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Association of sun exposure, hormonal factors, and cosmetic use with melasma: An observational study in urban Indian women.

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Abstract

Background:

Melasma is a common acquired hypermelanosis characterized by irregular brown macules, predominantly affecting women with darker skin types.

Objectives:

To evaluate the association of sun exposure, hormonal factors, and cosmetic use with the clinical patterns and severity of melasma among urban Indian women.

Methods:

A cross-sectional observational study was conducted among **100 women** clinically diagnosed with melasma attending a tertiary dermatology outpatient clinic in urban India. Data on demographic profile, duration of sun exposure, hormonal history (pregnancy, oral contraceptive use), and cosmetic usage were collected using a structured questionnaire. Clinical evaluation included pattern classification and severity assessment using the **Modified Melasma Area and Severity Index (mMASI)**. Statistical significance of associations was analyzed using the chi-square test, with **$p < 0.05$** considered significant.

Results:

The mean age of participants was 34.8 ± 6.7 years, with the majority in the 30–40-year group (58%). The malar pattern (52%) was most frequent, followed by centrofacial (38%) and mandibular (10%) types. Moderate-to-severe melasma was noted in 54% of women. Significant associations were found with sun exposure >2 hours/day ($p < 0.01$), hormonal influences including pregnancy and OCP use ($p = 0.02$), and regular cosmetic use ($p = 0.03$). Family history of melasma was observed in 34% of participants, predominantly among those with Fitzpatrick skin type IV.

Conclusion:

Melasma among Indian women shows a clear association with prolonged sun exposure, hormonal influences, and regular cosmetic use. The predominance of malar and centrofacial patterns, particularly in women with Fitzpatrick skin type IV, highlights the combined impact of environmental triggers and genetic predisposition.

Recommendations:

Dermatologists should incorporate counseling on UV protection, screening for hormonal triggers, and guidance on safe cosmetic practices into routine management protocols for melasma. Longitudinal studies are recommended to assess the long-term impact of behavioral modification and hormonal regulation on melasma recurrence.

Keywords: *Melasma, Sun exposure, Hormonal factors, Oral contraceptives, Cosmetic use, Urban Indian women, Photoprotection, mMASI score.*

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Introduction

Melasma is a chronic, acquired disorder of hyperpigmentation characterized by symmetrical brownish macules and patches, most commonly distributed over the face. It predominantly affects women, particularly those with darker skin phototypes, and significantly impacts

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psychosocial well-being and quality of life [1,2]. The condition is especially prevalent in tropical and subtropical regions, such as India, where high ultraviolet (UV) exposure and hormonal fluctuations play critical etiologic roles [3]. Although benign, its recurrent nature and therapeutic resistance often result in emotional distress and reduced self-esteem.

The pathogenesis of melasma is multifactorial, involving intricate interactions among genetic predisposition, UV radiation, hormonal factors, and exposure to cosmetics or photosensitizing agents [1–4]. Prolonged sun exposure remains a key environmental trigger, as UV radiation induces oxidative stress, upregulates melanogenic enzymes, and increases melanocyte activity, thereby enhancing pigmentation [2]. Hormonal influences, particularly pregnancy and oral contraceptive pill (OCP) use, contribute through elevated estrogen and melanocyte-stimulating hormone levels, which amplify melanin synthesis and pigment deposition [4,5]. Furthermore, the unregulated use of fairness creams, bleaching agents, and cosmetic products containing fragrances or corticosteroids has been shown to aggravate or precipitate melasma, especially among women with underlying genetic susceptibility [5].

Urban Indian women face increased exposure to these precipitating factors due to changing occupational patterns, environmental pollution, and cosmetic use behaviors. Despite melasma's high prevalence, there is a paucity of Indian data examining the combined influence of sun exposure, hormonal variations, and cosmetic practices on disease severity and pattern distribution. Understanding these associations is crucial for formulating preventive strategies, individualized management protocols, and evidence-based counseling tailored to darker skin types in tropical climates.

Hence, the present observational study was undertaken to evaluate the relationship between sun exposure, hormonal factors, and cosmetic use with the clinical pattern and severity of melasma among urban Indian women. The study aims to provide evidence-based insights into modifiable risk factors that could help in designing comprehensive prevention and management strategies tailored to Indian skin types.

Methodology

Study Design and Setting

This was a cross-sectional observational study conducted in the Department of Dermatology, Government Medical College (GMC), Nalgonda, Telangana, India, over a period of nine months, from September 2024 to May 2025. The institution serves as a tertiary-care referral center catering to both urban and peri-urban populations of Nalgonda district, providing a representative sample of women exposed to diverse environmental and lifestyle factors.

Study Population and Sample Size

A total of 100 female participants clinically diagnosed with melasma were enrolled consecutively from the outpatient dermatology clinic. The sample size was determined based on the average monthly patient load and feasibility during the study period. Previous Indian studies evaluating melasma-associated factors have typically included 80–120 participants, which provided adequate power for chi-square–based association testing. In alignment with these methodological standards and considering the expected distribution of key variables, a sample size of 100 was deemed sufficient to obtain reliable estimates within the available resources and study duration.

Inclusion Criteria

Female patients aged 20 to 55 years.

Clinically diagnosed cases of melasma confirmed by dermatological examination.

Residents of urban or semi-urban areas of Nalgonda district.

Willingness to provide informed written consent.

Exclusion Criteria

Patients with other pigmentary disorders (e.g., post-inflammatory hyperpigmentation, Addison's disease).

Those on treatment for melasma within the last three months.

Pregnant or lactating women at the time of study participation.

Individuals with systemic illnesses such as thyroid disorders, polycystic ovarian syndrome (PCOS), or hepatic disease.

Data Collection and Assessment Tools

Each participant was interviewed using a structured questionnaire to obtain demographic details (age, marital status, occupation, and skin phototype), along with data on sun exposure, hormonal history, and cosmetic use.

Sun exposure was recorded as average daily duration (<1 hour, 1–2 hours, >2 hours).

Hormonal factors included pregnancy-related onset, worsening during pregnancy, and use of oral contraceptive pills (OCPs).

Cosmetic exposure assessed frequency, type of product (fairness creams, bleaching agents, makeup), and any adverse skin reactions.

Clinical evaluation was performed under natural daylight and categorized into malar, centrofacial, and mandibular patterns. The Modified Melasma Area and Severity Index (mMASI) was used to grade disease severity as mild, moderate, or severe.

Efforts to Minimize Bias

Several steps were taken to reduce potential biases during the study.

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Selection bias was minimized by enrolling consecutive women meeting the inclusion criteria from a uniform outpatient setting.
Information bias was controlled by using a structured, pre-tested questionnaire administered by the same investigator to ensure consistency in data collection.
Observer bias was reduced by conducting all clinical examinations under similar lighting conditions and applying standardized mMASI scoring criteria.
Recall bias related to sun exposure and cosmetic use was minimized by restricting questions to recent, clearly defined time periods.
Confounding was partially controlled by analyzing associations within relevant subgroups and focusing on major known risk factors such as sun exposure duration, hormonal history, and cosmetic products.

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee of Government Medical College, Nalgonda. Written informed consent was taken from all participants after explaining the purpose and confidentiality of the study.

Statistical Analysis

Data were entered and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were expressed as mean ± standard deviation (SD) and percentages. The Chi-square test was applied to assess associations between categorical variables such as sun exposure, hormonal factors, and cosmetic use with melasma severity. A p-value < 0.05 was considered statistically significant.

Results

Participant Flow

During the study period, 112 women presenting with facial pigmentation were screened for eligibility. Of these, 104 met the preliminary clinical suspicion of melasma and underwent detailed dermatological examination. Four patients were excluded (two due to concurrent pigmentary disorders and two due to recent melasma treatment within the past three months). The remaining 100 women fulfilled all eligibility criteria and were enrolled consecutively. All 100 participants completed the clinical assessment and were included in the final analysis, with no loss to follow-up or missing data (Figure 1).

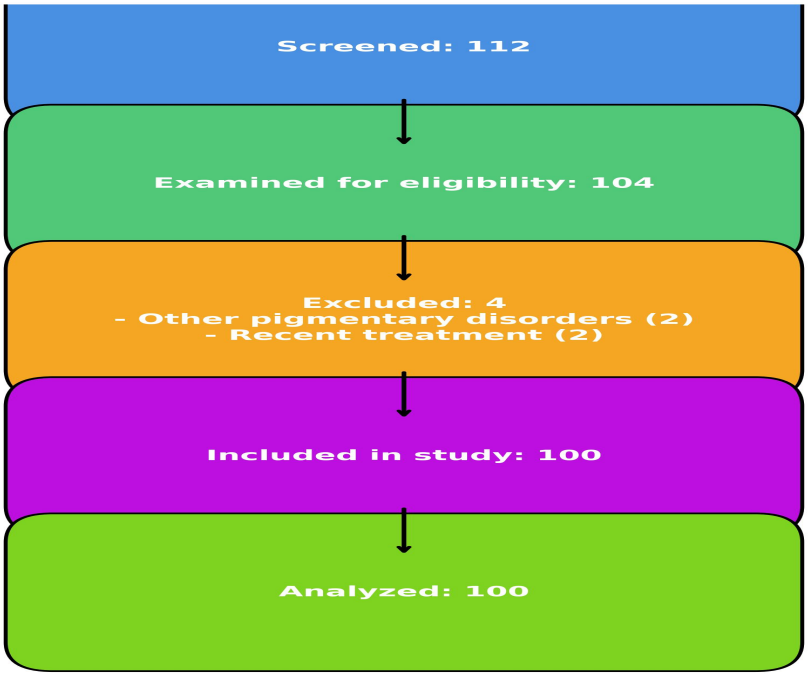

Figure No. 1 Participant Flow Diagram

A total of 100 urban Indian women clinically diagnosed with melasma were included in the present observational study. The demographic characteristics of the study participants are summarized in Table 1. The age of participants ranged from 21 to 55 years, with a mean age of 34.8 ± 6.7 years. The majority belonged to the 30–40-year age group (58%), followed by 20–29 years (24%) and above 40 years (18%). Most participants were married (72%), and a significant proportion were homemakers (64%). Based on Fitzpatrick skin phototypes, Type IV was predominant (66%), while Type III and Type V were observed in 28% and 6% of participants, respectively.

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Table 1. Demographic Characteristics of Study Participants (n = 100)

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	20–29	24	24.0
	30–40	58	58.0
	>40	18	18.0
Mean age ± SD (years)	—	34.8 ± 6.7	—
Marital status	Married	72	72.0
	Unmarried	28	28.0
Occupation	Homemaker	64	64.0
	Working professional	36	36.0
Skin type (Fitzpatrick)	Type III	28	28.0
	Type IV	66	66.0
	Type V	6	6.0

The clinical distribution and severity pattern of melasma are presented in Table 2. The malar pattern was most common, observed in 52% of cases, followed by centrofacial (38%) and mandibular (10%) types. According to the Modified Melasma Area and Severity Index (mMASI), 46% of patients had mild melasma, 38% moderate, and 16% severe pigmentation. A positive family history of melasma was reported by 34% of participants, suggesting a possible genetic predisposition.

Table 2. Clinical Profile of Melasma

Variable	Category	Frequency (n)	Percentage (%)
Clinical pattern	Malar	52	52.0
	Centrofacial	38	38.0
	Mandibular	10	10.0
mMASI severity	Mild	46	46.0
	Moderate	38	38.0
	Severe	16	16.0
Family history of melasma	Present	34	34.0
	Absent	66	66.0

The association of environmental and hormonal factors with melasma is detailed in Table 3. A majority (68%) of women reported daily sun exposure exceeding two hours, while only 12% had less than one hour of exposure. This correlation between prolonged sun exposure and higher mMASI scores was statistically significant ($p < 0.01$). Regular use of sunscreen was reported by 58%, whereas 42% either used it occasionally or not at all.

Table 3. Association of Environmental and Hormonal Factors

Factor	Category	Frequency (n)	Percentage (%)	Statistical Association (p-value)
Daily sun exposure	<1 hour	12	12.0	
	1–2 hours	20	20.0	
	>2 hours	68	68.0	**p < 0.01**
Sunscreen use	Regular	58	58.0	
	Occasional/None	42	42.0	
Pregnancy-related melasma	Present	47	47.0	**p = 0.02**
OCP-related onset	Present	22	22.0	

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Total hormonal influence (pregnancy + OCP)	—	56	56.0	**p = 0.02**

Regarding hormonal influences, 47% of participants developed melasma during pregnancy, and 22% reported onset following oral contraceptive pill (OCP) use. When combined, 56% of the cohort had a positive hormonal influence, which showed a significant association with the presence of moderate-to-severe melasma (p = 0.02).

Details regarding cosmetic use are shown in Table 4. Regular use of cosmetic products was reported by 74% of the participants, among whom fairness creams (40%) were the most frequently used, followed by bleaching/whitening agents (18%) and makeup products (16%). About 29% of cosmetic users reported skin irritation or exacerbation of pigmentation following product use. Statistical analysis revealed a significant association between cosmetic use and melasma (p = 0.03). The majority of cosmetic users demonstrated facial (malar/centrofacial) pattern predominance (70%).

Table 4. Cosmetic Use and Its Association with Melasma

Variable	Category	Frequency (n)	Percentage (%)	p-value
Regular cosmetic use	Yes	74	74.0	**0.03**
Type of product used	Fairness creams	40	40.0	
	Bleaching/whitening agents	18	18.0	
	Makeup products	16	16.0	
Adverse skin reaction after use	Present	29	29.0	—
Pattern predominance among cosmetic users	Facial (malar / centrofacial)	70	70.0	—

The association between sun exposure and melasma severity was statistically significant ($\chi^2 = 14.82$, df = 2, $p < 0.01$). Hormonal influences, including pregnancy-related onset and OCP use, also showed a significant association with severity ($\chi^2 = 7.63$, df = 1, p = 0.02). Cosmetic use was similarly associated with melasma pattern and severity ($\chi^2 = 4.71$, df = 1, p = 0.03). These findings indicate that environmental, hormonal, and cosmetic factors contribute meaningfully to disease severity.

Discussion

The present study analyzed the influence of sun exposure, hormonal factors, and cosmetic use on melasma among urban Indian women, highlighting that environmental and endocrine triggers act synergistically on genetically predisposed skin to produce persistent pigmentation. The findings corroborate emerging international evidence regarding the multifactorial nature of melasma [6–12].

A large proportion of participants belonged to the 30–40-year age group, aligning with global observations that melasma predominantly affects women in their reproductive years [12]. The predominance of the malar and centrofacial patterns in this study is consistent with previous epidemiological reports [12]. The high occurrence of Fitzpatrick skin type IV further emphasizes the increased vulnerability of intermediate skin tones to UV-induced melanogenesis and post-inflammatory pigmentation [7].

Ultraviolet exposure emerged as a critical aggravating factor. The findings of this study parallel earlier evidence showing that photoprotection, particularly with iron oxide–enriched or tinted sunscreens, significantly reduces relapse rates in patients with melasma, especially those with darker phototypes [7,8]. The significant association between longer daily sun exposure and higher mMASI scores underscores UV radiation as a major modifiable determinant in melasma pathophysiology.

Hormonal influences—specifically pregnancy and oral contraceptive use—were significantly associated with moderate-to-severe disease, supporting the endocrine basis of melasma pathogenesis described in previous mechanistic studies [6,11]. Estrogen and progesterone are known to upregulate melanocortin-1 receptors and increase tyrosinase expression, explaining the increased pigment synthesis during pregnancy and hormonal therapy.

Cosmetic use was another important contributing factor, with 74% of participants reporting regular use of fairness or bleaching creams. This observation aligns with previous studies reporting unsafe hydroquinone concentrations and

inadequate awareness regarding harmful cosmetic ingredients in women using skin-lightening products [6]. Continuous application of such formulations can aggravate epidermal melanosis, highlighting the dermatological risks associated with unregulated cosmetic usage.

The Modified Melasma Area and Severity Index (mMASI) proved to be a reliable clinical tool in this study, consistent with reported validation data demonstrating its reliability and sensitivity in quantifying melasma severity [9,10]. The use of this standardized scoring system enhances comparability with existing literature.

Overall, the findings of this study support a multifaceted understanding of melasma, wherein genetic susceptibility, environmental exposure, and hormonal influences interact to shape clinical severity [11]. This complex interplay highlights the importance of individualized assessment in routine clinical practice.

Finally, in agreement with earlier cross-sectional evidence, this study reinforces that sun exposure, hormonal imbalance, and cosmetic misuse function as interconnected risk factors that significantly affect melasma severity in women with darker skin phototypes [12]. These insights strengthen the evidence base for improved preventive strategies and targeted patient counseling in Indian dermatology settings.

Generalizability

The findings of this study are generalizable to urban Indian women of reproductive age with similar socio-environmental exposure patterns, particularly those residing in tropical climates. However, variations in lifestyle, sun protection behavior, and cosmetic use practices across regions may influence applicability, warranting caution when extrapolating results to rural or non-Indian populations.

Conclusion

Melasma among urban Indian women is a multifactorial pigmentary disorder significantly influenced by prolonged sun exposure, hormonal fluctuations, and cosmetic use. The predominance of the malar and centrofacial patterns, particularly in women with Fitzpatrick skin type IV, underscores the role of both environmental and genetic predisposition. Regular sunscreen application, avoidance of harsh or bleaching cosmetics, and hormonal assessment in susceptible women are essential preventive strategies. Dermatologists should focus on patient education, photoprotection, and counseling as integral components of management. Future multicentric, longitudinal studies integrating hormonal profiling and lifestyle interventions are recommended to establish causal pathways and improve preventive and therapeutic outcomes in melasma management.

Limitations

The study was limited by its cross-sectional design, which restricts assessment of temporal relationships between risk factors and disease progression. Hormonal assays and biochemical evaluations were not performed to quantify endocrine influences. Self-reported data on sun exposure and cosmetic use could introduce recall bias. The sample size, though adequate for preliminary analysis, restricts subgroup comparisons. Additionally, the study population represented a single urban tertiary-care setting, limiting external validity to broader regional populations.

Recommendations

Dermatologists should prioritize comprehensive patient education focusing on consistent photoprotection, use of broad-spectrum sunscreens, and adoption of protective clothing and shade-seeking behavior. Counseling should include screening for hormonal factors, particularly in women with pregnancy-related or contraceptive-induced melasma. Public awareness programs are essential to discourage the indiscriminate use of fairness creams and bleaching agents. Regulatory authorities should monitor and restrict harmful cosmetic ingredients. Incorporating preventive counseling and lifestyle modification into routine dermatological practice can significantly reduce the melasma burden. Future multicentric longitudinal studies evaluating the effectiveness of these interventions are strongly recommended to guide evidence-based clinical protocols.

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Abbreviations

UV – Ultraviolet
OCP – Oral Contraceptive Pill
mMASI – Modified Melasma Area and Severity Index
SPSS – Statistical Package for the Social Sciences
GMC – Government Medical College
PCOS – Polycystic Ovarian Syndrome
SD – Standard Deviation

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The study had no funding.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

RM-Concept and design of the study, results interpretation, review of literature, and preparation of the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript. SVK-Design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript, revision of the manuscript. PM-Review of literature and preparing the first draft of the manuscript. Statistical analysis and interpretation.

Data availability

Data available on request

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