



Research Article

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Incidence and Associated Risk Factors of Axillary Bromhidrosis Following Laser Hair Removal: A Prospective Cohort Study

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Abstract

Background: Axillary bromhidrosis causes a considerable negative effect on social, psychological, and emotional well-being. Laser hair removal has recently been reported as the most commonly used cosmetic procedure. **Objective:** To investigate the incidence, severity, and determinants of axillary bromhidrosis in healthy individuals undergoing laser hair removal. **Methods:** A prospective longitudinal cohort study was carried out in a private dermatology clinic in Baghdad from February 2024 to February 2026. It included 184 individuals who underwent axillary hair removal laser by one of two Alexandrite laser systems (Candela or DEKA). A total of six sessions (1.5 to 2.5 months apart depending on hair growth cycle) is recommended, followed by maintenance sessions as needed. The severity of axillary bromhidrosis was assessed clinically based on the distance from which the odor can be detected. **Results:** In this study, axillary bromhidrosis was noticed in 41 participants (22.3%); 58.5% experienced a moderate level of severity, and 95.1% of them were resolved after finishing all sessions. Multivariable logistic regression identified obesity and Fitzpatrick skin type II as independent predictors of axillary bromhidrosis following laser hair removal. These factors were obesity (OR=2.55 with 95% CI:1.61-4.44) and Fitzpatrick skin type II (OR=3.27 with 95% CI:1.89-6.41). **Conclusions:** Although laser hair removal is generally safe and successful, certain individuals, especially those at higher risk, may develop transient axillary bromhidrosis during treatment, a condition that can be treated. Important patient-related characteristics that contribute to vulnerability include obesity and Fitzpatrick skin type II.

Keywords: Axillary; Bromhidrosis; Hair removal; Incidence; Laser.

معدل حدوث وعوامل الخطر المرتبطة برائحة العرق الأبطية بعد إزالة الشعر بالليزر: دراسة جماعية مستقبلية

الخلاصة

الخلفية: تسبب رائحة العرق الأبطية تأثيراً سلبياً كبيراً على الصحة الاجتماعية والنفسية والعاطفية. تم الإبلاغ مؤخراً عن إزالة الشعر بالليزر كأكثر الإجراءات التجميلية استخداماً. **الهدف:** دراسة معدل حدوث وشدة ومحددات رائحة العرق الأبطية لدى الأفراد الأصحاء الذين يخضعون لإزالة الشعر بالليزر. **الطرائق:** أجريت دراسة جماعية طولية مستقبلية في عيادة خاصة للأمراض الجلدية في بغداد للفترة من فبراير 2024 إلى فبراير 2026. شملت 184 شخصاً خضعوا لإزالة الشعر الإبطي بالليزر باستخدام أحد نظامي ليزر الكسندريت (كنديل أو ديكا). يوصى بإجراء ست جلسات (بفواصل 1.5 إلى 2.5 شهر حسب دورة نمو الشعر)، تليها جلسات أدامة حسب الحاجة. تم تقييم رائحة العرق الأبطية سريرياً بناءً على المسافة التي يمكن من خلالها اكتشاف الرائحة. **النتائج:** في هذه الدراسة، لوحظت رائحة العرق الأبطية في 41 مشاركاً (22.3%)؛ وشهد 58.5% مستوى متوسط من الشدة، انتهت مشكلة 95.1% منهم بعد الانتهاء من جميع الجلسات. حدد الانحدار اللوجستي متعدد المتغيرات السمنة وجلد فيتزباتريك النوع الثاني كعوامل مستقلة قد تزيد احتمال حصول رائحة العرق الأبطية بعد إزالة الشعر بالليزر. كانت هذه العوامل السمنة (OR=2.55 مع 95% CI:1.61-4.44) وجلد فيتزباتريك النوع الثاني (OR=3.27 مع 95% CI:1.89-6.41). **الاستنتاجات:** على الرغم من أن إزالة الشعر بالليزر آمنة وناجحة عموماً، إلا أن بعض الأفراد، خاصة الأكثر عرضة للخطر، قد يعانون من رائحة العرق الأبطية بصورة مؤقتة أثناء العلاج، وهي حالة يمكن علاجها. تشمل العوامل المهمة المتعلقة بالمرضى التي تساهم في التعرض للخطر السمنة وجلد فيتزباتريك النوع الثاني.

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INTRODUCTION

Axillary bromhidrosis is a condition that occurs when the axillary apocrine sweat glands produce an offensive, strong odor [1]. Some think it develops when apocrine sweat glands in the axilla break down unsaturated branched-chain fatty acids. Resident skin bacteria metabolize these produced fatty acids, resulting in a characteristic unpleasant odor in the underarm area [2]. It has an incidence of around 2.8%, and the most affected patients were adolescents [3]. Major aspects in the development of bromhidrosis include apocrine secretion and bacterial breakdown of sweat [4]. The diagnosis of bromhidrosis is still subjective because odor is a

subjective element. Because apocrine sweat glands do not start producing sweat until adolescence, most people who experience axillary odor do so after this developmental stage [5]. There is no immediate danger to life from axillary bromhidrosis, but there are significant emotional and social costs associated with the condition. This disorder can exacerbate feelings of shame and inadequacy, making it even more challenging to connect with others and advance socially in certain communities [6]. As a more effective and long-lasting alternative to previous methods, laser hair removal has become one of the most popular cosmetic operations [7]. The usage of laser-based technology for axillary hair

reduction has increased, making laser hair removal one of the most performed cosmetic operations [8]. Theoretically, axillary hair removal might reduce odor by lowering the retention of microorganisms linked with hair. On the other hand, laser treatments have the potential to cause temporary localized heat and inflammation. A change in axillary odor could be the result of these impacts, which could cause a transient shift in the skin's environment and the way sweat glands work [9]. Transient laser-induced thermal impacts might change the way sweat glands work or the patterns of sweating but not necessarily damage the glands themselves. [10]. Crucially, one should not automatically assume that this process results in hyperhidrosis due to the loss of sweat glands. On the contrary, glandular activity or sweating patterns may be momentarily altered by laser-induced heat effects. There may be a temporary functional change in sweating, as there is prior evidence that shows an increase in sweat production after axillary laser hair removal [11]. The main types of laser hair removal techniques that utilize specific wavelengths of light to target hair follicles are Alexandrite (quick, light skin), Diode (versatile, fair-to-medium skin), Nd:YAG (deep penetration, dark skin), and IPL (broad-spectrum, best for fair skin) [12]. The aim of this study is to determine the incidence and severity of axillary bromhidrosis during axillary laser hair removal and to identify demographic and clinical characteristics associated with its occurrence. We also evaluated whether the type of laser device used was associated with the development of bromhidrosis.

Rationale of this study and research gap

In Iraq, the market for laser hair removal is experiencing a surge in demand and popularity, transitioning from basic technologies to more advanced systems, with a high degree of patient satisfaction, often reporting over 90% satisfaction rates [13]. As of October 2025, there are approximately 17 registered specialized laser hair removal services in Iraq, representing a 21% increase from 2023 [14]. Combined with a significant lack of localized research addressing the effects of these treatments, conducting a longitudinal study on bromhidrosis following axillary laser hair removal in Iraq is essential. Bromhidrosis after laser hair removal has been recorded in case reports and retrospective research, but there is a lack of prospective longitudinal studies that assess its incidence, severity, progression over time, and risk factors [15]. So, to fill this crucial research gap, this study was conducted. It may provide valuable insights to guide informed decision-making for patients and healthcare providers alike.

METHODS

Study design and setting

A prospective longitudinal cohort study was carried out in a private dermatology clinic in Baghdad during a

period of two years from February 2024 to February 2026.

Study participants

The study comprised 184 individuals who attended the clinic and underwent axillary hair removal laser by one of two devices available in the clinic. Individuals who did any previous laser hair removal, who had skin or systemic diseases such as diabetes, atopic dermatitis, psoriasis, or herpetic and dermatophyte infections, those who took immunosuppressive drugs, who had received any kind of oral or topical antibiotics within 72 hours before any sampling session, those with any bromhidrosis before the first laser session (all participants were clinically free from bromhidrosis), pregnant and lactating women, and those who refused to participate were excluded from the study (Figure 1).

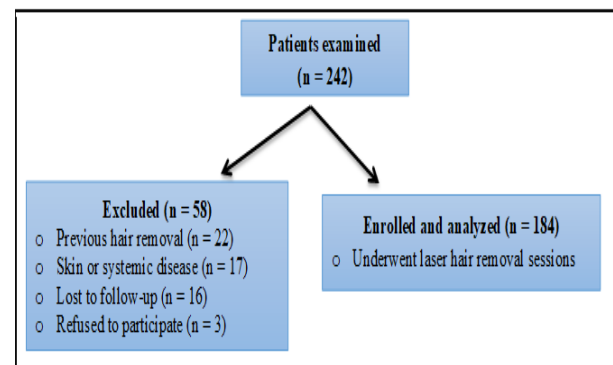


Figure 1: The study's strict inclusion criteria (Patient Flow Diagram)

Sample size calculation

The sample size was calculated in this study depending on the following formula [16,17]:

$$n = \left[\frac{Z^2 * p (1 - p)}{E^2} \right] * \frac{1}{1 - r}$$

Where n = required sample size; Z = Z-value (1.96 for 95% confidence level); p = expected proportion of the outcome (bromhidrosis incidence), which is about 7.5% [18]; E = margin of error (the desired precision is 0.05); and r = expected rate of loss with pre- and post-care instructions, feeling heat or discomfort or excessive pain during the session, and details of bromhidrosis, if it occurred, follow-up (20%). So, the required sample was 134 individuals. We included 184 individuals to increase the power of the study, as shown in Figure 1.

Data collection

Demographics (age, gender, residence, occupation, BMI level, smoking status, and medication intake), Fitzpatrick skin types, history of hyperpigmentation or melasma, devices used, compliance to pre- and post-care instruction, feeling heat or discomfort or excessive pain

during the session, and details of bromhidrosis if it occurred were collected.

Laser hair removal protocol

The procedure was done by two laser hair removal devices (Candela and DEKA) (Figures 2 and 3).



Figure 2: Candela laser hair removal device. Model: Gentle Max Pro, Type: Dual-wavelength medical laser system, Wavelength: 755 nm (Alexandrite) and 1064 nm (Nd:YAG), Pulse duration 0.25–100 ms.

A total of six sessions is recommended, followed by maintenance sessions as needed. Shaving should be performed one day before the session. Shaving between sessions is not recommended. The session can be performed one week before menstruation or one week after. Throughout the trial, participants who were eligible were requested not to use any antifungal, antibacterial, or deodorant items in their axillary regions. Wearing underwear made of cotton was also requested, as was the

removal of axillary hairs just by shaving. On top of that, they were instructed to wait 24 hours before the laser treatment to wash that area.



Figure 3: DEKA laser hair removal device. Model: Again Pro Plus, Type: Fractional CO₂ laser platform, Wavelength: 10,600 nm, Pulse duration: 0.2 – 300 ms.

After each session, the participant should avoid water exposure for 4–6 hours, use a medical-grade moisturizer that is free from fragrances and exfoliating agents, apply zinc oxide ointment twice daily for three days to sensitive areas, refrain from physical exfoliation for 10 days after the session and for 10 days before the next session, and postpone treatment for fungal infections, genital warts, or any skin disease until they have consulted a specialist. Patients with hormonal imbalance or polycystic ovary syndrome should consult a physician and adhere strictly to the laser treatment schedule. Sessions are repeated every 1.5 to 2.5 months depending on the hair growth cycle (Table 1).

Table 1: Laser hair removal protocol

Parameter	Protocol
Guidelines	Light skin → higher fluence Dark skin → lower fluence
Pulse Duration	Measured in milliseconds (ms) and should match the thermal relaxation time (TRT) of the hair.
Selection	Thick hair → longer pulse Fine hair → shorter pulse Skin preparation:
Pre-treatment preparation	• Clean skin (no creams or makeu). • Shave 24 hours before session. • Avoid waxing and plucking.
Number of sessions	Standard: 6–8 sessions
Interval	4–10 weeks

Follow up

Assessment of each participant was done at each session and at least three months after the last session. Bromhidrosis was diagnosed using a standardized clinical assessment performed by the same experienced dermatologist at each visit to minimize interobserver variability. The assessment was performed under standardized clinical conditions and at a consistent close-range observation distance. Bromhidrosis was

considered clinically present when a persistent unpleasant axillary odor was detectable despite routine bathing and regular deodorant or aluminum chloride-based antiperspirant use and when it was associated with a perceived negative effect on daily activities, social interactions, or self-esteem. Severity of axillary bromhidrosis was assessed clinically based on the 0 to 5 Odor Intensity Scale [19, 20] (0= No odor, detected; 1= Very faint odor, present but difficult to characterize; 2=

Faint odor, noticeable and can be characterized after a few moments; 3= Easily detectable odor; obvious immediately; 4= Strong odor, noticeably unpleasant; 5= Forceful/intolerable odor). It is a standardized tool used in previous studies to measure and rank the strength of a smell as perceived by a human evaluator. It is a 6-point odor intensity scale that could serve as linguistic cues, enabling evaluators to provide ratings based on their absolute scale [21].

Ethical considerations

The Declaration of Helsinki establishes the fundamental principles for ethical conduct. Approval was obtained from the Ibn Sina University of Medical and Pharmaceutical Sciences Ethics Committee (approved no.: ISU-2023-162). All patients were signed a written consent about the study, giving them full information about the treatment options, and they were requested to be a part of this work. Data were stored securely using coded identifiers in a password-protected environment.

Statistical analysis

The data was analyzed using Statistical Package for the Social Sciences (SPSS) version 28. The data is presented using standard deviation, ranges, and mean. Statistical information presented in the form of percentages and frequencies. Normality: The data was assessed by the Shapiro-Wilk test and showed normal distribution. To determine whether there was a correlation between the use of laser equipment and axillary bromhidrosis, the chi-square test was utilized. The likelihood of axillary bromhidrosis after laser hair removal served as the dependent variable in a logistic regression analysis, with the variables determined to be significant in the binary analysis serving as independent variables. We considered a *p*-value less than 0.05 to be statistically significant.

RESULTS

The final sample comprised 184 participants. Nearly half of them (50.5%, *n* = 93) aged between 20 and 25 years, 25.28 ± 5.4 , and aged from 17 to 45 years, 83.2% were females, 84.2% were living in urban areas, 33.2% were employees, 47.3% had normal BMI levels, 22.8% were current smokers, and 37% took photosensitive medications. Patients' characteristics are presented in Table 2. In this study, the most common Fitzpatrick skin types were III (41.8%); 21.2% had a history of hyperpigmentation or melasma; two laser devices were used in this clinic for axillary hair removal (Candela in 54.9% and DEKA in 45.1%); 38.6% were partially followed pre- and post-care instructions; 25.5% felt heat or discomfort during sessions; and 17.9% experienced excessive pain during sessions (Table 3). During the laser axillary hair removal, axillary bromhidrosis was noticed in 41 participants (22.3%), as shown in Figure 4.

Table 2: Participants' characteristics (*n* = 184)

Variable	n(%)
<i>Age Groups (year)</i>	
< 20	32(17.4)
20 – 29	93(50.5)
30 – 39	38(20.7)
≥ 40	21(11.4)
<i>Gender</i>	
Male	31(16.8)
Female	153(83.2)
<i>Residence</i>	
Urban	155(84.2)
Rural	29(15.8)
<i>Occupation</i>	
Housewife	33(17.9)
Employee	61(33.2)
Student	42(22.8)
Private work	48(26.1)
<i>BMI Level</i>	
Normal	87(47.3)
Overweight	66(35.9)
Obese	31(16.8)
<i>Smoking status</i>	
Current smokers	42(22.8)
Non-smokers	142(77.2)
<i>Medication intake (Photosensitive)</i>	
Yes	68(37.0)
No	116(63.0)

Table 3: Clinical and treatment-related characteristics of participants undergoing axillary laser hair removal (*n* = 184)

Variable	n(%)
<i>Fitzpatrick skin types</i>	
I	20(10.9)
II	31(16.8)
III	77(41.8)
IV	56(30.4)
<i>History of hyperpigmentation or melasma</i>	
Yes	39(21.2)
No	145(78.8)
<i>Laser hair removal device used</i>	
Candela	101(54.9)
DEKA	83(45.1)
<i>Pre- and post-care instruction followed</i>	
Totally	54(29.3)
Partially	71(38.6)
No	59(32.1)
<i>Feeling heat or discomfort during session</i>	
Yes	47(25.5)
No	137(74.5)
<i>Excessive pain during session</i>	
Yes	33(17.9)
No	151(82.1)

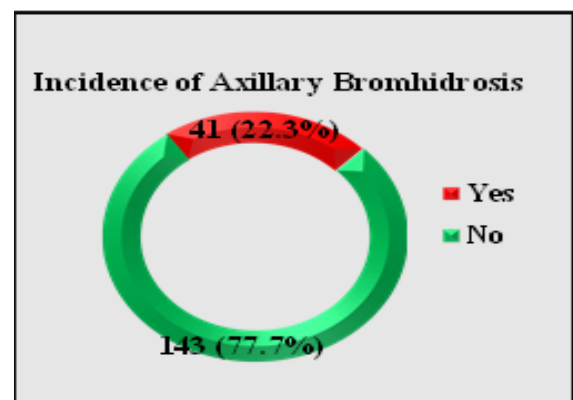


Figure 4: Incidence of axillary bromhidrosis.

Among those who are diagnosed with axillary bromhidrosis, 58.5% experienced a moderate level of severity (2-3 on the odor intensity scale), 36.5% of them experienced axillary bromhidrosis after the 3rd session, and in 95.1% of them the bromhidrosis was resolved after finishing all sessions (Table 4).

Table 4: Characteristics of axillary bromhidrosis (n= 41)

Variable	n(%)
<i>Severity of bromhidrosis (Odor Intensity Scale)</i>	
1 - 2	9(22)
3 - 4	24(58.5)
5	8(19.5)
<i>Session that bromhidrosis detected after</i>	
2 nd	17(41.5)
3 rd	15(36.5)
4 th	9(22)
<i>Bromhidrosis resolved after finishing all sessions (six)</i>	
Yes	39(95.1)
No	2(4.9)

As shown in Table 5, there is no statistically significant association between the type of laser device used for hair removal and the incidence of bromhidrosis. Thus, both the Candela and DEKA laser hair removal devices show similar rates of bromhidrosis among their users. Therefore, the type of laser device is unlikely to have a major impact on the incidence of axillary bromhidrosis.

Table 5: Association between axillary bromhidrosis and laser devices used

Laser Hair Removal Device	Axillary Bromhidrosis		Total (n=184)	p-value
	Yes (n= 41)	No (n= 143)		
Candela	25(24.8)	76(75.2)	101(54.9)	0.374
DEKA	16(19.3)	67(80.7)	83 (45.1)	

Results are presented as frequency and percentage.

Logistic regression analysis was applied (Table 6) using incidence of axillary bromhidrosis following laser hair removal as the dependent variable. Two factors were found to be important independent risk factors for the occurrence of axillary bromhidrosis following laser hair removal. These factors were obesity (OR= 2.55 with 95% CI: 1.61 to 4.44) and Fitzpatrick skin type II (OR= 3.27 with 95% CI: 1.89 to 6.41), as the occurrence of axillary bromhidrosis was observed in 5/20 (25%) of participants with type I skin, 18/31 (58.1%) with type II skin, 11/77 (14.3%) with type III skin, and 7/56 (12.5%) with type IV.

Table 6: Logistic regression analysis of possible risk factors for incidence of axillary bromhidrosis following laser hair removal

Variable	Odds Ratio (OR)	95% CI for OR
<i>BMI level (Reference is normal BMI)</i>		
Obese	2.55	1.61 – 4.44
<i>Fitzpatrick skin types (Reference type IV)</i>		
II	3.27	1.89 – 6.41

DISCUSSION

With the rise in popularity of laser hair removal and the positive perceptions around it, dermatologists have begun to place a greater emphasis on finding effective

solutions for axillary bromhidrosis following these procedures [7]. One important part of this discussion is addressed in this study, which looks at how often bromhidrosis occurs after laser hair removal in Iraq and what factors contribute to it. This study investigates the potential effects of two laser devices, the Candela and the DEKA, on the occurrence of bromhidrosis in patients receiving hair removal treatments. Our research clarifies the relationship between axillary laser treatments and apocrine sweat gland responses, aiding medical professionals in enhancing patient outcomes and addressing social issues. In this study, the clinical incidence of axillary bromhidrosis is around 22.3%. Lower results were noticed in the Hérou *et al.* retrospective case-control study of patients undergoing laser-assisted axillary hair removal, and they reported that 4% of them had complained of bromhidrosis [22]. Possible explanations for the increased bromhidrosis incidence in our study compared to others include variations in study design, patient characteristics, and diagnostic approach. Our prospective cohort design included multiple standardized assessments over six therapy sessions, which increased the possibility of discovering temporary instances, in contrast to the retrospective analysis by Hérou *et al.* It is also possible that differences in obesity rates, climate, ethnicity, Fitzpatrick skin type distribution, and laser treatment techniques impacted the emergence and diagnosis of bromhidrosis. Moreover, different research used different criteria to define and evaluate bromhidrosis. Hair follicles are anatomically associated with apocrine glands, and apocrine sweat glands are located near sebaceous glands in the axillary fossa, areola, eyelids, pubic, and perineal regions [23]. Axillary odor is the distinctive foul smell of adults. Apocrine sweat, which is both sterile and odorless when it surfaces, is its principal source. But when it reacts with the germs in the air, it makes a very unpleasant smell. The odorless apocrine sweat is broken down into short-chain fatty acids and ammonia by the local bacterial flora, which includes diphtheroid and gram-positive cocci, in the humid and hot axillary region [24]. Laser hair removal may cause axillary bromhidrosis because it may transiently alter the local cutaneous microbiome through thermal effects [25]. If the skin's bacterial balance is shifted by the laser, odor-causing bacteria such as *Staphylococcus epidermidis* and *Micrococcus luteus* can experience an upsurge [26]. The study found a relatively high incidence of bromhidrosis (22.3%), which might be explained by this proposed mechanism. Most cases occurred between the 2nd and 4th treatment sessions, and 95.1% resolved after the treatment course was completed. This suggests that the condition may have been a temporary alteration of the axillary microbial environment rather than a permanent change, which is important to consider. Therefore, it's possible that increasing odor generation during therapy due to repetitive laser exposure momentarily disrupts the local cutaneous ecosystem, which then returns to its

normal state after the treatment is over. Thus, axillary bromhidrosis usually goes away or drastically reduces after a full course of sessions of laser hair removal, as shown in this study. This study concluded that the incidence of axillary bromhidrosis was not significantly correlated with the kind of laser device employed, indicating that the unfavorable effect is likely caused by the biological response to laser-induced thermal exposure rather than the device itself. It is biologically reasonable to expect equal rates of bromhidrosis from the Candela and DEKA systems because they both remove hair by selective photothermolysis. In the current work, two factors were found to be important independent risk factors for the occurrence of axillary bromhidrosis following laser hair removal. These factors were obesity and Fitzpatrick skin type II. Hyperhidrosis, or an increase in perspiration, can occur in obese people because their insulating adipose tissue is able to retain more heat. Unpleasant smells develop when microbes break down this extra perspiration, especially in crevices of the skin [27]. One potential side effect of laser hair removal is irritation or temporary malfunction of the sweat glands. It is more likely that the transient increase in sweating may develop into persistent, bromhidrosis in an obese individual due to the preexisting circumstances (excessive sweating, skin folds) [28]. As a result of their lower melanin level, fair-skinned people with Fitzpatrick type II skin may be more prone to thermal damage, irritation, and laser-induced erythema compared to darker skin types [29]. This heightened sensitivity could make it so that the local skin barrier is more severely damaged after laser treatment. A change in the local bacterial balance and the environment of the skin, caused by a brief rupture of the barrier, could lead to the development of bromhidrosis and the creation of malodor compounds [30].

Study Limitations

Despite its valuable findings, this study had limitations, including the fact that the results may not be generalized because it only involved one private dermatology clinic in Baghdad, and the diagnosis and grading of axillary bromhidrosis were based on subjective judgment of odor and clinical examination. Both the diagnosis and severity grading of bromhidrosis are susceptible to classification bias due to the subjective nature of body odor perception, and the risk of residual confounding persists even after accounting for several demographic and clinical variables. Some confounding variables were not collected or adjusted for, including dietary habits, psychological stress, environmental factors (such as temperature and humidity), thorough hormone profiles, and small differences in personal hygiene practices. Lastly, given the subjective nature of odor perception and the lack of a centimeter-based prospective record of the exact observer-to-patient assessment distance, it is not possible to rule out the possibility of measurement variability.

Conclusion

According to this longitudinal cohort study, axillary bromhidrosis appears to be a relatively common but usually transient adverse effect after axillary laser hair removal, which usually manifests between the second and fourth treatment sessions. The overwhelming majority of cases reported that it's resolved after the six sessions, suggesting that it is typically temporary. Important patient-related characteristics that contribute to vulnerability include obesity and Fitzpatrick skin type II. Although laser hair removal is generally safe and successful, certain individuals, especially those at higher risk, may experience bromhidrosis, a condition that can be treated. Larger, multicenter studies with larger sample sizes are recommended to evaluate incidence and risk factors, use objective tools for odor assessment to reduce subjectivity, and have longer follow-up periods to assess persistence or recurrence of bromhidrosis. Furthermore, routine assessment of BMI, skin type, and any pre-existing axillary odor before treatment is considered.

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Conflict of interests

The authors declared no conflict of interest.

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Data sharing statement

The data that supports the findings of this study are available from the corresponding author upon a reasonable request

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