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Study of the International Epidemiology of Androgenetic Alopecia in Young Caucasian Men Using Photographs From the Internet

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Abstract

Background: The epidemiological evaluation of androgenetic alopecia (AGA) is based mainly on direct observation and questionnaires. The international epidemiology and environmental risk factors of AGA in young Caucasian men remain unknown. **Aim:** To use photographs and data from the Internet to evaluate severe AGA and generate greater understanding of the international epidemiology of the disorder in young Caucasian men. **Materials and Methods:** A population-based cross-sectional study design was used. The sample included 26,340 Caucasian men aged 30 to 40 years who had uploaded profiles to two dating websites. Their photographs were evaluated for AGA and graded as follows: severe AGA (Norwood type VI-VII), non-severe AGA, and unknown. Epidemiological data were collected from the sites. Logistic regression was used to analyze the effect of risk factors on the prevalence of severe AGA. **Results:** The overall success rate for identifying severe AGA by indirect evaluation of Internet photographs was 94%. The prevalence of severe AGA was 15.33% overall and varied significantly by geographical region. The risk of having severe AGA was increased by 1.092 for every year of age between 30 and 40 years. Severe AGA was more prevalent in subjects with higher body mass index. **Conclusions:** Photographs from the Internet can be used to evaluate severe AGA in epidemiological studies. The prevalence of severe AGA in young Caucasian men increases with age and varies by geographical region. Body mass index is an environmental risk factor for severe AGA.

Key Words: *Androgenetic alopecia, epidemiology, Internet*

What was known?
- Epidemiological data on androgenetic alopecia are based on direct observations and questionnaires
- There is little information on the potential effect of nongenetic factors on the prevalence of androgenetic alopecia in young Caucasian men.

Introduction

Androgenetic alopecia (AGA) is the most common type of hair loss.[1] It is characterized by progressive thinning of the scalp hair and a reduction in hair density and diameter.[2,3] Male AGA presents with a typical pattern of bitemporal and frontal recession of the hair line or vertex thinning which gradually extends anteriorly.[4-7] The prevalence increases with age, from 30% for men in their 30s to 50% for men in their 50s.[5] Nongenetic causes have received little scientific attention, and data on environmental factors that may aggravate male AGA remain sparse.[8]

Materials and Methods

The present population-based cross-sectional study was carried out between May and September 2011. A stratified sampling method was used. The study protocol was approved by the Human Research Ethics Committee of Szeged University.

The study sample consisted of Caucasian men aged 30 to 40 years who had uploaded a profile to one of two dating websites: Jdate, which targets Jewish subjects, and OkCupid, a general dating service from which we selected non-Jewish subjects using the search criteria. A total of 26,340 profiles were examined, each containing several photographs of the individual subject. The photographs were magnified and graded for the presence of alopecia according to the Norwood classification.[6] Each profile was evaluated twice in a blinded fashion by a single observer. Thereafter, randomly selected photographs were again evaluated by an independent dermatologist blinded to the results of the first observer. Intra- and interobserver variability were analyzed with Cramer's reliability test and joint probability of agreement statistics. On the basis of the findings, subjects were divided into three groups: Severe AGA (Norwood type VI or VII), non-severe AGA (Norwood type <VI), and unknown. Profiles for which we were unable to ascertain the AGA status were excluded from the analysis.

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Besides religion, data on age and place of residence were collected for each subject from the websites. We calculated the age-specific prevalence of AGA and the prevalence of severe AGA for every country of residence that was cited by at least 50 subjects. In addition, body mass index (BMI) was determined for subjects for whom data on weight and height were available. Logistic regression analysis was used to identify potential risk factors of AGA, with AGA status as the dependent variable, age and BMI as independent continuous variables, and website as an independent categorical variable.

Several volunteers provided written informed consent to be photographed from distances of several meters using their personal cameras ("regular photographs"), followed by close-up head photographs of the frontal, temporal, mid-pattern, and vertex regions, similar to global photographs used in clinical trials and follow-up studies of alopecia.[4] The regular and close-up photographs were compared for their ability to serve as a tool for predicting severe alopecia by an observer.

Results

Of the 26,340 profiles included in the study, 15,091 were uploaded in Jdate and 11,249 in OkCupid. On average, the Jdate profiles contained 3 photographs of each subject (SD 1.9), and the OkCupid profiles, 4.9 photographs (SD 4.2). On the initial evaluation, intraobserver variability was 84% by Cramer's reliability test and 96% by joint probability of agreement. Of the Jdate profiles, 3033 underwent repeated evaluation by an independent dermatologist. Interobserver variability was 81% by Cramer's reliability test and 96% by joint probability of agreement.

A total of 1638 subjects were excluded because their AGA status could not be determined on the basis of the photographs, leaving 24,702 profiles for analysis: 14,709 on Jdate and 9993 on OkCupid. The overall success rate of indirect evaluation of severe AGA using photographs was 94%, with a significant difference between websites: 97.46% for Jdate profiles and 88.83% OkCupid profiles ($P < 0.001$). The ability to clearly distinguish severe from nonsevere AGA using this method was supported by the evaluation of the "regular" photographs of the volunteers [Figure 1]. Severe AGA was identified in 3786 subjects (2,419 on Jdate and 1,367 on OkCupid), for an overall prevalence of 15.33%. The difference between websites was statistically significant: 16.45% for Jdate, 13.68% for OkCupid ($P < 0.0001$).

Table 1 shows the findings for potential risk factors. The risk for having severe AGA increased with age. Logistic regression analysis of the total 24,702 subjects yielded an increased risk of 1.092 for every yearly increase in age between 30 and 40 ($P < 0.0001$) [Figure 2]. In addition, there was a positive association between the presence of severe AGA and higher BMI. Logistic regression analysis of 10,691men on Jdate for whom data on height and weight were available yielded an increased risk of 1.027 for each unit of BMI for individuals of the same age ($P < 0.001$). The risk of having severe AGA was higher by 1.426 for Jewish men on Jdate than for non-Jewish men of the same age on OkCupid ($P < 0.0001$).

Table 2 shows the findings for the geographical analysis. The prevalence of severe AGA varied significantly among countries ($P < 0.001$). Comparison of the two countries listed most often by the study sample yielded a 19.89% prevalence of severe AGA in the 5886 Jewish men from Israel and 13.75% for the 8066 Jewish men from the USA ($P < 0.001$).

Discussion

The main purpose of the present study was to suggest a novel method for conducting epidemiological studies of AGA using photographs and data from the Internet. The secondary purpose of the study was to compare the prevalence of AGA among different countries and to investigate potential risk factors for AGA such as age, BMI and genetic background. Obviously, we could not authenticate the collected photographs and data viewed

Figure 1: Regular vs. close-up photographs. The top photographs are of two representative volunteers taken from a distance of several meters using the individual's personal camera ("regular photographs"). Underneath each regular photograph are close-up head photographs of the same volunteers showing their frontal, temporal, mid-pattern, or vertex regions. The regular and close-up photographs were compared for their ability to serve as a tool for predicting severe alopecia by an observer

on the Internet. Therefore, our working assumption was that we would find similar amount of true and false data uploaded by Internet users among the different countries enabling us to compare the prevalence of AGA and the potential risk factors between the investigated countries.

The strengths of this method are its ease, rapidity, and low cost, and the access it provides to large populations with an international distribution. The limitations of this method are low accuracy for individual diagnoses of AGA compared to the traditional method of face-to-face examination, the inert inability to verify the authenticity of the gathered data and the limited background data available for the subjects. For instance, the prevalence may be underestimated because people are more likely to upload their photograph with more hair. Furthermore, we focused only on single men as a subgroup of the general male population of the studied age. For these reasons the overall studied prevalence may differ from that of the general population. Yet, we were able to compare the prevalence of the particular studied population between different countries. It was also impossible to exclude other potential types of hair loss that mimic AGA, such as acute and chronic telogen effluvium, diffuse or reverse ophiasis, alopecia areata, and early cicatricial alopecia.

We selected a narrow study population of 24,702 Caucasian men aged 30-40 years who had uploaded profiles

Table 1: Logistic regression analysis with estimates of odds ratios and 95% confidence intervals and *P* values of potential risk factors of severe androgenetic alopecia

Variable	OR	95% CI	*P*
Age*	1.087	1.08-1.10	<0.0001
BMI*	1.027	1.04-1.01	<0.001
Website/Religion			
OkCupid/Non-Jewish	1	-	
Jdate/Jewish	1.426	1.32-1.53	<0.0001

OR: Odds ratio, CI: Confidence interval, BMI: Body mass index, *Continuous variables

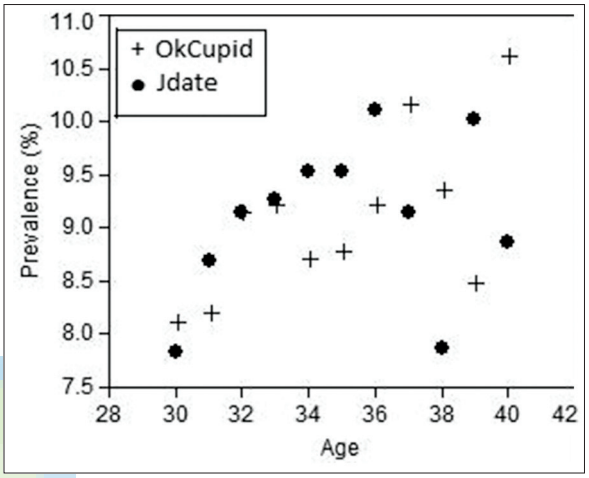

Figure 2: Logistic regression analysis of the relationship of AGA with age. There was an increased risk of 1.092 for every yearly increase in age between 30 and 40 years ($P < 0.0001$). The results from the two websites are compared

Table 2: Prevalence of androgenetic alopecia by countries of origin

Countries	Jdate			OkCupid			Total		
	(%, 95% CI)	AGA, *n*	Total no.	(%, 95% CI)	AGA, *n*	Total no.	(%, 95% CI)	AGA, *n*	Total no.
USA	(13.75, 13.0-14.5)	1109	8066	(13.43, 12.6-14.2)	936	6969	(13.0, 13.06-14.1)	2045	15035
Israel	(19.89, 18.8-20.9)	1171	5886				(19.89, 18.8-20.9)	1171	5886
United Kingdom	(17.44, 12.7-23.3)	34	195	(19.17, 16.6-22)	158	824	(18.84, 16.5-21.3)	192	1019
Germany				(10.65, 7.6-14.7)	31	291	(11.4, 8.3-15.4)	35	307
Canada	(19.23, 14.9-24.4)	50	260	(12.5, 6.9-21.5)	10	80	(17.65, 13.9-22.0)	60	340
Italy				(21.86, 17.4-27.0)	61	279	(21.88, 17.4-27.0)	63	288
France	(15.52, 10.0-23.2)	18	116	(12.38, 7.3-20.0)	13	105	(14.03, 10.0-19.2)	31	221
Australia	(17.17, 11.0-25.7)	17	99	(5.88, 2.5-13.0)	5	85	(11.96, 8.0-17.4)	22	184
Spain				(13.48, 8.8-20.0)	19	141	(13.99, 9.2-20.6)	20	143
Netherlands				(14.39, 9.4-21.3)	19	132	(14.48, 9.6-21.1)	21	145
Finland				(12.73, 7.7-20.2)	14	110	(12.73, 7.7-20.2)	14	110
Turkey				(7.69, 3.5-15.7)	6	78	(7.59, 3.5-15.5)	6	79
Romania				(6.02, 2.6-13.3)	5	83	(6.02, 2.6-13.3)	5	83
Sweden				(16.67, 10.2-26.0)	14	84	(18.39, 11.6-27.8)	16	87
Brazil				(0, 0.0-5.6)	0	64	(3.9, 1.3-10.8)	3	77
Portugal				(6.45, 2.5-15.4)	4	62	(6.45, 2.5-15.4)	4	62
Greece				(9.26, 4.0-19.9)	5	54	(9.26, 4.0-19.9)	5	54
Belgium				(10.64, 4.6-22.6)	5	47	(11.54, 5.4-22.9)	6	52
Switzerland				(18.18, 9.5-31.9)	8	44	(20, 11.2-33.0)	10	50

AGA: Androgenetic alopecia, *Raw data used for statistical analysis is included as Supplementary files for review, CI: Confidence interval

to one of two major dating websites. We defined severe AGA as type VI or VII in the Norwood classification, and non-severe AGA as any level below VI. Similarly, previous epidemiological studies classified AGA into two[9-11] or three[8,12] levels. By examining the photographs, we identified severe AGA in 15.33% of the subjects. To determine the extent to which our findings might be affected by bias or confounding as a consequence of the indirect method of evaluation, we searched the medical literature for previous studies based on direct examination by face-to-face interviews in similar age groups. Severi *et al*.[8] reported a 19% rate of severe (Hamilton-Norwood types IV-VII) frontal and vertex AGA in men aged 40 to 55 years, and in a study from India, Krupa Shankar *et al*.[13] reported an 18.52% rate of severe (Hamilton-Norton type VI) AGA in men aged 30 to 35 years. In the Dayton study, Rhodes *et al*.[14] found that 23% of men aged 30-39 years had severe AGA (Hamilton-Norwood type VI or VII) compared to 22% in the Hamilton study[5] and only 3% in the Norwood study.[6] In a self-report study of 7250 men aged 20-50 years, 19.5% graded themselves as Hamilton-Norwood type V or higher.[15] Several others noted that 30% of Caucasian men in their 30s have some level of AGA.[5,8,14-16] The similar prevalence of AGA in all these studies, in the same age group as in the present study, supports the use of our novel method.

The evaluation of severe AGA using regular photographs was based on the rationale that frontal-pattern AGA is the most common type of AGA in Caucasian males[5] and vertex involvement is apparently associated with temporal and frontal involvement in virtually all patients.[12] Therefore, photographs that show the face and the frontal and temporal regions of the scalp can be used to differentiate severe from nonsevere AGA [Figure 1]. Pathomvanich[17] performed an indirect survey of 20,000 males in Bangkok based on quick and distant visual studies in shopping malls and on the street in order to evaluate the prevalence of AGA in all age groups. Our study offers the extra advantages of access to several photographs of each subject, several times over and at high magnitude. Using the websites' search criteria, we were also able to collect epidemiological data on age, religion, place of residence, and BMI, which made it possible to conduct more in-depth analyses for potential risk factors.

Although previous studies noted a link between AGA and age,[5] our study refined this association by focusing on a specific population within a narrow age range. Our results show that in Caucasian men, the risk of AGA increased by 1.092 for every year between ages 30 and 40 years.

In addition, the Jewish population is known to have a high prevalence of several genetic diseases such as Tay Sachs, Gaucher's disease, familial Mediterranean fever, phenylketonuria, and beta-thalassemia. AGA has a known polygenetic mode of inheritance, with newly identified susceptibility genes on chromosomes 3q26 and 20p11.[18] Thus, to determine if genetic background plays a role in the prevalence of AGA, we compared subjects from Jdate, a website targeted to the Jewish population, with subjects from OkCupid, a website targeted to the general population from which we selected the non-Jewish subjects. A significant difference in the rate of AGA was found (16.45% vs 13.68%, $P < 0.0001$). However, several differences between the websites may have affected these results, such as the number and quality of the photographs per profile and the number of profiles from which we were able to identify the AGA status. We presume that some of these differences are related to the fact that Jdate charges a membership fee whereas OkCupid does not. We attempted to overcome these differences by excluding the profiles from which we were unable to identify the AGA status. We suggest that future comparisons be done between websites that share more features.

The involvement of environmental and other nongenetic factors in AGA has received little scientific attention.[8] Wang *et al*.[12] found significant variations in the prevalence of AGA among six cities in China, which they presumptively attributed to differences in climate, lifestyle, and socioeconomic levels. In the present study, the analysis by geographical region was based on the assumption that men within the same age group who subscribe to dating websites have a similar tendency to acquire severe AGA. The results showed a significant difference in prevalence among the 19 different countries cited by at least 50 subjects each ($P < 0.0001$). When we compared the subjects from the two most-cited locations, we found a prevalence of 19.89% among 5,886 Jewish men from Israel as opposed to 13.75% among 8066 Jewish men from the USA ($P < 0.001$). These findings are consistent with those of Wang *et al*.[12] and suggest a possible effect of local environmental risk factors on severe AGA.

BMI is another important environmental factor that may play a role in AGA. Metabolic syndrome (MetS) is defined by the National Cholesterol Education Program Adult Treatment Panel III[19] as the combination of three or more of the following criteria: Waist circumference >90 cm, serum triglyceride level >150 mg/dL, high-density lipoprotein cholesterol level <40 mg/dL, impaired fasting glucose level 110–125 mg/dL, and blood pressure >130/85 mmHg or treated hypertension. Studies of the possible association of MetS with AGA have yielded inconsistent results. AGA was found to be linked to cardiovascular diseases,[20] coronary heart diseases,[21] insulin resistance,[22] hypertension,[23] abnormal serum lipid profiles[24] and obesity.[25] Su and Chen[9] noted that patients with severe AGA (type V or above) had a 2.6-fold higher prevalence of MetS than patients with moderate AGA (types III and IV), and Pathomvanich *et al*.[26] suggested that the increasing incidence of obesity in Bangkok may be contributing to the higher prevalence of male AGA compared to other Asian countries.[2,12,27] However, Yi *et al*.[28] recently reported that the risk of acquiring Norwood type IV AGA or

greater was not increased in subjects with MetS relative to those without MetS. We examined the BMI of 10,691men on Jdate who had included data on height and weight in their profile. There was a positive association between the presence of severe AGA and higher BMI, with an increased risk of 1.027 for every unit of BMI for men of the same age. If this finding is confirmed, severe AGA may serve as a predictive factor for the early diagnosis of MetS and aid physicians in the prevention of its complications.[9]

In conclusion, the present study describes a novel method for conducting epidemiological research of AGA using photographs and data from the Internet. To the best of our knowledge, this is the largest epidemiological study to investigate AGA and the first to use this method. We focused on young Caucasian men within a narrow age range of 30-40 years. Our findings link AGA with advancement in age and with higher BMI, and show significant differences in the prevalence of AGA among countries pointing to some potential environmental risk factors.

What is new?

1. Evaluation of photographs and data from the Internet can serve as a novel method of studying the international epidemiology of androgenetic alopecia.
2. High body mass index and exposure to high environmental levels of ultraviolet radiation may aggravate AGA.

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