and potentially complete baldness on the top of the head. • Miniaturized follicles produce hairs that are finer and weaker. Over time, these hairs may become almost invisible, contributing to the appearance of baldness.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. Androgenetic alopecia is caused by a combination of genetic and hormonal factors. • **Genetics:** A family history of hair loss is a strong predictor of developing androgenetic alopecia. • **Hormones:** The male hormone dihydrotestosterone (DHT) plays a key role. DHT shrinks hair follicles, leading to thinner, shorter hairs that eventually stop growing. In women, androgenetic alopecia is also influenced by hormones, but the exact mechanisms are not fully understood.	Androgenetic alopecia, also known as male or female pattern baldness, is primarily caused by a combination of genetic, hormonal, and environmental factors. Here's a detailed breakdown of the key causes: 1. **Genetic Predisposition** • **Inherited Traits**: Androgenetic alopecia is strongly linked to genetics. If you have a family history of hair loss (especially on either parent's side), you are more likely to develop it. • **Gene Variants**: Specific genes, such as those related to androgen receptors on hair follicles, can make follicles more sensitive to androgens (male hormones). 2. **Hormonal Factors** • **Dihydrotestosterone (DHT)**: This is the primary hormone responsible for androgenetic alopecia. DHT is derived from testosterone through the action of an enzyme called **5-alpha reductase**. • In genetically susceptible individuals, DHT binds to receptors in hair follicles, particularly in the scalp's frontal and crown areas. • Over time, DHT shrinks (miniaturizes) the hair follicles, leading to shorter, thinner hairs and eventually preventing new hair growth. • **Androgen Sensitivity**: Some people have hair follicles that are more sensitive to androgens, even at normal levels, which accelerates hair loss. 3. **Aging** • As people age, hair follicles become more susceptible to the effects of DHT, leading to progressive thinning and hair loss. • The hair growth cycle shortens, and the resting phase (telogen) becomes longer, resulting in fewer active hair follicles. 4. **Gender Differences** • **Men**: Male pattern baldness is driven by high levels of DHT and typically follows a predictable pattern (receding hairline and thinning at the crown). • **Women**: Female pattern baldness is often related to hormonal changes, such as those during menopause, and results in diffuse thinning across the scalp rather than a receding hairline. 5. **Environmental and Lifestyle Factors** While genetics and hormones are the primary drivers, certain factors can exacerbate androgenetic alopecia: • **Stress**: Chronic stress can worsen hair loss by disrupting the hair growth cycle. • **Poor Nutrition**: Deficiencies in vitamins and minerals (e.g., iron, zinc, vitamin D) can weaken hair follicles. • **Smoking**: Reduces blood flow to the scalp, impairing hair follicle health. • **Scalp Health**: Conditions like dandruff or seborrheic dermatitis can worsen hair loss. 6. **Underlying Medical Conditions** • **Polycystic Ovary Syndrome (PCOS)**: In women, PCOS can cause elevated androgen levels, leading to hair loss. • **Thyroid Disorders**: Both hypothyroidism and hyperthyroidism can disrupt the hair growth cycle. • **Insulin Resistance**: Linked to hormonal imbalances that may contribute to hair loss.

	4. **Age:** • AGA typically starts to show signs in the late teens to early 20s and progresses with age. As men age, the levels of DHT can fluctuate, and the density of hair may decrease due to accumulated follicular miniaturization. 5. **Other Contributing Factors:** • **Lifestyle and Stress**: While not direct causes of AGA, stress and an unhealthy lifestyle can potentially accelerate the hair loss process or exacerbate the condition. • **Underlying Medical Conditions**: Some medical issues, such as hormonal imbalances or conditions affecting the scalp (e.g., seborrheic dermatitis), can make hair loss more noticeable or contribute to hair loss, although they are not the primary causes of AGA.		7. **Medications** Certain medications, such as anabolic steroids or hormone therapies, can increase androgen levels and accelerate hair loss in genetically predisposed individuals. **Summary** Androgenetic alopecia is primarily caused by a combination of genetic susceptibility and the effects of DHT on hair follicles. While it cannot be completely prevented, treatments like **minoxidil**, **finasteride** (for men), **spironolactone** (for women), and lifestyle changes can help slow its progression and manage symptoms. Early intervention is key to preserving hair density. Consulting a dermatologist or healthcare provider is recommended for personalized treatment options.
4. Is androgenetic alopecia contagious?	No, androgenetic alopecia (AGA) is not contagious. It cannot be spread from person to person through direct contact or any other means. AGA is a **genetic and hormonal condition**, and its primary causes are related to inherited genes and the body's response to hormones, particularly **dihydrotestosterone** (**DHT**). **Why AGA Is Not Contagious:** 1. **Genetic Basis**: AGA is linked to your genetic makeup. If you have a family history of male or female pattern baldness, you may be more predisposed to developing it, but it is not something that can be caught from others. 2. **Hormonal Influence**: The process involves hormonal changes in the body, specifically how the hormone DHT affects hair follicles. This interaction is internal to the individual and does not involve external transmission. 3. **Non-Communicable Nature**: Unlike certain infections or skin conditions that can be transmitted through contact, AGA is not spread by sharing personal items, close physical contact, or any environmental factors.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. No, androgenetic alopecia is not contagious. [1] **It's not caused by an infection:** It's a genetic condition influenced by hormones, not a disease that can be spread from person to person. You cannot "catch" androgenetic alopecia from someone else.	No, **androgenetic alopecia (male or female pattern baldness) is not contagious**. It is a genetic and hormonal condition that results from a combination of inherited traits and the effects of hormones like dihydrotestosterone (DHT) on hair follicles. It cannot be spread from person to person through physical contact, sharing personal items, or any other means. **Key Points:** 1. **Genetic Basis**: Androgenetic alopecia is caused by inherited genes that make hair follicles more sensitive to DHT. 2. **Hormonal Influence**: DHT, a derivative of testosterone, shrinks hair follicles over time, leading to thinning and hair loss. 3. **Non-Communicable**: Since it is not caused by bacteria, viruses, or fungi, it cannot be transmitted to others. If you are experiencing hair loss, it is important to consult a dermatologist or healthcare provider to confirm the diagnosis and explore treatment options.

Table 1 (*Continued*)

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1. *(continued)*

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
5. What are the symptoms of androgenetic alopecia?	The symptoms of androgenetic alopecia (AGA) vary depending on whether it affects men or women, but they generally involve progressive hair thinning and loss that follows specific patterns. Here's a breakdown of the typical symptoms for each gender: 1. **In Men (Male Pattern Baldness):** • **Receding Hairline**: The first noticeable symptom is a gradual receding of the hairline, often starting at the temples and moving backward. This can create an "M" shape as the hairline retreats. • **Thinning at the Crown**: Hair loss often continues with thinning or balding at the crown of the head. Over time, this area may become more prominent, leading to a bald spot. • **Progression to Bald Spots**: The hair thinning at the crown and receding hairline can merge, forming larger bald areas on the top of the head. • **Preserved Hair on the Sides and Back**: Typically, hair loss in AGA does not affect the sides and back of the scalp, which often retain full hair growth even as the top becomes bald. • **Miniaturization of Hair Follicles**: The hair shafts produced by the follicles become thinner and weaker as AGA progresses, resulting in finer and shorter hair. 2. **In Women (Female Pattern Hair Loss):** • **Diffuse Thinning**: Women often experience more diffuse thinning of hair rather than bald patches. The hair generally thins evenly over the top of the scalp while the hairline usually remains intact. • **Widening Part**: One of the early signs in women is a widening part, where the scalp becomes more visible. • **Thinning at the Crown**: Women may notice thinning at the crown, which can become more noticeable over time but typically does not progress to complete baldness as it does in men. • **Retention of Hairline**: Unlike men, women with AGA often retain their natural hairline, with thinning occurring more throughout the top and crown areas.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. Androgenetic alopecia, also known as male or female pattern baldness, is the most common cause of hair loss. It results in a gradual thinning of hair on the scalp. **Here are some common symptoms:** • **Gradual thinning of hair:** This is the most noticeable symptom. The hair may become thinner and finer over time. • **Receding hairline:** In men, the hairline often recedes in an "M" shape. • **Hair loss on the crown:** In both men and women, hair loss can occur on the top of the head (crown). • **Widening part:** In women, the part in the hair may become wider. **It's important to note:** • **The severity of hair loss varies:** Some people may experience only mild thinning, while others may experience significant hair loss. • **The rate of hair loss also varies:** Hair loss can occur gradually over many years. If you are concerned about hair loss, it is important to see a doctor to rule out any underlying medical conditions.	Androgenetic alopecia, also known as male or female pattern baldness, has distinct symptoms that vary between men and women. Here's a detailed breakdown of the symptoms: **Symptoms in Men (Male Pattern Baldness)** 1. **Receding Hairline:** • Hair loss typically begins at the temples, creating an "M-shaped" hairline. 2. **Thinning at the Crown:** • Hair thinning or bald spots develop at the top (vertex) of the scalp. 3. **Progressive Hair Loss:** • Over time, the receding hairline and crown thinning may meet, leaving a horseshoe-shaped ring of hair around the sides and back of the head. 4. **Miniaturization of Hair:** • Affected hairs become finer, shorter, and lighter in color before eventually stopping growth. **Symptoms in Women (Female Pattern Baldness)** 1. **Diffuse Thinning:** • Hair thinning occurs across the entire scalp, but it is most noticeable at the part line. 2. **Widening Part Line:** • The part line becomes wider as hair density decreases. 3. **Preserved Hairline:** • Unlike men, women usually retain their frontal hairline but may experience overall thinning. 4. **Reduced Hair Volume:** • Hair may feel thinner and less dense, especially on the top of the scalp. 5. **Miniaturization of Hair:** • Similar to men, affected hairs become finer and shorter over time. **Common Symptoms in Both Men and Women** 1. **Increased Hair Shedding:** • More hair than usual may fall out during brushing, washing, or styling. 2. **Slower Hair Growth:** • Hair may take longer to grow back after shedding. 3. **Scalp Visibility:** • The scalp may become more visible as hair thins. 4. **Itching or Tenderness:** • Some individuals may experience mild scalp discomfort, though this is less common. **Stages of Androgenetic Alopecia** • **Men**: The progression is often measured using the **Norwood-Hamilton Scale**, which categorizes the stages of male pattern baldness. • **Women**: The progression is measured using the **Ludwig Scale**, which describes the stages of female pattern thinning.

	• **Gradual Progression**: The hair loss in women tends to be more gradual compared to men, and it may take many years before it becomes severe. **General Symptoms of AGA:** • **Reduced Hair Density**: Both men and women will notice that their hair density decreases as AGA progresses. • **Miniaturized Hairs**: Hair follicles produce thinner, softer hairs, which are often less noticeable and may not grow long. • **Slower Hair Growth**: Hair may grow more slowly as follicles become less effective. • **No Other Health Issues**: AGA is usually not associated with pain, itching, or other scalp issues, making it distinct from other types of hair loss that may be related to medical conditions (e.g., alopecia areata, scalp psoriasis).		**When to See a Doctor** If you notice sudden or excessive hair loss, or if the pattern of hair loss is unusual, consult a dermatologist or healthcare provider. They can confirm whether it is androgenetic alopecia or another type of hair loss (e.g., alopecia areata, telogen effluvium) and recommend appropriate treatments. **Key Takeaway** Androgenetic alopecia is a gradual process, and early intervention can help slow its progression. Treatments like **minoxidil**, **finasteride** (for men), **spironolactone** (for women), and lifestyle changes can be effective in managing symptoms.
6. Can androgenetic alopecia be confused with other hair loss conditions?	Yes, androgenetic alopecia (AGA) can sometimes be confused with other types of hair loss conditions because several conditions cause similar symptoms, such as thinning, shedding, or balding. However, the underlying causes and patterns of hair loss typically differ. Here's a look at some conditions that can be mistaken for AGA: 1. **Telogen Effluvium:** • **What It Is:** Telogen effluvium is a temporary form of hair loss triggered by factors like stress, illness, nutritional deficiencies, or medications. It occurs when a large number of hair follicles enter the shedding phase (telogen) prematurely. • **How It Differs from AGA:** Unlike AGA, which is a progressive condition and typically follows a pattern of thinning (e.g., along the crown or temples), telogen effluvium causes diffuse shedding throughout the scalp. The hair loss in telogen effluvium usually resolves once the underlying trigger is addressed, whereas AGA tends to worsen over time if untreated. 2. **Alopecia Areata:** • **What It Is:** Alopecia areata is an autoimmune disorder where the body's immune system attacks the hair follicles, leading to patchy hair loss. It can affect any area of the scalp or body. • **How It Differs from AGA:** While both cause hair loss, alopecia areata results in round, smooth patches of hair loss, not the gradual thinning seen in AGA. AGA typically results in diffuse thinning in specific areas (e.g., crown and temples), while alopecia areata can cause sudden, localized hair loss.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. Yes, androgenetic alopecia can sometimes be confused with other hair loss conditions. This is because the symptoms can overlap, making it difficult to distinguish between them based on appearance alone. **Here are some conditions that androgenetic alopecia can be confused with:** • **Alopecia areata:** This autoimmune condition causes patchy hair loss on the scalp, and sometimes other parts of the body. While it can sometimes mimic the appearance of androgenetic alopecia, especially in its diffuse form, the pattern of hair loss is often different. • **Telogen effluvium:** This is a type of temporary hair loss triggered by stress, illness, or certain medications. It often presents as diffuse thinning all over the scalp, which can resemble female pattern hair loss. • **Anagen effluvium:** This type of hair loss is caused by certain medications, such as chemotherapy drugs. It results in rapid hair shedding and can cause significant hair loss within weeks.	(The server is busy. Please try again later.) Yes, **androgenetic alopecia** can sometimes be confused with other hair loss conditions because the symptoms of hair thinning or shedding may overlap. However, each type of hair loss has distinct characteristics, causes, and patterns. Here are some conditions that can be mistaken for androgenetic alopecia and how to differentiate them: 1. **Telogen Effluvium** • **Cause**: Temporary hair shedding triggered by stress, illness, surgery, hormonal changes, or nutritional deficiencies. • **Symptoms**: • Diffuse thinning across the scalp. • Increased hair shedding (e.g., more hair on pillows, brushes, or in the shower). • **Key Difference**: Telogen effluvium is usually temporary and reversible once the underlying cause is addressed, whereas androgenetic alopecia is progressive and permanent without treatment. 2. **Alopecia Areata** • **Cause**: An autoimmune condition where the immune system attacks hair follicles. • **Symptoms**: • Sudden, patchy hair loss on the scalp or other body areas. • Smooth, round bald patches. • **Key Difference**: Alopecia areata causes patchy hair loss rather than the patterned thinning seen in androgenetic alopecia.

Table 1 (*Continued*)

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1. *(continued)*

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
	3. **Traction Alopecia:** • **What It Is:** Traction alopecia is caused by prolonged tension or pulling on the hair, often due to tight hairstyles like braids, ponytails, or buns. • **How It Differs from AGA:** This type of hair loss is usually localized to areas where tension is applied (e.g., along the hairline or nape of the neck) and is reversible if the damaging hairstyles are stopped. AGA, on the other hand, is more diffuse and progressive, often affecting the crown or temples and generally not related to hair styling habits. 4. **Hormonal Imbalances (e.g., Polycystic Ovary Syndrome - PCOS):** • **What It Is:** Hormonal imbalances, such as those seen in conditions like PCOS, can lead to hair thinning, particularly in women. High levels of androgens (male hormones) can cause thinning of hair on the scalp while promoting excessive hair growth on other parts of the body (hirsutism). • **How It Differs from AGA:** While both conditions can cause thinning hair, PCOS-related hair loss may also present with other symptoms such as acne, irregular periods, or excessive body hair. AGA tends to be more gradual and is usually seen in a characteristic pattern, especially in men (receding hairline, crown thinning) and women (diffuse thinning on the top and crown of the scalp). 5. **Scalp Infections or Dermatologic Conditions:** • **What It Is:** Fungal infections (like ringworm) or skin conditions (such as psoriasis or seborrheic dermatitis) can lead to hair loss due to inflammation or infection of the scalp. • **How It Differs from AGA:** These conditions often present with additional symptoms, such as redness, flaking, or scaling on the scalp. The hair loss in these cases may be more patchy or sudden and is typically associated with inflammation or visible scalp irritation, whereas AGA causes gradual thinning with no such visible signs of infection.	• **Hormonal imbalances:** Conditions like hypothyroidism, hyperthyroidism, and polycystic ovary syndrome (PCOS) can cause hair loss. These conditions can sometimes be associated with androgenetic alopecia, but the underlying cause is different. • **Nutritional deficiencies:** Deficiencies in iron, protein, zinc, and biotin can lead to hair loss. These deficiencies can sometimes be mistaken for androgenetic alopecia, especially if they cause diffuse thinning. • **Medications:** Certain medications, such as blood thinners and beta-blockers, can cause hair loss as a side effect. This type of hair loss can sometimes be confused with androgenetic alopecia. • **Traction alopecia:** This type of hair loss is caused by tight hairstyles, such as braids and ponytails, that put excessive tension on the hair follicles. It can cause hair loss in specific areas, such as the hairline or the crown, which can sometimes resemble the pattern of hair loss in androgenetic alopecia. • **Trichotillomania:** This is a mental health condition that causes people to compulsively pull out their hair. It can lead to patchy hair loss in various areas of the scalp, which can sometimes be confused with alopecia areata. If you are experiencing hair loss, it is important to see a doctor to determine the underlying cause. They can perform a physical examination and order any necessary tests to rule out other conditions. Once the cause of hair loss is identified, the appropriate treatment can be started.	3. **Traction Alopecia** • **Cause**: Hair loss due to prolonged tension on the hair from tight hairstyles (e.g., braids, ponytails, or extensions). • **Symptoms**: • Hair loss at the hairline or areas where tension is applied. • Broken hairs or redness and irritation on the scalp. • **Key Difference**: Traction alopecia is localized to areas where hair is pulled, whereas androgenetic alopecia follows a genetic pattern. 4. **Scarring Alopecia (Cicatricial Alopecia)** • **Cause**: Inflammation or damage to hair follicles, leading to permanent hair loss and scarring. • **Symptoms**: • Patchy hair loss with visible scarring or redness on the scalp. • Itching, burning, or pain in affected areas. • **Key Difference**: Scarring alopecia involves visible damage to the scalp and is not patterned like androgenetic alopecia. 5. **Nutritional Deficiencies** • **Cause**: Lack of essential nutrients like iron, zinc, vitamin D, or protein. • **Symptoms**: • Diffuse thinning or increased shedding. • Brittle, dry, or dull hair. • **Key Difference**: Hair loss due to nutritional deficiencies often improves with dietary changes or supplements, unlike androgenetic alopecia. 6. **Thyroid Disorders** • **Cause**: Hypothyroidism (underactive thyroid) or hyperthyroidism (overactive thyroid). • **Symptoms**: • Diffuse thinning or shedding. • Other symptoms like fatigue, weight changes, or skin dryness. • **Key Difference**: Thyroid-related hair loss is accompanied by other systemic symptoms and can be reversed with proper thyroid treatment. 7. **Trichotillomania** • **Cause**: A psychological condition where individuals compulsively pull out their hair. • **Symptoms**: • Irregular patches of hair loss. • Broken hairs of varying lengths. • **Key Difference**: Trichotillomania is behavioral and not patterned like androgenetic alopecia. 8. **Fungal Infections (e.g., Tinea Capitis)** • **Cause**: Fungal infection of the scalp. • **Symptoms**: • Patchy hair loss with scaling, redness, or itching. • Broken hairs or black dots on the scalp.

	6. **Anagen Effluvium (Chemotherapy-Induced Hair Loss):** • **What It Is:** Anagen effluvium occurs when hair loss happens during the active growth phase (anagen) of the hair cycle, often as a result of chemotherapy or radiation therapy. • **How It Differs from AGA:** This type of hair loss is typically rapid and occurs all over the scalp. In contrast, AGA is progressive and tends to start slowly in specific areas of the scalp, such as the crown or temples. **How to Differentiate AGA from Other Conditions:** • **Pattern of Hair Loss:** AGA usually follows a predictable pattern, starting at the temples or crown. In women, it may begin with overall thinning at the crown. • **Progression:** AGA is gradual and progressive. If hair loss is sudden or patchy, other conditions like alopecia areata or telogen effluvium are more likely. • **Associated Symptoms:** Conditions like PCOS, scalp infections, or hormonal imbalances may have other visible symptoms, such as acne, irregular periods, or scalp irritation. **Conclusion:** While androgenetic alopecia is one of the most common causes of hair loss, other conditions can present with similar symptoms. A healthcare provider or dermatologist can perform a thorough examination and possibly run tests (like blood tests or scalp biopsies) to differentiate AGA from other hair loss conditions and determine the most appropriate treatment.		• **Key Difference**: Fungal infections often cause inflammation and scaling, which are not seen in androgenetic alopecia. **How to Differentiate Androgenetic Alopecia** • **Pattern**: Androgenetic alopecia follows a specific pattern (receding hairline and crown thinning in men, diffuse thinning in women). • **Progression**: It is gradual and progressive over time. • **Family History**: A family history of pattern baldness is a strong indicator. • **Diagnostic Tools**: A dermatologist may use tools like a **trichoscope** (scalp magnifier) or perform a **hair pull test** or **biopsy** to confirm the diagnosis. **When to See a Doctor** If you're unsure about the cause of your hair loss, consult a dermatologist. They can accurately diagnose the condition and recommend appropriate treatments. Early intervention is key to managing androgenetic alopecia and other types of hair loss effectively.

Table 1 (*Continued*)

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1. *(continued)*

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
7. How is androgenetic alopecia recognized?	Androgenetic alopecia (AGA) is usually recognized through a combination of **medical history**, **physical examination**, and, in some cases, **diagnostic tests**. Here's how healthcare professionals typically diagnose AGA: 1. **Clinical Evaluation:** • **Medical History**: The doctor will first take a detailed medical history, including questions about family history of hair loss (to assess genetic predisposition), age of onset, progression of hair loss, and any related symptoms or health issues. • **Physical Examination**: The healthcare provider will examine the scalp and hair pattern to identify signs of AGA. For men, this includes checking the hairline and crown. For women, it involves observing the top of the scalp for thinning and widening parts. • **Assessment of Hair Loss Pattern**: The classic pattern of AGA is used to help identify it. In men, this typically involves a receding hairline and thinning crown. In women, it usually involves diffuse thinning with a widening part, but the hairline is often preserved. 2. **Norwood-Hamilton Scale (for Men):** • This scale is used to classify the severity of male pattern baldness. It helps doctors determine the stage of hair loss, ranging from Type I (minimal hair loss) to Type VII (severe hair loss). The scale is essential for evaluating progression and planning treatment. 3. **Ludwig Scale (for Women):** • For women, the Ludwig scale is used to assess the extent of hair loss. It categorizes the severity from Type I (mild thinning) to Type III (advanced thinning). 4. **Pull Test:** • A doctor may perform a pull test, which involves gently pulling a small section of hair to determine how easily hairs come out. This helps differentiate AGA from other types of hair loss, such as telogen effluvium, where hair falls out more readily.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. Androgenetic alopecia is usually diagnosed based on a physical examination and a review of your medical history. A doctor may also use tools like a magnifying lamp or dermoscopy to look at your scalp more closely. Here are some of the common signs of androgenetic alopecia: • **Gradual thinning of hair:** This is the most common symptom, especially in the crown area for women and the temples and crown for men. • **Widening part:** The part in your hair may become wider over time. • **Receding hairline:** In men, the hairline often recedes in a characteristic "M" shape. • **Increased hair shedding:** You may notice more hair in your brush or on your pillow than usual. If you're concerned about hair loss, it's important to see a doctor to rule out any underlying medical conditions.	Androgenetic alopecia (AGA), also known as male or female pattern baldness, is recognized through a combination of clinical evaluation, medical history, and sometimes diagnostic tests. Here's how it is typically identified: 1. **Clinical Evaluation** • **Pattern of Hair Loss:** • **Men**: Receding hairline (temporal areas) and thinning at the crown (vertex), often following the **Norwood-Hamilton Scale**. • **Women**: Diffuse thinning over the top of the scalp with a widening part line, often following the **Ludwig Scale**. • **Hair Miniaturization:** • Affected hairs become finer, shorter, and lighter in color over time. • **Scalp Visibility:** • The scalp becomes more visible as hair density decreases. 2. **Medical History** • **Family History:** • A family history of androgenetic alopecia (in parents or siblings) is a strong indicator, as the condition is highly genetic. • **Onset and Progression:** • Gradual hair loss over years, rather than sudden shedding. • **Associated Symptoms:** • In women, symptoms like irregular periods or hirsutism (excessive hair growth in male-pattern areas) may suggest hormonal imbalances (e.g., PCOS). 3. **Physical Examination** • **Hair Pull Test:** • Gently pulling on a small section of hair to check for excessive shedding. In androgenetic alopecia, the hair pull test is usually negative (few hairs come out). • **Scalp Inspection:** • The scalp typically appears normal without redness, scaling, or scarring, which helps rule out other conditions like fungal infections or scarring alopecia. 4. **Diagnostic Tools** • **Trichoscopy:** • A dermatoscope is used to magnify the scalp and hair follicles. In androgenetic alopecia, trichoscopy may show: • Hair shaft variability (thick and thin hairs). • Perifollicular discoloration (brownish halos around follicles). • **Scalp Biopsy:** • Rarely needed, but a biopsy can confirm the diagnosis by showing miniaturized hair follicles and a higher ratio of vellus (fine) hairs to terminal (thick) hairs.

	5. **Dermatoscopy or Scalp Examination:** • A dermatoscope may be used to inspect the scalp and hair follicles more closely. This device can reveal miniaturized hair follicles and other subtle changes that indicate AGA, such as the presence of short, thin hairs. 6. **Hair Density and Count:** • In some cases, a more detailed analysis might be conducted to count hair density and assess the proportion of terminal (thicker) to vellus (finer) hairs. AGA is characterized by an increased proportion of miniaturized vellus hairs compared to terminal hairs. 7. **Blood Tests and Hormonal Assessments:** • While AGA itself doesn't require blood tests for diagnosis, doctors might conduct hormonal assessments to rule out other conditions, particularly in women. Elevated androgens or other hormonal imbalances might be tested to differentiate AGA from conditions like polycystic ovary syndrome (PCOS) or other endocrine disorders. • **Thyroid function tests** may also be ordered to exclude thyroid dysfunction as a contributing factor. 8. **Biopsy (Rarely Used):** • A scalp biopsy is not typically needed for diagnosing AGA but may be used if the diagnosis is unclear or if the doctor suspects another type of hair loss. A small sample of the scalp is taken and examined under a microscope to analyze hair follicle size, density, and the presence of miniaturized hairs. 9. **Family History and Risk Assessment:** • A thorough family history helps establish whether there is a genetic component to the hair loss. This is particularly significant since AGA is often hereditary.		• **Blood Tests:** • Blood tests may be ordered to rule out other causes of hair loss, such as: • Thyroid function tests (to check for hypothyroidism or hyperthyroidism). • Hormone levels (e.g., testosterone, DHEA-S, prolactin) in women. • Iron studies (to check for anemia or iron deficiency). 5. **Differential Diagnosis** The doctor will rule out other conditions that can mimic androgenetic alopecia, such as: • **Telogen Effluvium**: Diffuse shedding without a specific pattern. • **Alopecia Areata**: Patchy hair loss with smooth, bald areas. • **Scarring Alopecia**: Hair loss with visible scarring or inflammation. • **Nutritional Deficiencies**: Hair loss due to low iron, zinc, or vitamin D. 6. **Staging and Classification** • **Men**: The **Norwood-Hamilton Scale** is used to classify the stages of male pattern baldness. • **Women**: The **Ludwig Scale** is used to describe the progression of female pattern hair loss. **Key Takeaways** • Androgenetic alopecia is recognized by its characteristic pattern of hair loss, family history, and gradual progression. • A dermatologist or healthcare provider can confirm the diagnosis through clinical evaluation, trichoscopy, and sometimes blood tests or a biopsy. • Early diagnosis and treatment are crucial to slow progression and improve outcomes. If you suspect androgenetic alopecia, consult a dermatologist for a proper evaluation and personalized treatment plan.

Table 1 (*Continued*)

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1. *(continued)*

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
8. How is androgenetic alopecia treated?	Treating androgenetic alopecia (AGA) involves a variety of approaches aimed at slowing hair loss and, in some cases, promoting hair regrowth. The treatment options range from **medications** and **topical treatments** to **surgical procedures** and **lifestyle changes**. The appropriate treatment depends on the severity of the condition, the patient's goals, and any underlying health conditions. Here's a comprehensive overview of the most common treatments for AGA: 1. **Medications**: a. **Minoxidil (Rogaine):** • **How it Works**: Minoxidil is a topical treatment that helps stimulate hair growth and slow hair loss. It is thought to widen blood vessels in the scalp, which may improve blood circulation and nourish hair follicles. • **Usage**: Applied directly to the scalp, usually twice a day. • **Effectiveness**: It can be effective for both men and women, though it may not be as effective in advanced cases. It can promote new hair growth and slow hair loss but does not cure AGA. • **Side Effects**: Potential side effects include scalp irritation, dryness, and unwanted facial hair growth in women. b. **Finasteride (Propecia):** • **How it Works**: Finasteride is an oral medication that inhibits the enzyme **5-alpha reductase**, which converts testosterone into dihydrotestosterone (DHT). Since DHT contributes to hair follicle miniaturization, reducing its levels can slow hair loss and even stimulate new growth. • **Usage**: Taken as a daily pill. • **Effectiveness**: Effective in slowing hair loss and promoting hair regrowth in men. It may also prevent further hair loss, but it is generally not recommended for women, especially those who are pregnant or may become pregnant, due to potential birth defects. • **Side Effects**: Possible side effects include decreased libido, erectile dysfunction, and a slight risk of depression.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. There are several treatments available for androgenetic alopecia, but none can completely stop hair loss or regrow all lost hair. Some common options include: • **Medications:** • **Minoxidil (Rogaine):** This over-the-counter topical medication can slow hair loss and promote some regrowth in both men and women. • **Finasteride (Propecia):** This prescription oral medication is effective for men in slowing hair loss and promoting regrowth. It's generally not recommended for women. • **Other treatments:** • **Low-level laser therapy (LLLT):** This involves using a device that emits low-level lasers to stimulate hair growth. • **Hair transplant surgery:** This is a surgical option that involves transplanting hair follicles from a hair-bearing area of the scalp to a balding area. The best treatment for you will depend on several factors, including your age, sex, the severity of your hair loss, and your personal preferences. It's important to talk to a doctor to discuss your options and determine the	Androgenetic alopecia (AGA), or male/female pattern baldness, can be managed with a variety of treatments aimed at slowing hair loss, promoting regrowth, and improving hair density. The choice of treatment depends on the severity of hair loss, gender, and individual preferences. Here are the most common and effective treatments: 1. **Medications** **For Men and Women:** • **Minoxidil (Rogaine):** • A topical solution or foam applied directly to the scalp. • Stimulates hair growth and slows hair loss by prolonging the growth phase of hair follicles. • Available over-the-counter in 2% and 5% strengths (5% is more effective for men, while women typically use 2% or 5%). • Results take 4–6 months to become noticeable. **For Men Only:** • **Finasteride (Propecia):** • An oral medication that inhibits the enzyme **5-alpha reductase**, reducing the production of dihydrotestosterone (DHT), the hormone responsible for shrinking hair follicles. • Effective at slowing hair loss and promoting regrowth in men. • Requires a prescription and must be taken continuously to maintain results. • Results may take 3–6 months to appear. **For Women Only:** • **Spironolactone:** • An oral anti-androgen medication that blocks the effects of androgens (male hormones) on hair follicles. • Often prescribed for women with androgenetic alopecia, especially those with hormonal imbalances (e.g., PCOS). • Requires a prescription and regular monitoring by a doctor. 2. **Low-Level Laser Therapy (LLLT)** • **How It Works:** Uses red light lasers or LED devices to stimulate hair follicles and improve blood flow to the scalp. • **Devices:** Available as combs, caps, or helmets for home use. • **Effectiveness:** May help slow hair loss and improve hair density, especially when used in combination with other treatments. • **FDA-Approved:** Devices like the **HairMax LaserComb** are FDA-cleared for treating androgenetic alopecia.

	c. **Other Hormonal Treatments:** • For women, especially those with elevated androgens or conditions like polycystic ovary syndrome (PCOS), hormonal treatments such as **birth control pills** or **spironolactone** may be prescribed. These help reduce androgens, potentially slowing hair loss and promoting hair growth. 2. **Low-Level Laser Therapy (LLLT):** • **How it Works**: This therapy uses red light to stimulate hair follicles and promote hair growth. The treatment can be done at home with laser combs, helmets, or caps. • **Effectiveness**: It can be effective in improving hair density and slowing hair loss, although results vary among individuals. • **Safety**: Generally considered safe with minimal side effects like scalp irritation. 3. **Hair Transplant Surgery:** • **How it Works**: Hair transplant procedures involve moving hair follicles from areas of the scalp that are resistant to hair loss (usually the back or sides) to areas experiencing thinning or baldness. • **Techniques:** • **FUT (Follicular Unit Transplantation)**: Involves removing a strip of skin with hair and dissecting it into individual grafts. • **FUE (Follicular Unit Extraction)**: Involves extracting individual hair follicles directly from the scalp and transplanting them to the desired area. • **Effectiveness**: Effective for those with significant hair loss and a good donor area. Results are permanent as long as the transplanted follicles are healthy. • **Side Effects**: Includes scarring (with FUT) and potential for infection, pain, or uneven hair growth. 4. **Lifestyle and Hair Care:** • **Diet and Nutrition**: A well-balanced diet rich in vitamins and minerals, especially **iron**, **zinc**, **biotin**, and **protein**, can support overall hair health. While diet alone won't prevent or treat AGA, maintaining healthy hair and scalp conditions is important. • **Reducing Stress**: Stress can exacerbate hair loss, so stress management techniques such as meditation, exercise, and adequate sleep can be beneficial. • **Avoiding Hair Damage**: Using gentle hair care products and avoiding harsh chemicals, heat styling, or tight hairstyles can help minimize hair breakage.		3. **Platelet-Rich Plasma (PRP) Therapy** • **How It Works**: A concentrated solution of the patient's own platelets is injected into the scalp to stimulate hair growth and improve follicle health. • **Procedure**: Blood is drawn, processed to isolate platelets, and injected into thinning areas. • **Effectiveness**: Studies show PRP can improve hair density and thickness, especially when combined with other treatments. • **Frequency**: Requires multiple sessions (e.g., 3–4 initial treatments, followed by maintenance sessions). 4. **Hair Transplant Surgery** • **How It Works**: Hair follicles are taken from areas of the scalp with healthy hair growth (usually the back or sides) and transplanted to thinning or bald areas. • **Techniques**: • **Follicular Unit Transplantation (FUT)**: A strip of scalp is removed, and follicles are transplanted. • **Follicular Unit Extraction (FUE)**: Individual follicles are extracted and transplanted. • **Effectiveness**: Provides permanent, natural-looking results. • **Considerations**: Expensive and requires a skilled surgeon. Best for individuals with significant hair loss who have sufficient donor hair. 5. **Lifestyle and Nutritional Support** • **Diet**: A balanced diet rich in vitamins and minerals (e.g., iron, zinc, vitamin D, biotin) supports hair health. • **Supplements**: Biotin, collagen, or specialized hair growth supplements may help, especially if nutritional deficiencies are present. • **Stress Management**: Reducing stress through exercise, meditation, or therapy can improve overall hair health. 6. **Cosmetic Solutions** • **Hair Fibers**: Products like Toppik or Caboki use keratin fibers to cover thinning areas and create the appearance of thicker hair. • **Wigs or Hairpieces**: High-quality wigs or hair systems can provide a non-invasive solution for significant hair loss. • **Styling Techniques**: Hairstyles that add volume or cover thinning areas can help camouflage hair loss. 7. **Emerging Treatments** • **Dutasteride**: A stronger 5-alpha reductase inhibitor than finasteride, sometimes used off-label for men with severe hair loss. • **Clascoterone (Breezula)**: A topical anti-androgen currently under investigation for treating androgenetic alopecia. • **Stem Cell Therapy**: Experimental treatments using stem cells to regenerate hair follicles are being studied but are not yet widely available. **Key Considerations** • **Consistency**: Most treatments require consistent, long-term use to maintain results. • **Early Intervention**: Starting treatment early yields the best outcomes. • **Combination Therapy**: Using multiple treatments (e.g., minoxidil + finasteride) often provides better results than a single treatment alone. **When to See a Doctor** If you're experiencing hair loss, consult a dermatologist or healthcare provider to confirm the diagnosis and develop a personalized treatment plan. They can recommend the most appropriate therapies based on your specific needs and medical history.

Table 1 (*Continued*)

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1. *(continued)*

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
	5. **Emerging Treatments:** • **Platelet-Rich Plasma (PRP) Therapy**: This involves injecting a concentration of the patient's own platelets into the scalp to potentially promote hair growth and improve hair follicle health. • **Stem Cell Therapy**: Still largely experimental, this approach aims to use stem cells to regenerate hair follicles and promote hair growth. • **New Medications**: Research is ongoing for new drugs and treatments that may target hair loss pathways more effectively and with fewer side effects. 6. **Consulting a Specialist:** • If you're experiencing hair loss and suspect it might be androgenetic alopecia, it's crucial to consult with a dermatologist or a trichologist (a specialist in hair and scalp disorders). They can assess the severity, discuss potential treatment options, and guide you toward the most effective approach based on your individual needs. **Important Notes:** • **Consistency**: Many treatments require long-term commitment to be effective. For example, minoxidil and finasteride often need to be used continuously to maintain results. • **Side Effects**: Always discuss potential side effects and benefits with a healthcare professional before starting a treatment. • **Effectiveness Varies**: Individual responses to treatment vary, and while some people may see significant improvements, others may not respond as well. In summary, while there is no cure for androgenetic alopecia, various treatments can help manage and slow down the progression of hair loss and promote regrowth in some cases.		

9. Can androgenetic type alopecia be prevented?	Androgenetic alopecia (AGA), also known as male or female pattern baldness, is a genetic condition, which means it can't be completely prevented. However, there are measures that can be taken to **slow down its progression** and potentially **preserve hair** for as long as possible. Here are some ways to manage and possibly delay the onset or progression of AGA: 1. **Early Detection and Treatment:** • **Start Treatment Early**: The sooner you start treatment after noticing hair loss, the better the outcome. Treatments like **minoxidil** (topical) and **finasteride** (oral) can help slow hair loss and, in some cases, promote new hair growth. • **Regular Check-Ups**: Periodic visits to a dermatologist or trichologist can help monitor the condition and adjust treatments as necessary. 2. **Medications and Topical Treatments:** • **Minoxidil (Rogaine)**: This topical solution or foam can be applied to the scalp to stimulate hair growth and slow hair loss. It's effective in men and women and is available over-the-counter. • **Finasteride (Propecia)**: An oral medication that reduces the levels of dihydrotestosterone (DHT), a hormone linked to hair follicle shrinkage. This medication can help slow or even reverse hair loss, especially in men. • **Other Medications**: For women, **spironolactone** or **birth control pills** can be prescribed to reduce androgen levels and slow hair loss. 3. **Lifestyle Adjustments:** • **Healthy Diet**: Ensure you get sufficient nutrients that support hair health, such as **protein, iron, zinc, biotin**, and **vitamins A, C, D, and E**. While diet alone can't prevent AGA, good nutrition can help maintain overall hair health. • **Manage Stress**: Chronic stress can contribute to hair loss, so practices like meditation, yoga, or regular exercise can help manage stress levels and promote overall well-being. • **Avoid Hair Damage**: Limit the use of harsh hair products, reduce heat styling, and avoid hairstyles that pull tightly on the hair, which can lead to breakage and worsen hair loss.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. Unfortunately, androgenetic alopecia (male or female pattern baldness) **cannot be prevented**. • **Genetic Predisposition:** Androgenetic alopecia is primarily caused by a combination of genetic factors and sensitivity to androgens (male hormones). If you have a family history of hair loss, you are more likely to experience it yourself. **However, there are things you can do to potentially slow down hair loss or minimize its impact:** • **Early Treatment:** If you notice signs of hair loss, consulting a doctor early on can help. There are medications available (like minoxidil and finasteride) that can slow down hair loss and potentially regrow some hair. • **Healthy Lifestyle:** While not a guaranteed prevention, maintaining a healthy lifestyle can support overall hair health. This includes: • **Balanced Diet:** Ensure you're getting enough protein, vitamins, and minerals essential for hair growth. • **Stress Management:** Chronic stress can contribute to hair loss. Find healthy ways to manage stress, such as exercise, yoga, or meditation. • **Gentle Hair Care:** Avoid harsh hairstyles, excessive heat styling, and chemical treatments that can damage hair. **It's important to remember:** • **Individual Results Vary:** The effectiveness of treatments and lifestyle changes can vary from person to person. • **Consult a Professional:** A dermatologist can provide personalized advice and recommend the most suitable treatment options for your specific situation.	

Table 1 (*Continued*)

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1. *(continued)*

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
	1. **Avoid Hormonal Triggers:** • **Monitor Hormonal Changes**: Hormones, especially androgens like testosterone and DHT, play a significant role in AGA. For individuals predisposed to AGA, avoiding hormone imbalances (e.g., those caused by certain medications or medical conditions) may help slow the progression. • **Consult a Healthcare Provider**: If you're taking medications that affect hormone levels, speak with your doctor about potential impacts on hair health. 2. **Low-Level Laser Therapy (LLLT):** • **Laser Treatments**: Devices such as laser combs, helmets, or caps use low-level laser light to stimulate hair follicles, potentially improving hair growth and slowing hair loss. • **Effectiveness**: This treatment is considered safe and non-invasive, though results can vary, and it may need to be used consistently over time. 3. **Scalp Care:** • **Keep Your Scalp Healthy**: Proper scalp hygiene and massage can help promote circulation and create a better environment for hair growth. Use gentle shampoos and conditioners to avoid irritating the scalp or stripping the hair of natural oils. • **Avoid Harsh Chemicals**: Stay away from shampoos and hair products with harsh chemicals that can damage hair and scalp health. 4. **Medical Procedures:** • **Hair Transplant Surgery**: While not a preventive measure, if hair loss has progressed to a significant stage, a hair transplant can be an option to restore hair in balding areas. This procedure moves hair from areas resistant to hair loss (usually the back or sides of the scalp) to the thinning or bald areas. **Important Considerations:** • **Genetics and Irreversibility**: AGA is largely determined by genetics, and once hair loss begins, it is difficult to reverse completely. Treatments can help slow or stop the progression but typically won't prevent it entirely.	While you can't completely prevent androgenetic alopecia, taking proactive steps and consulting with a healthcare professional can help you manage hair loss and maintain the healthiest hair possible.	

	• **Commitment to Treatment**: Many of the treatments require ongoing use to maintain results. If you stop treatment, hair loss may resume or progress as it would have without the intervention. • **Consultation with Specialists**: For the most effective management, work with a dermatologist or a hair specialist to create a tailored treatment plan based on your specific needs. **Conclusion:** While androgenetic alopecia cannot be completely prevented due to its genetic nature, taking proactive steps like starting early treatment, making lifestyle adjustments, and using medications and therapies can significantly slow the progression and help maintain hair for as long as possible. Consulting with a specialist can help you find the best approach for managing hair loss and potentially delaying or reducing its impact.		
10. Will hair continue to fall out if treatment is stopped?	Yes, if treatment for androgenetic alopecia (AGA) is stopped, hair loss is likely to continue and progress as it would have if no treatment had been started. Here's what typically happens when treatment is discontinued: 1. **Minoxidil (Topical Treatment):** • **Immediate Effects**: Minoxidil can help slow hair loss and even promote new hair growth in some cases. If you stop using minoxidil, the benefits it provided will start to diminish. • **Regrowth Loss**: Any new hair growth achieved during treatment will likely be lost within a few months after discontinuation. The hair follicles will revert to their pre-treatment state, which often means continued thinning or shedding. • **Timeline**: Hair loss may resume within a few weeks to a few months after stopping minoxidil. It generally takes 3-6 months for the hair to return to the state it would have been in if treatment had never been started. 2. **Finasteride (Oral Treatment):** • **Mechanism of Action**: Finasteride works by reducing the levels of dihydrotestosterone (DHT), a hormone linked to hair follicle shrinkage. It helps prevent hair loss and can promote regrowth in men. • **Stopping Treatment**: If finasteride is stopped, DHT levels will return to normal, and hair loss will continue. The process of hair loss will resume as it would have without the medication.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. Yes, if you stop treatment for androgenetic alopecia (male or female pattern baldness), hair loss will likely resume. • **Medications:** Medications like minoxidil and finasteride work to slow down hair loss and potentially regrow some hair. However, these effects are usually temporary. Once you stop taking them, the hair loss will likely return to its previous rate. **Here's what typically happens:** • **Minoxidil**: • Regrown hair may start to fall out within a few months of stopping treatment. • The amount of hair loss can vary from person to person. • **Finasteride:** • Hair loss may gradually resume over time, but the rate may be slower than before treatment.	

Table 1 (*Continued*)

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1. *(continued)*

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
	• **Timeline**: Hair loss may start within a few months after discontinuing finasteride, and within 12 months, most men who stop treatment will experience a return to their baseline level of hair loss or even a worsening of the condition. 1. **Other Treatments:** • **Spironolactone (for Women)**: If used to manage hair loss due to hormonal imbalances, stopping spironolactone can lead to the return of hair loss, especially if androgens (male hormones) are a contributing factor. • **Low-Level Laser Therapy (LLLT)**: Stopping laser therapy will mean that any positive effects on hair growth may gradually decline, and hair loss could resume over time. • **Platelet-Rich Plasma (PRP) Therapy**: While PRP can improve hair density and stimulate hair growth, its effects will diminish if treatments are stopped, and the hair loss process will continue as it would have without treatment. **Key Points to Remember:** • **Hair Regrowth Loss**: Any hair that was regrown due to treatment is usually lost after discontinuation. Hair typically reverts to its pre-treatment state within 3-6 months. • **Treatment Maintenance**: Treatments for AGA require ongoing use to maintain results. If you stop using them, the benefits are lost, and hair loss will continue according to your natural pattern. • **Consult a Specialist**: If you are considering stopping treatment, consult with a dermatologist or hair specialist. They can discuss potential outcomes and may offer alternative options or suggest a gradual transition. **Conclusion:** Stopping treatment for androgenetic alopecia can lead to a return to the natural progression of hair loss. The hair that was maintained or regrown with treatment will likely be lost, and thinning will resume. Consistency is key for most AGA treatments, and if you want to preserve your results, it's important to continue the treatment as recommended by your doctor.	**Important Considerations:** • **Individual Results Vary:** The exact effects of stopping treatment can vary depending on factors like the type of medication used, the severity of hair loss, and individual response. • **Underlying Condition:** Androgenetic alopecia is a progressive condition. Even without treatment, hair loss will likely continue, but potentially at a slower rate. **If you're considering stopping treatment for androgenetic alopecia, it's important to discuss this with your doctor.** They can help you understand the potential risks and benefits and advise you on the best course of action for your individual situation.	

11.Do women with androgenetic alopecia have more male hormones?	Women with androgenetic alopecia (AGA), also known as female pattern hair loss, do not necessarily have more male hormones, but the condition is influenced by the balance of hormones, including androgens (male hormones like testosterone). In women, androgens are produced in smaller amounts than in men, but they still play a role in hair growth. Androgenetic alopecia in women is typically associated with an increased sensitivity of hair follicles to these androgens, rather than an overall excess of male hormones. Several factors contribute to this sensitivity: 1. **Hormonal Changes:** Women may experience fluctuations in androgens due to menopause, polycystic ovary syndrome (PCOS), or other hormonal imbalances, which can make hair follicles more sensitive to these hormones. 2. **Genetics:** A genetic predisposition to androgenetic alopecia can make hair follicles more prone to shrinking in response to androgens, leading to hair thinning and shedding. In summary, while women with androgenetic alopecia may have normal or even slightly elevated androgen levels, the primary issue is often the sensitivity of hair follicles to these hormones, rather than an overall excess of male hormones. Treatment for this condition can sometimes include medications that block the effects of androgens, such as spironolactone, or topical treatments like minoxidil to help stimulate hair growth.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. It's a common misconception that women with androgenetic alopecia (female pattern hair loss) necessarily have higher levels of male hormones (androgens). **Here's the truth:** • **Androgens Play a Role:** Androgens, like testosterone, do play a role in female pattern hair loss. However, most women with this condition have normal androgen levels. • **Sensitivity to Androgens:** The key factor is often not the level of androgens, but rather an increased sensitivity to these hormones in the hair follicles. • **Genetic Predisposition:** Androgenetic alopecia is primarily a genetic condition. Women with a family history of hair loss are more likely to experience it, even with normal hormone levels. **When Androgens Might Be a Factor:** • **In some cases,** women with androgenetic alopecia may have slightly elevated androgen levels. • **Certain conditions,** such as polycystic ovary syndrome (PCOS), can cause an imbalance in hormones and contribute to hair loss. **It's important to note:** • **Individual Variation:** The cause of androgenetic alopecia can vary from woman to woman. • **Hormone Testing:** If your doctor suspects a hormonal imbalance, they may recommend hormone tests to investigate further. **If you're concerned about hair loss, it's best to consult a doctor or dermatologist.** They can help determine the underlying cause and recommend the most appropriate treatment option	

Table 1 (*Continued*)

Table 1. Questions and Answers to ChatGPT, Gemini Flash 1.5, and DeepSeek R1. *(continued)*

QUESTIONS	ChatGPT 4.o's answers	Gemini's answers	DeepSeek R1'S answers
12.In androgenetic alopecia, does the hereditary character come from the mother's or father's side?	In androgenetic alopecia (AGA), the hereditary factors that contribute to the condition can come from both the mother's and father's sides of the family, though the genetic inheritance pattern is more complex than being solely from one side. **Key points about inheritance:** 1. **X-Chromosome Influence:** The most significant genetic influence for androgenetic alopecia is thought to be related to a gene on the **X chromosome**. Since women have two X chromosomes (one from each parent) and men only have one (from their mother), the condition is often more strongly inherited through the maternal side in men. If a man's mother carries the gene for AGA, he is more likely to develop the condition, even though his father might not have it. 2. **Polygenic Inheritance:** The inheritance of AGA is **polygenic**, meaning it involves multiple genes. These genes can come from both sides of the family. While the X-chromosome influence is particularly important, other genes on both the X and non-sex chromosomes contribute to the condition as well. 3. **Both Parents Can Contribute:** While the maternal side plays a large role due to the X chromosome, the father's genes can also contribute. For example, if the father has androgenetic alopecia, his children (both sons and daughters) may inherit a genetic predisposition from him as well. **Conclusion:** In general, the condition is often inherited through the **mother's side**, particularly in men, because of the X-chromosome connection. However, the genetics are multifactorial, so both the mother's and father's genes can influence the development of androgenetic alopecia.	This is for informational purposes only. For medical advice or diagnosis, consult a professional. Androgenetic alopecia, often referred to as male or female pattern baldness, is a complex genetic condition. It's a common misconception that it's solely inherited from the mother's side. **The Reality:** • **Both Parents Contribute:** The genetic predisposition for androgenetic alopecia comes from both parents. • **X Chromosome Influence:** A key gene involved in hair loss, the androgen receptor (AR) gene, is located on the X chromosome. Since males inherit their only X chromosome from their mothers, this has led to the "mother's side" myth. • **Multiple Genes:** However, multiple genes on different chromosomes also play a role. These genes can be inherited from either parent. **Key Points:** • **Family History Matters:** A family history of hair loss on either side increases the risk, but doesn't guarantee it. • **Individual Variation:** The severity and pattern of hair loss can vary greatly, even within the same family. **If you're concerned about hair loss, it's best to consult a doctor or dermatologist for personalized advice.** They can help you understand your specific situation and recommend appropriate treatment options.	

* In the interest of copyright compliance and intellectual property protection, the incorporation of relevant photographs has been withheld from this document.

Table 2. The Accuracy of Responses Provided by ChatGPT 4.o, Gemini Flash 1.5, and DeepSeek R1.

Question Number	*ChatGPT 4.o*	*Gemini Flash 1.5*	*DeepSeek R1*
	Answer Accuracy Score	***Answer Accuracy Scores***	***Answer Accuracy Score***
1	2-2	2-2	2-2
2	2-2	1-1	1-1
3	1-1	1-1	1-1
4	1-1	1-1	1-1
5	1-1	1-1	1-1
6	2-2	2-2	4-4
7	2-1	1-1	1-1
8	1-1	2-2	1-1
9	1-1	1-1	
10	1-1	1-1	
11	1-1	1-1	
12	1-1	1-1	

Table 3. Comparisons among Large Language Model-Based Artificial Intelligent Applications in terms of FKGL ve FRES levels (N=8).

	FKGL	FRES
Chat GPT	10.5±1.18	44.1±9.1
Gemini Flash 1.5	10.8±1.94	39.7±13.8
DeepSeek R1	10.6±1.49	35.6±9.6
p-value[A]	0.666	0.053

Data were shown as mean ± SD. [A]Repeated measures of ANOVA via Wilks' Lambda test.

Table 4. Comparisons between ChatGPT 4.o and Gemini Flash 1.5 in terms of FKGL vs FRES levels (N=12).

	FKGL	FRES
Chat GPT	11.0±1.61	42.0±9.3
Gemini	11.2±1.62	37.5±11.5
p-value [A]	0.674	0.059

Data are shown as mean ± SD. [A] Paired samples t-test.

R1 experienced considerable delays in the response process commencing from the sixth question and could only respond to eight questions due to augmented response times. This delay resulted in DeepSeek R1 receiving the lowest score for speed and practicality in the user experience survey. Conversely, ChatGPT 4.o and Gemini Flash 1.5 demonstrated high levels of speed and practicality. In a similar vein, a study by Heather C. Lent et al. evaluated the responses of ChatGPT 4.o to questions regarding actinic keratosis, and ChatGPT 4.o received high scores in terms of speed and practicality.

Another notable finding of the user survey is that DeepSeek R1 received very low scores in the "friendly," "enjoyable," and "boring" categories. In contrast, ChatGPT 4.o and Gemini Flash 1.5 scored high in these categories. As a result, ChatGPT 4.o and Gemini Flash 1.5 met user expectations, while DeepSeek R1 did not. Although LLMs have been around for a few years, one reason for the widespread interest in this technology is the emergence of user-friendly interfaces. Our findings suggest that language model-based AI tools should be evaluated not only for their technical accuracy but also for their interface and interaction features that improve the user experience. Especially in terms of patient education, it is inevitable to prefer AI tools that provide fast accessible information. Accordingly, in order for DeepSeek R1 to be more effective in patient education processes, it is necessary to make the responses fast and uninterrupted and to make interface improvements to improve the user experience.

When ChatGPT 4.o and Gemini Flash 1.5 were compared, although both met the expectations in user experience and received valid answers for all questions, Gemini Flash 1.5 was found to be easier and more practical to use than was ChatGPT 4.o, and the former was seen as more understandable; it was thus considered more valuable and better by the users. This resulted in a higher score in terms of meeting expectations. In the light of these findings, Gemini Flash 1.5 is more prominent in terms of user experience compared to ChatGPT 4.o.

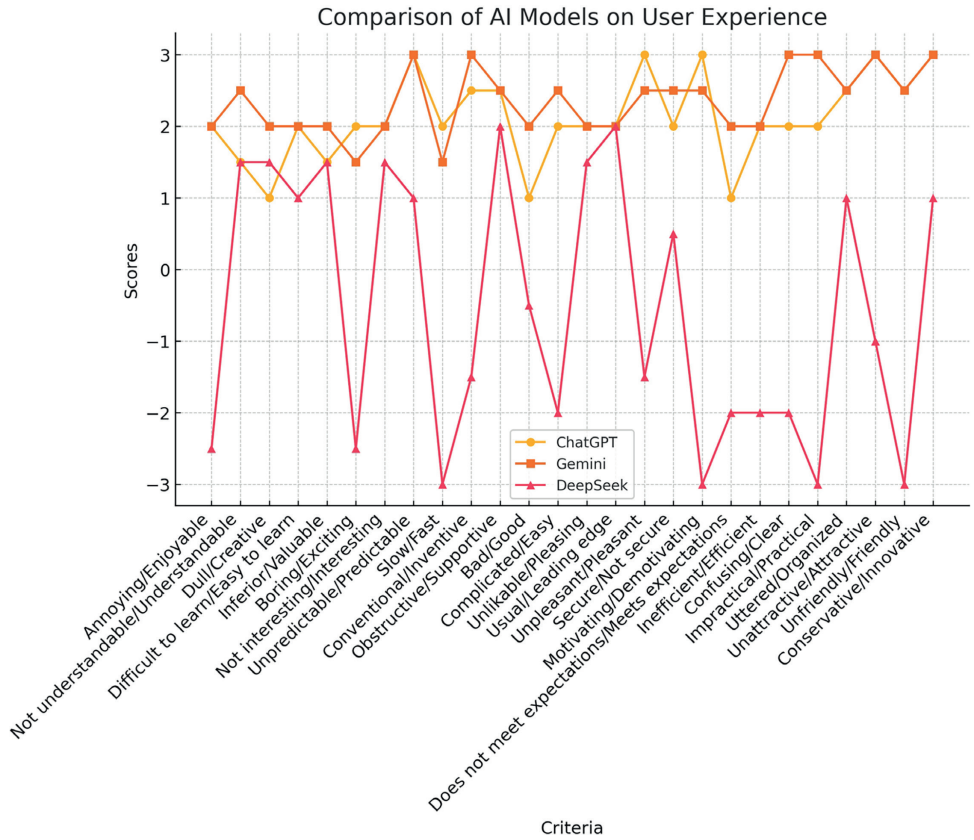

Figure 1. Mean user experience ratings for ChatGPT-4.o, Gemini Flash 1.5, and DeepSeek R1, derived from the feedback of dermatology specialists who completed a user experience questionnaire on AI-assisted analysis. Scores range from –3 to +3, where values between –0.8 and +0.8 denote a neutral evaluation, values above +0.8 indicate a positive evaluation, and values below –0.8 indicate a negative evaluation.

It is interesting to note that Gemini 1.5 Flash provided visual materials with its answers to some questions, in contrast to ChatGPT 4.o and DeepSeek R1, which did not. While visual aids can enhance comprehension, they may pose a risk for individuals with limited visual health literacy, potentially leading to misinterpretation of medical information. Further studies are needed to assess the impact of AI-generated visuals on patient education.

The phenomenon of AI hallucinations emerges when machine learning models such as Gemini 1.5, Flash, ChatGPT-4.o, and DeepSeek R1 endeavour to generate content that extends beyond the boundaries of their training data. AI hallucinations can be delineated as content that is not grounded in reality and is not derived from authentic data. Instead, it is the product of extrapolation or creative interpretation of a machine learning model's training data [13]. Therefore, users of ChatGPT 4.o are notified with the warning "ChatGPT 4.o may make errors. Check important information," while Gemini 1.5 Flash provides users with a warning that says, "Verify the answers given by Gemini Flash 1.5 as it can make mistakes." In contrast, DeepSeek R1 does not provide any information to users in this regard. Since Deepsek R1 does not provide any warnings about potential errors, users may perceive the information it provides as entirely accurate. In cases where the model disseminates incorrect or misleading information, this could lead to delays in seeking medical assistance and the misuse of over-the-counter products, resulting in inappropriate treatment approaches.

In the present study, references were appended to the responses of Gemini 1.5 Flash to a number of questions. In contrast, ChatGPT 4.o did not provide references in any of the responses analyzed in this study, although it is capable of including references under the conditions specified by the algorithm. Similarly, DeepSeek R1 did not include any references in its responses. This distinction enables the evaluation of Gemini 1.5 Flash's responses as either verifiable information or AI hallucinations, while the reliability of ChatGPT 4.o's and DeepSeek R1's responses becomes more uncertain. Additionally, DeepSeek R1's failure to notify users of potential inaccuracies due to AI hallucinations may lead to misleading and potentially damaging consequences, as users may not realize that inaccurate or incomplete information is presented.

The response of ChatGPT 4.o, Gemini Flash 1.5, and DeepSeek R1 to the question "Why does hair fall out?" was deemed to be "Satisfactory with minimal explanation required" by both evaluators. This assessment was made on the basis that cicatricial alopecia was not identified as a cause of

hair loss [14]. Although DeepSeek R1 discusses lichen planus and lupus under autoimmune diseases, it does not sufficiently address or provide examples of scarring alopecias.

ChatGPT 4.o's response to the query regarding the onset of androgenetic alopecia was evaluated by both assessors as "Satisfactory with minimal clarification required." Androgenetic alopecia, also known as male pattern baldness, affects both males and females, yet ChatGPT 4. o's response exclusively addressed the topic to men [2].

In their response to the question "Can androgenetic alopecia be confused with other hair loss conditions," both ChatGPT 4.o and Gemini Flash 1.5 were deemed by Reviewer 1 to provide a satisfactory answer that requires minimal clarification. This is because it does not mention fibrosing alopecia in pattern distribution, which is often confused with AGA-related seborrhoeic dermatitis [15].

The response provided by DeepSeek R1 to this question was evaluated by both reviewers as "Unsatisfactory, requiring substantial clarification." The statement given to distinguish androgenetic alopecia from scarring alopecia, "Scarring alopecia involves visible damage to the scalp and is not patterned like androgenetic alopecia," is incorrect. Fibrosing alopecia with pattern distribution was described approximately 30 years ago in a group of Australian women as a subtype of lichen planopilaris [16]. Over time, it has been reported in an increasing number of patients of both sexes [17,18]. Contrary to DeepSeek R1's response, there is a type of scarring alopecia that exhibits a pattern distribution resembling androgenetic alopecia. The provision of incorrect information by DeepSeek R1 could lead to negative consequences for patients. This may cause delays in seeking consultation with a dermatologist and significant time loss. It should be noted that time is a critical factor in the treatment of scarring alopecia. Delayed treatment can result in permanent damage to more hair follicles. Furthermore, patients may incur financial losses by spending money on shampoos or hair cosmetics that have no effect on the treatment of scarring alopecia. These findings underscore the necessity for the information provided by artificial intelligence tools to undergo expert supervision before being applied in clinical settings.

ChatGPT 4. o's response to the question "How is androgenetic alopecia recognised?" was described by both assessors as "Satisfactory requiring minimal clarification required." The response indicated that the pull test can be used to differentiate androgenetic alopecia (AGA) from telogen effluvium. However, it should be noted that the pull test may also be positive in AGA [19].

Gemini Flash 1.5's response to the query regarding the treatment of androgenetic alopecia was evaluated by both assessors as "Satisfactory with minimal clarification." Gemini Flash 1.5 did not mention platelet-rich plasma treatment and was therefore assessed as such [20].

Artificial intelligence models, thanks to their free versions, provide accessible sources of information for a wide range of users. However, the readability level of the information they provide may be above the level that the general public can understand. The answers produced by ChatGPT 4.o, Gemini Flash 1.5, and DeepSeek R1, which we examined in our study, were found to be at the 10^{th}–11^{th} grade FKGL (Flesch-Kincaid Grade Level) and were evaluated as difficult to read in terms of FRES (Flesch Reading Ease Score). However, the American Medical Association (AMA) and the National Institutes of Health (NIH) recommend that patient education materials be written at the 6^{th} and the 8^{th} grade level, respectively [21].

Previous studies have also shown that medical questions posed to AI models for patient education are above the recommended readability level and generally produce answers at the 10^{th}–11^{th} grade and university level [22-23]. These findings suggest that AI-based information resources in the field of healthcare may be insufficient in terms of comprehensibility for patients. Therefore, it is emphasised that the readability level of the information provided by artificial intelligence models be improved and made more suitable for public health needs.

Limitations

This study is not without limitations. Firstly, the questions used in this study were selected based on clinical experience without the application of a standardized selection protocol, which may have limited its reproducibility and introduced selection bias. Additionally, although the accuracy of the questions was evaluated using an evidence-based approach and demonstrated high inter-reviewer reliability, subjectivity remains. Additionally, user experience is entirely subjective and based on individual evaluation.

Second, each question was asked only once and in a literary style. Since the quality of the input presented to the AI tools directly affects the accuracy of the responses, different answers may be generated for the same question. Furthermore, as the free version of ChatGPT 4.o has question limitations, the system may switch to an older version (ChatGPT 3.5) during the conversation, potentially leading to different responses. Moreover, all AI tools may be updated based on new training data. Given these factors, the results obtained may differ from those of a real conversation.

Third, while the rating system we used has been successfully employed in similar studies, it is a relatively new and evolving scoring system

Finally, all questions in our study were presented in English. As AI-based tools may generate responses that are influenced by linguistic and cultural factors, the generalizability of the findings to other languages and cultural contexts may be limited.

References

1. Alessandrini A, Starace M, D'Ovidio R, et al. Androgenetic alopecia in women and men: Italian guidelines adapted from European Dermatology Forum/European Academy of Dermatology and Venereology guidelines. *G Ital Dermatol Venereol*. 2020;155(5):622-631. DOI:10.23736/S0392-0488.19.06399-5
2. Vañó-Galván S, Fernandez-Crehuet P, Garnacho G, et al. [Translated article] Recommendations on the Clinical Management of Androgenetic Alopecia: A Consensus Statement From the Spanish Hair Disorders Group of the Spanish Academy of Dermatology and Venererology (AEDV). *Actas Dermosifiliogr*. 2024;115(4):T347-T355. DOI:10.1016/j.ad.2023.10.043
3. Piraccini BM, Blume-Peytavi U, Scarci F, et al. Efficacy and safety of topical finasteride spray solution for male androgenetic alopecia: a phase III, randomized, controlled clinical trial [published correction appears in J Eur Acad Dermatol Venereol. 2023 Feb;37(2):452. DOI: 10.1111/jdv.18750.]. *J Eur Acad Dermatol Venereol*. 2022;36(2):286-294. DOI:10.1111/jdv.17738
4. Kanti V, Messenger A, Dobos G, et al. Evidence-based (S3) guideline for the treatment of androgenetic alopecia in women and in men - short version. *J Eur Acad Dermatol Venereol*. 2018;32(1):11-22. DOI:10.1111/jdv.14624
5. Mika AP, Martin JR, Engstrom SM, Polkowski GG, Wilson JM. Assessing ChatGPT Responses to Common Patient Questions Regarding Total Hip Arthroplasty. *J Bone Joint Surg Am*. 2023;105(19):1519-1526. DOI:10.2106/JBJS.23.00209
6. Dave T, Athaluri SA, Singh S. ChatGPT in medicine: an overview of its applications, advantages, limitations, future prospects, and ethical considerations. *Front Artif Intell*. 2023;6:1169595. Published 2023 May 4. DOI:10.3389/frai.2023.1169595
7. Lent HC et al. A chat about actinic keratosis: examining capabilities and user experience of ChatGPT as a digital health technology in dermato-oncology. *JEADV Clin Pract*. 2024;3(1):258-265.
8. Masalkhi M, Ong J, Waisberg E, Lee AG. Google DeepMind's gemini AI versus ChatGPT: a comparative analysis in ophthalmology. *Eye (Lond)*. 2024;38(8):1412-1417. DOI:10.1038/s41433-024-02958-w
9. Liu A, Feng B, Wang B, et al. Deepseek-v2: A strong, economical, and efficient mixture-of-experts language model. *arXiv Preprint*. 2024;arXiv:2405.04434.
10. Mika AP, Martin JR, Engstrom SM, Polkowski GG, Wilson JM. Assessing ChatGPT Responses to Common Patient Questions Regarding Total Hip Arthroplasty. *J Bone Joint Surg Am*. 2023;105(19):1519-1526. DOI:10.2106/JBJS.23.00209
11. FLESCH R. A new readability yardstick. *J Appl Psychol*. 1948;32(3):221-233. DOI:10.1037/h0057532
12. Di Fraia M, Tieghi L, Magri F, et al. A Machine Learning Algorithm Applied to Trichoscopy for Androgenic Alopecia Staging and Severity Assessment. *Dermatol Pract Concept*. 2023;13(3):e2023136. Published 2023 Jul 1. DOI:10.5826/dpc.1303a136
13. Hatem R, Simmons B, Thornton JE. A Call to Address AI "Hallucinations" and How Healthcare Professionals Can Mitigate Their Risks. *Cureus*. 2023;15(9):e44720. Published 2023 Sep 5. DOI:10.7759/cureus.44720
14. Olsen EA, Bergfeld WF, Cotsarelis G, et al. Summary of North American Hair Research Society (NAHRS)-sponsored Workshop on Cicatricial Alopecia, Duke University Medical Center, February 10 and 11, 2001. *J Am Acad Dermatol*. 2003;48(1):103-110. DOI:10.1067/mjd.2003.68
15. Griggs J, Trüeb RM, Gavazzoni Dias MFR, Hordinsky M, Tosti A. Fibrosing alopecia in a pattern distribution. *J Am Acad Dermatol*. 2021;85(6):1557-1564. DOI:10.1016/j.jaad.2019.12.056
16. Kossard S, Lee MS, Wilkinson B. Postmenopausal frontal fibrosing alopecia: a frontal variant of lichen planopilaris. *J Am Acad Dermatol*. 1997;36(1):59-66. DOI:10.1016/s0190-9622(97)70326-8
17. Singh A, Arshdeep, Batrani M, Kubba A. Male Frontal Fibrosing Alopecia with Generalized Body Hair Loss. *Int J Trichology*. 2022;14(4):147-149. DOI:10.4103/ijt.ijt_66_20
18. Ormaechea-Pérez N, López-Pestaña A, Zubizarreta-Salvador J, Jaka-Moreno A, Panés-Rodríguez A, Tuneu-Valls A. Frontal Fibrosing Alopecia in Men: Presentations in 12 Cases and a Review of the Literature. Alopecia frontal fibrosante en el varón: presentación de 12 casos y revisión de la literatura. *Actas Dermosifiliogr*. 2016;107(10):836-844. DOI:10.1016/j.ad.2016.07.004
19. Kutlubay, Z., Bağlam, S., Engin, B., & Serdaroğlu, S. (2014). Erkeklerde androgenetik alopesi. *Archives of the Turkish Dermatology & Venerology/Turkderm*, *48*.
20. Gupta AK, Cole J, Deutsch DP, et al. Platelet-Rich Plasma as a Treatment for Androgenetic Alopecia. *Dermatol Surg*. 2019;45(10):1262-1273. DOI:10.1097/DSS.0000000000001894
21. Rooney MK, Santiago G, Perni S, et al. Readability of Patient Education Materials From High-Impact Medical Journals: A 20-Year Analysis. *J Patient Exp*. 2021;8:2374373521998847. Published 2021 Mar 3. DOI:10.1177/2374373521998847
22. Campbell DJ, Estephan LE, Mastrolonardo EV, Amin DR, Huntley CT, Boon MS. Evaluating ChatGPT responses on obstructive sleep apnea for patient education. *J Clin Sleep Med*. 2023;19(12):1989-1995. DOI:10.5664/jcsm.1072.
23. Şahin MF, Keleş A, Özcan R, et al. Evaluation of information accuracy and clarity: ChatGPT responses to the most frequently asked questions about premature ejaculation. *Sex Med*. 2024;12(3):qfae036. Published 2024 Jun 2. DOI:10.1093/sexmed/qfae036