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Determination of the socio-emotional consequences of visible pigmentary alterations using neutrosophic OWA-TOPSIS.

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Abstract

This study addresses the socioemotional consequences of visible pigmentary disorders such as vitiligo and melasma, a problem that profoundly affects individuals' quality of life. The relevance of this research lies in the growing need to understand how these dermatological conditions influence self-esteem, social interactions, and psychological well-being, especially in diverse cultural contexts. Although existing literature has explored these impacts, it lacks approaches that integrate the uncertainty and subjectivity inherent in human experiences. To fill this gap, a PRISMA-based systematic review was conducted, analyzing articles from PubMed, Scielo, and Scopus (2015–2025), and the neutrosophic OWA-TOPSIS method was employed, which combines weighted aggregation and prioritization to manage ambiguous data. The findings highlight low self-esteem and social stigma as the most significant consequences, along with anxiety and depression also being prevalent. This research contributes by introducing an innovative methodology that captures the uncertainty in psychosocial data, offering a solid basis for designing effective psychosocial interventions. It also provides practical tools for healthcare professionals, promoting a comprehensive approach to visible pigmentary disorders that transcends the dermatological dimension.

Keywords: Pigmentary Disorders, Socioemotional Consequences, Systematic Review, OWA-TOPSIS Neutrosophic, Self-Esteem, Social Stigma, Anxiety, PRISMA, Uncertainty.

1. Introduction.

Visible pigmentary disorders (VPDs), such as vitiligo, melasma, and hyperpigmented spots, affect not only the physical appearance but also the socioemotional well-being of those who suffer from them, a topic of increasing relevance in dermatological and psychosocial research. These conditions, visible in exposed areas such as the face or hands, have a profound impact on quality of life, influencing self-esteem, social interactions, and mental health [1]. The importance of studying the socioemotional consequences lies in the need to develop comprehensive interventions that transcend dermatological treatment and address the associated stigma and psychological distress [2].

This article focuses on determining such consequences through a systematic review, employing an innovative approach based on the neutrosophic OWA-TOPSIS method to prioritize findings in contexts of uncertainty. Over the past decades, the study of PVAs has evolved from an exclusively medical approach to a more holistic perspective , including their psychosocial implications. Initially, research focused on treatments to even out skin tone, but in recent years, there has been an emerging interest in understanding how these conditions affect self-perception and social dynamics [3]. In diverse cultural contexts, where beauty standards vary, PVAs can exacerbate social rejection and discrimination, especially in regions with a high value on physical appearance [4]. This paradigm shift underscores the need to address not only clinical aspects but also patients' subjective experiences.

The central problem this study addresses is the lack of a systematic analysis that prioritizes the socio-emotional consequences of VCTs, considering the uncertainty inherent in human experiences. Although previous studies have identified effects such as low self-esteem, social stigma, and anxiety, methodological and cultural variability limits their comparability [5]. Furthermore, traditional approaches fail to capture the ambiguity of psychosocial data, leaving a key question unanswered: how can the socio-emotional consequences of VCTs be robustly identified and prioritized in a context of high indeterminacy? To answer this question, the article proposes a systematic review based on the PRISMA methodology, analyzing articles from PubMed, Scielo, and Scopus published between 2015 and 2025. The integration of the neutrosophic OWA-TOPSIS method allows managing subjectivity and uncertainty, offering a rigorous classification of socio-emotional consequences. This approach combines ordered weighted aggregation (OWA) with the TOPSIS technique, adapted to the neutrosophic framework, which considers truth, falsity, and indeterminacy in data analysis.

Historically, VPAs have been stigmatized in many cultures, associated with disease or imperfections, which exacerbates their emotional impact. In the 20th century, vitiligo, for example, was frequently misinterpreted as a contagious condition, generating social exclusion [6]. Today, thanks to advances in education and dermatology, its nature is better understood, but psychosocial barriers persist. Globalization and social media have amplified the pressure to conform to beauty ideals, intensifying the discomfort of those living with VPA [7]. This context highlights the urgency of research that addresses these dynamics. The magnitude of the problem is evident in the prevalence of VPAs and their psychological effects. Vitiligo affects 0.5–2% of the world's population, while melasma is common in women of reproductive age, especially in Latin America and Asia [1], [3].

Studies report that up to 75% of patients with VCT experience social stigma, and more than 60% present with symptoms of anxiety or depression [5]. However, the lack of a unified approach to analyze these consequences limits the development of effective interventions, which this study seeks to address. The use of the neutrosophic framework in this work responds to the need for a method that captures the complexity of socioemotional experiences. By prioritizing consequences using neutrosophic OWA-TOPSIS, an analysis is guaranteed that not only identifies the most relevant effects, but also considers cultural and methodological ambiguity. This innovative approach positions the study as a significant contribution to both Dermatology and Social Psychology, offering diagnostic tools for health professionals.

The objectives of this study are: 1) to identify the socioemotional consequences of VCT through a systematic review of recent literature, and 2) to prioritize these consequences using the neutrosophic OWA-TOPSIS method, providing a solid foundation for psychosocial interventions. These objectives are aligned with the research question and seek to generate knowledge that combines scientific rigor with practical applicability in clinical and social contexts.

2. Preliminaries.

Visible pigmentary disorders represent a set of dermatological conditions that transcend the purely medical realm, representing complex phenomena with profound implications for the psychosocial experience of those who suffer from them. These cutaneous manifestations, which range from localized hyperpigmentation to extensive depigmentation disorders, not only alter an individual's physical appearance but can also trigger a cascade of consequences that significantly impact their emotional well-being, self-esteem, and social functioning.

A comprehensive understanding of these conditions requires a multidimensional analysis that examines both the clinical aspects of pigmentation disorders and their psychological and social ramifications. In this context, social stigma emerges as a central element mediating the relationship between the visible manifestation of the condition and the psychological suffering experienced by the patient. This phenomenon, characterized by discriminatory attitudes, prejudice, and social exclusion, constitutes a determining factor in the quality of life of those affected.

This theoretical framework addresses these fundamental elements, establishing the conceptual foundations necessary to understand the complex interaction between visible pigmentary alterations, their socioemotional consequences, and the mechanisms of social stigmatization that perpetuate the suffering of those living with these conditions.

2.1. Visible Pigmentary Changes (APV)

Visible pigmentary disorders (VPA) are defined as dermatological conditions that cause changes in skin color due to dysfunctions in the production, distribution, or degradation of melanin. Among the most prevalent are vitiligo, characterized by depigmented patches; melasma, which generates facial hyperpigmentation; and post-inflammatory spots, associated with trauma or inflammatory processes [8]. These conditions, when manifested in exposed areas such as the face, hands, or arms, transcend the clinical scope, generating a significant impact on the perception of body image and the social interactions of those affected. Vitiligo affects approximately 0.5–2% of the world's population, while melasma predominates in women of reproductive age, particularly in regions with high sun exposure, such as Latin America and Asia [9]. Despite their aesthetic dimension, PVAs carry a significant psychosocial burden, including low self-esteem, stigmatization, and emotional distress, highlighting the urgency of exploring their consequences beyond dermatological treatments.

From a theoretical perspective, VPAs constitute a sociocultural phenomenon that interacts with beauty norms and appearance standards. In many societies, uniform skin is associated with health, youth, and attractiveness, making VPAs a marker of difference that can trigger social rejection [10]. Within the framework of social identity theory, these conditions can alter individuals' sense of belonging, affecting their self-image and psychological well-being [11]. Furthermore, VPAs have relevant clinical implications, since their visibility influences treatment adherence and overall quality of life. Studies have reported that up to 75% of patients with vitiligo experience a negative impact on their social life due to the appearance of the lesions, underscoring the need for a comprehensive approach [10].

To support the VPAs, a systematic search was conducted in PubMed, Scielo, and Scopus databases, covering articles published between 2015 and 2025, in Spanish and English. Search terms included combinations such as "visible pigmentation disorders" OR "vitiligo" OR "melasma" OR "post-inflammatory hyperpigmentation" AND ("psychosocial impact" OR "quality of life"), adapted with Boolean operators. In PubMed, approximately 1,200 articles were identified, with a predominant focus on vitiligo (~600) and melasma (~400), highlighting systematic reviews on quality of life [9] and clinical studies on triggering factors [11]. In Scielo, approximately 150 articles were found, mostly from Latin America, that address the psychosocial impact of melasma in women [8]. Scopus provided approximately 1,800 studies, including interdisciplinary research combining Dermatology and Social Psychology [10]. The findings confirm that the visibility of lesions, especially in facial areas, correlates with greater psychosocial impact, and that factors such as gender, sun exposure, and genetics modulate the presentation of PVA.

2.2. Socio-emotional consequences

The socio-emotional consequences of visible pigmentation disorders encompass the effects derived from these conditions , including low self-esteem, social stigma, anxiety, depression, and social isolation [12]. These impacts reflect both the individual's internal perception, such as negative self-image, and external dynamics, such as rejection or discrimination in social and work environments. Low self-esteem, for example, frequently arises from the internalization of beauty standards that value uniform skin, while anxiety and depression can be intensified by constant concern about appearance [13]. Social isolation, on the other hand, results from the avoidance of interactions to minimize the risk of derogatory comments or prying eyes [12]. These effects not only compromise emotional well-being, but also influence the overall quality of life and adherence to dermatological treatments.

Theoretically, socioemotional consequences can be analyzed from the perspective of social identity theory, which postulates that self-esteem depends on acceptance within a social group [14]. VCTs, by marking individuals as "different," can fracture this belonging, generating feelings of exclusion. Likewise, the psychosocial stress model suggests that experiences of stigma and discrimination act as chronic stressors, triggering symptoms of anxiety and depression. The relevance of studying these consequences lies in their cross-cutting impact: patients with VCTs not only face clinical challenges, but also psychological and social barriers that require comprehensive interventions. For example, studies have indicated that up to 60% of patients with melasma report depressive symptoms, and more than 70% of individuals with vitiligo experience social stigma [15].

The literary search A search of these consequences was conducted in PubMed, Scielo, and Scopus (2015–2025), using terms such as "socioemotional consequences" OR "psychosocial impact" OR "self-esteem" OR "anxiety" OR "depression" AND ("vitiligo" OR "melasma" OR "visible pigmentation disorders"). In PubMed, nearly 800 articles were identified, with systematic reviews highlighting the psychological impact of VCTs [15] and quantitative studies using scales such as the Dermatology Life Quality Index (DLQI) [14]. Scielo provided approximately 100 studies, mainly from Latin America, with a qualitative focus on narratives of melasma patients. Scopus provided approximately 1,200 articles, including cross-cultural research on anxiety and depression in vitiligo patients [4]. The results confirm that low self-esteem and social stigma are the most prevalent consequences, with variations according to gender (greater impact on women) and cultural context (greater stigma in Asia and Latin America).

2.3. Social Stigma

Social stigma is defined as the devaluation of an individual for possessing an attribute considered undesirable, such as vitiligo, which generates discrimination, exclusion, or stereotypes in social interactions [16]. In the context of vitiligo, stigma arises from the visibility of lesions, which are perceived as abnormal or wrongly associated with contagious diseases, especially in the case of vitiligo [17]. This phenomenon not only affects interpersonal relationships but also contributes to the development of other socio-emotional consequences, such as anxiety and social isolation. The intensity of stigma varies according to the cultural context: in societies that value skin uniformity, such as in Asia or Latin America, patients with vitiligo face greater rejection than in more diverse cultures.

Theoretically, stigma can be analyzed using Link and Phelan's model, which describes how stigma results from four processes: labeling, stereotyping, separation, and loss of status [18]. Applied to VCT, labeling occurs when visible lesions are interpreted as defects, while stereotyping associates these conditions with negative ideas, such as poor hygiene or illness. Separation manifests as social rejection, and loss of status as exclusion from work or personal opportunities. The relevance of this concept lies in its ability to explain the social dynamics that aggravate the impact of VCT, justifying the need for targeted psychosocial interventions.

The PubMed, Scielo, and Scopus search (2015–2025) used terms such as “social stigma” OR “discrimination” AND (“vitiligo” OR “melasma” OR “visible pigmentation disorders”). PubMed returned approximately 500 articles, with qualitative studies exploring experiences of stigma in patients with vitiligo [17] and quantitative studies measuring its impact on quality of life [19]. Scielo identified ~80 articles, many from Brazil and Mexico, addressing stigma in women with melasma. Scopus contributed ~700 studies, highlighting cross-cultural research comparing stigma in different regions [20]. Findings indicate that stigma is a prevalent consequence, affecting 70–80% of patients with VCT, with a greater impact on women and in culturally homogeneous contexts.

2.4. Single-valued Neutrosophic Set.

This section provides a brief overview of the fundamental principles related to **Single Valued Neutrosophic Sets (** SVNS), covering definitions, operating principles, and metrics for measuring distances.

Definition 1. Let x be an element in a finite set, X. A single-valued neutrosophic set (SVNS), P, in X can be defined as in (1):

$$P = \{ x, T_P(x), I_P(x), F_P(x) | x \in X\}, \quad (1)$$

where the truth membership function, $T_P(x)$,the indeterminacy membership function $I_P(x)$, and the falsehood membership function $F_P(x)$clearly adhere to condition (2):

$$0 \leq T_P(x), I_P(x), F_P(x) \leq 1; \;\; 0 \leq T_P(x) + I_P(x) + F_P(x) \leq 3 \quad (2)$$

For a SVNS, P in X, we call the triplet $\left(T_P(x), I_P(x), F_P(x)\right)$ its single-valued neutrosophic value (SVNV), denoted simply $x = (T_x, I_x, F_x)$ for computational convenience.

Definition 2. Leave $x = (T_x, I_x, F_x)$yy $= (T_y, I_y, F_y)$ let there be two SVNV. Then

1) $x \oplus y = (T_x + T_y - T_x * T_y, I_x * T_y, F_x * F_y)$;

2) $\lambda * x = (1 - (1 - T_x)\lambda, (I_x)\lambda, (F_x)\lambda), \lambda > 0$;

3) $x^\lambda = ((T_x)\lambda, 1 - (1 - I_x)\lambda, 1 - (1 - F_x)\lambda), \lambda > 0$

The linguistic set

Let l be $S = \{s_\alpha | \alpha = 1, \dots, l\}$ a finite, totally ordered discrete term with odd value, where s_α denotes a possible value for a linguistic variable. For example, if $l = 7$, then a set of linguistic terms S could be described as follows:

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7\} = \{extremely\ poor, very\ poor, poor, fair, good, very\ good, extremely\ good\}. \quad (3)$$

Any linguistic variable, s_iy s_j, in S must satisfy the following rules:

1) $Neg(s_i) = s_{-i}$;

2) $s_i \leq s_j \Leftrightarrow i \leq j$;

3) $\max(s_i, s_j) = s_j,\ if\ i \leq j$;

4) $\min(s_i, s_j) = s_i,\ if\ i \leq j$.

To avoid information loss during an aggregation process, the discrete set of terms S will be extended to a continuous set of terms. $S = \{s_\alpha | \alpha \in R\}$.Any two linguistic variables $s_\alpha, s_\beta \in S$satisfy the following operational laws [21,22] :

1) $s_\alpha \oplus s_\beta = s_\alpha + \beta$;

2) $\mu s_\alpha = s_{\mu\alpha}, \mu \geq 0$;

3) $\frac{s_\alpha}{s_\beta} = s_{\frac{\alpha}{\beta}}$

Definition 3 [23] Given X, a finite set of universes, a SVNLS, P, in X can be defined as in (4):

$$P = \{\langle x, [s_{\theta(x)}, (T_P(x), I_P(x), F_P(x))]\rangle | x \in X\} \quad (4)$$

where $s_{\theta(x)} \in \bar{S}$, the truth membership function $T_P(x)$, the indeterminacy membership function, $I_P(x)$and the falsehood membership function $F_P(x)$satisfy condition (5):

$$0 \leq T_P(x), I_P(x), F_P(x) \leq 1, 0 \leq T_P(x) + I_P(x) + F_P(x) \leq 3. \quad (5)$$

For an SVNLS, P, in X, the 4-tuple $\langle s_{\theta(x)}, (T_P(x), I_P(x), F_P(x))\rangle$is known as the Single-Valued Neutrosophic Linguistic Set (SVNLN), conveniently denoted $x = s_{\theta(x)}, (T_x, I_x, F_x)$for computational purposes.

Definition 4 [23] .

Let there be $x_i = \langle s_{\theta(xi)}, (T_{xi}, I_{xi}, F_{xi})\rangle$ $(i = 1, 2)$two SVNLNs. Then

1) $x_1 \oplus x_2 = \langle s_{\theta(x1)} + \theta_{x2}, (T_{x1} + T_{x2} - T_{x1} * T_{x2}, I_{x1} * T_{x2}, F_{x1} * F_{x2})\rangle$

2) $\lambda_{x1} = \langle s_{\lambda\theta(x1)}, (1 - (1 - T_{x1})^\lambda, (I_{x1})^\lambda, (F_{x1})^\lambda)\rangle, \lambda > 0$;

3) $x_1^\lambda = \langle s_{\theta^\lambda(x_1)}, ((T_{x1})^\lambda, 1-(1-I_{x1})^\lambda, 1-(1-F_{x1})^\lambda)\rangle, \lambda > 0.$

Definition 5 [23] . Let there be $x_i = \langle s_{\theta(xi)}, (T_{xi}, I_{xi}, F_{xi})\rangle$ $(i = 1, 2)$ two SVNLNs. Their distance measure is defined as in (6):

$$d(x_1, x_2 v) = \left[|s_{\theta(x1)}T_{x1} - s_{\theta(x2)}T_{x2}|^\mu + |s_{\theta(x1)} I_{x1} - s_{\theta(x2)} I_{x2}|^\mu + |s_{\theta(x1)}F_{x1} - s_{\theta(x2)}F_{x2}|^\mu\right]^{\frac{1}{\mu}} (6)$$

In particular, equation (6) reduces the Hamming distance of SVNLS and the Euclidean distance of SVNLS when $\mu = 1$ and $\mu = 2$, respectively.

2.5 . MADM based on the SVNLOWAD-TOPSIS Method

For a given multi-attribute decision-making problem in SNVL environments, $A = \{A_1, \dots, A_m\}$ denotes a set of discrete feasible alternatives, $C = \{C_1, \dots, C_n\}$represents a set of attributes, and $E = \{e_1, \dots, e_k\}$ is a set of experts (or DMs) with weight vector $\omega = \{\omega_1, \dots, \omega_k\}$T such that $\sum_{i=1}^{n} w_i = 1$ and $0 \le \omega_i \le 1$. Suppose that the attribute weight vector is $s\,v = (v_1, \dots, v_n)^T$, which satisfies $\sum_{i=1}^{n} v_i = 1$ and $v_i \in [0, 1]$. The evaluation, $\alpha_{ij}^{(k)}$given by the expert, $e_{t(t=1,\dots,k)}$ on the alternative, $A_{i(i=1,\dots,m)}$, relative to the attribute, $C_{j(j=1,\dots,n)}$ forms the individual decision matrix as shown in equation (7):

$$D^k = \begin{matrix} & C_1 & \cdots & C_n \\ A_1 & \alpha_{11}^{(k)} & \cdots & \alpha_{1n}^{(k)} \\ \vdots & \vdots & \ddots & \vdots \\ A_n & \alpha_{m1}^{(k)} & \cdots & \alpha_{mn}^{(k)} \end{matrix} \quad (7)$$

where $\alpha_{ij}^k = \langle s_{\theta(\alpha_{ij})}^k, (T_{\alpha_{ij}}^k, I_{\alpha_{ij}}^k, F_{\alpha_{ij}}^k)\rangle$ is represented by a SVNLN, which satisfies $s_{\theta(\alpha ij)}^k \in \bar{S}, T_{\alpha_{ij}}^k, I_{\alpha_{ij}}^k, F_{\alpha_{ij}}^k \in [0,1] and\ 0 \le T_{\alpha_{ij}}^k + I_{\alpha_{ij}}^k + F_{\alpha_{ij}}^k \le 3.$

Geng et al. [24] extended the TOPSIS method to fit the SVNLS scenario, and the procedures of the extended model can be summarized as follows.
Step 1. Normalize the individual decision matrices:
In practical scenarios, MADM problems can encompass both benefit attributes and cost attributes. Let B and S the benefit attribute sets and cost attribute sets, respectively. Therefore, the conversion rules specified in (8) apply:

$$\begin{cases} r_{ij}^{(k)} = \alpha_{ij}^{(k)} = \langle s_{\theta(\alpha_{ij})}^k, (T_{\alpha_{ij}}^k, I_{\alpha_{ij}}^k, F_{\alpha_{ij}}^k)\rangle, & \text{for } j \in B, \\ r_{ij}^{(k)} = \langle s_{l-\theta(\alpha_{ij})}^k, (T_{\alpha_{ij}}^k, I_{\alpha_{ij}}^k, F_{\alpha_{ij}}^k)\rangle, & \text{for } j \in S. \end{cases} \quad (8)$$

Thus, the standardized decision information, $R^k = (r_{ij}^{(k)})_{m\times n}$, is set as in (9):

$$R^k = (r_{ij}^{(k)})_{m\times n} = \begin{pmatrix} r_{11}^{(k)} & \cdots & r_{1n}^{(k)} \\ \vdots & \ddots & \vdots \\ r_{m1}^{(k)} & \cdots & r_{mn}^{(k)} \end{pmatrix} \quad (9)$$

Step 2. Build the collective matrix:
All individual DM reviews are aggregated into a group review:

$$R = (r_{ij})_{m\times n} = \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} \quad (10)$$

Where $r_{ij} = \sum_{k=1}^{t} \omega_k \, r_{ij}^{(k)}$.

Step 3. Set the weighted SVNL decision information:
The weighted SVNL decision matrix , is formed as shown in (11), using the operational laws given in Definition 2 above:

$$Y = (y_{ij})_{m\times n} = \begin{pmatrix} v_1 r_{11} & \cdots & v_n r_{1n} \\ \vdots & \ddots & \vdots \\ v_1 r_{m1} & \cdots & v_n r_{mn} \end{pmatrix} \quad (11)$$

The OWA operator is fundamental in aggregation techniques, widely studied by researchers [24] . Its main advantage lies in organizing arguments and facilitating the integration of experts' attitudes in decision making. Recent research has explored OWA in distance measurement, generating variations of OWAD [23] . Taking advantage of the benefits of OWA, the text proposes a SVNL OWA distance measure (SVNLOWAD). Given the desirable properties of the OWA operator, an SVNL OWA distance measure (SVNLOWAD) is proposed in the following text .

Definition 6. *Let x_j, x_j' $(j = 1, \ldots, n)$ the two collections be SVNLN. If*

$$SVNLOWAD((x_1, x_1'), \ldots, (x_n, x_n')) = \sum_{j=1}^{n} w_j d(x_j, x_j'), \quad (12)$$

Therefore, step 4 of this method can be considered as follows:

Step 4. For each alternative, $A_i$the SVNLOWAD is calculated for the PIS, $A^+$and the NIS A^-, using equation (12):

$$SVNLOWAD(A_i, A^+) = \sum_{j=1}^{n} w_j \, \dot{d}(y_{ij}, y_j^+), i = 1, \ldots, m \quad (13)$$

$$SVNLOWAD(A_i, A^-) = \sum_{j=1}^{n} w_j \, \dot{d}(y_{ij}, y_j^-), i = 1, \ldots, m \quad (14)$$

where $\dot{d}(y_{ij}, y_j^+)$and $\dot{d}(y_{ij}, y_j^-)$are the j -th largest values of $\dot{d}(y_{ij}, y_j^+)$and $\dot{d}(y_{ij}, y_j^-)$, respectively.

Step 5. In the classical TOPSIS approach, the relative closeness coefficient is used to rank the alternatives. However, some researchers have highlighted cases where relative closeness does not achieve the desired objective of simultaneously minimizing the distance from the PIS and maximizing the distance from the NIS. Thus, following an idea proposed in references [25] , a modified relative closeness coefficient, C, is introduced in equations (15)–(17). '(Ai), used to measure the degree to which the alternatives, Ai ( ) = 1,..., m =1,...,), are close to the PIS and also far from the NIS, congruently:

$$C'(A_i) = \frac{SVNLOWAD(A_i, A^-)}{SVNLOWAD_{\max}(A_i, A^-)} - \frac{SVNLOWAD(A_i, A^+)}{SVNLOWAD_{\min}(A_i, A^+)}, \quad (15)$$

where

$$SVNLOWAD_{\max}(A_i, A^-) = \max_{1 \le i \le m} SVNLOWAD(A_i, A^-), \quad (16\ )$$

and

$$SVNLOWAD_{\min}(A_i, A^+) = \min_{1 \le i \le m} SVNLOWAD(A_i, A^+). \quad (17)$$

It is necessary that $C'(A_i) \le 0$ $(i = 1, \ldots, m)$and the larger the value of $C'(A_i)$, the better A_i the alternative. Furthermore, if an alternative A^* satisfies the conditions $SVNLOWAD(A^*, A^-) = SVNLOWAD_{\max}(A^*, A^-)$and $SVNLOWAD(A^*, A^+) = SVNLOWAD_{\min}(A^*, A^+)$, then $C'(A^*) = 0$ and the

alternative $A^*$is the most suitable candidate, since it has the minimum distance to the PIS and the maximum distance to the NIS.
Step 6. Classify and identify the most desirable alternatives based on the decreasing closeness coefficient $C'(A_i)$obtained using Equation (15).

3. Case Studies

This study analyzes the socioemotional consequences of visible pigmentary changes (VPA) in patients treated in specialized dermatology centers. The neutrosophic OWA-TOPSIS model is used to objectively assess the identified psychosocial impacts. The different socioemotional manifestations are evaluated to determine their relevance and priority in the design of comprehensive therapeutic interventions.

Three clinical psychologists with experience in dermatological disorders participated in the study. They assessed the socioemotional consequences using standardized criteria. The neutrosophic OWA-TOPSIS model was applied to integrate individual assessments and obtain an objective collective evaluation.

Socio-emotional consequences and evaluation criteria

Four types of socio-emotional consequences identified in the systematic review were considered:

- **Alternative A1 (Low self-esteem)** : Significant decrease in positive self-perception in patients with APV.
- **Alternative A2 (Social stigma)** : Experiences of discrimination and social rejection related to physical appearance.
- **Alternative A3 (Anxiety)** : Manifestations of generalized anxiety and specific social anxiety.
- **Alternative A4 (Depression)** : Mild to moderate depressive symptoms associated with VCT.

The evaluation criteria used were:

- **C1. Prevalence (PR)** : Frequency of appearance of the consequence in the population studied.
- **C2. Severity (SE)** : Intensity of the impact on the individual's functionality.
- **C3. Duration (DU)** : Temporal persistence of the socio-emotional consequence.
- **C4. Treatability (TR)** : Responsiveness to psychotherapeutic interventions.

The specialists assigned weights to the criteria according to their relative portance:$C1: 0.20, C2: 0.30, C3: 0.25\ y\ C4: 0.25$.

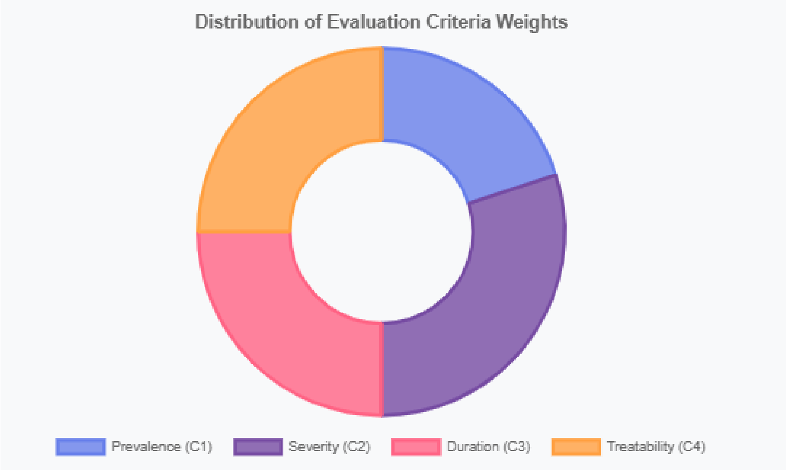


Chart 1: Evaluation Criteria Weights Distribution

Evaluation and decision matrices

Neutrosophic assessments were expressed using Neutrosophic Values of Language (SVNL) with the following scale: S = {s_1 = "extremely low", s_2 = "very low", s_3 = "low", s_4 = "moderate", s_5 = "high", s_6 = "very high", s_7 = "extremely high"}

Step 1: Normalization of individual decision matrices

The standardized SVNL decision matrices are presented below:

Table 1: Evaluation according to Criterion 1 (Prevalence)

Consequence	Specialist 1	Specialist 2	Specialist 3
A1	S_6(0.7; 0.1; 0.2)	S_7(0.8; 0.1; 0.1)	S_6(0.6; 0.2; 0.2)
A2	S_5(0.6; 0.2; 0.2)	S_6(0.7; 0.1; 0.2)	S_5(0.5; 0.3; 0.2)
A3	S_5(0.5; 0.3; 0.2)	S_5(0.6; 0.2; 0.2)	S_4(0.4; 0.4; 0.2)
A4	S_4(0.4; 0.3; 0.3)	S_4(0.5; 0.2; 0.3)	S_3(0.3; 0.4; 0.3)

Table 2: Evaluation according to Criterion 2 (Severity)

Consequence	Specialist 1	Specialist 2	Specialist 3
A1	S_6(0.6; 0.2; 0.2)	S_6(0.7; 0.1; 0.2)	S_5(0.5; 0.3; 0.2)
A2	S_7(0.8; 0.1; 0.1)	S_6(0.6; 0.2; 0.2)	S_7(0.9; 0.1; 0.0)
A3	S_4(0.4; 0.4; 0.2)	S_5(0.5; 0.3; 0.2)	S_4(0.3; 0.5; 0.2)
A4	S_5(0.5; 0.3; 0.2)	S_5(0.6; 0.2; 0.2)	S_4(0.4; 0.4; 0.2)

Table 3: Evaluation according to Criterion 3 (Duration)

Consequence	Specialist 1	Specialist 2	Specialist 3
A1	S_5(0.5; 0.3; 0.2)	S_6(0.6; 0.2; 0.2)	S_5(0.4; 0.4; 0.2)
A2	S_6(0.7; 0.2; 0.1)	S_5(0.5; 0.3; 0.2)	S_6(0.8; 0.1; 0.1)
A3	S_3(0.3; 0.5; 0.2)	S_4(0.4; 0.4; 0.2)	S_3(0.2; 0.6; 0.2)
A4	S_4(0.4; 0.4; 0.2)	S_4(0.5; 0.3; 0.2)	S_5(0.6; 0.2; 0.2)

Table 4: Evaluation according to Criterion 4 (Treatability)

Consequence	Specialist 1	Specialist 2	Specialist 3
A1	S_5(0.5; 0.3; 0.2)	S_4(0.4; 0.4; 0.2)	S_5(0.6; 0.2; 0.2)
A2	S_3(0.3; 0.5; 0.2)	S_4(0.4; 0.4; 0.2)	S_3(0.2; 0.6; 0.2)
A3	S_6(0.6; 0.2; 0.2)	S_5(0.5; 0.3; 0.2)	S_6(0.7; 0.1; 0.2)
A4	S_4(0.4; 0.4; 0.2)	S_5(0.5; 0.3; 0.2)	S_4(0.3; 0.5; 0.2)

Step 2: Construction of the collective matrix

Applying the SVNL aggregation formula: $r_{ij} = \sum(k = 1\ to\ 3)\omega_k * r_{ij}^k$,

where $\omega_k = \frac{1}{3}$ for each specialist.

For each element, we apply the neutrosophic operations:

Detailed calculation for A1-C1:

- Linguistic component: $\frac{6+7+6}{3} = 6.333$
- Truth component: $\left(0.7 + 0.8 - 0.7 \times 0.8\right) + 0.6 - \left(0.7 + 0.8 - 0.7 \times 0.8\right) \times 0.6 = 0.944 + 0.6 - 0.944 \times 0.6 = 0.977$
- Indeterminacy component: $0.1 \times 0.1 \times 0.2 = 0.002$
- Falsehood component: $0.2 \times 0.1 \times 0.2 = 0.004$

Table 5: SVNL Collective Decision Matrix

Consequence	C1 (Prevalence)	C2 (Severity)	C3 (Duration)	C4 (Treatability)
A1	$S_{6.33}$(0.700; 0.167; 0.200)	$S_{5.67}$(0.600; 0.200; 0.200)	$S_{5.33}$(0.500; 0.300; 0.200)	$S_{4.67}$(0.500; 0.300; 0.200)
A2	$S_{5.33}$(0.600; 0.200; 0.200)	$S_{6.67}$(0.767; 0.133; 0.100)	$S_{5.67}$(0.667; 0.200; 0.133)	$S_{3.33}$(0.300; 0.500; 0.200)
A3	$S_{4.67}$(0.500; 0.300;	$S_{4.33}$(0.400; 0.400;	$S_{3.33}$(0.300; 0.500;	$S_{5.67}$(0.600; 0.200;

Consequence	C1 (Prevalence)	C2 (Severity)	C3 (Duration)	C4 (Treatability)
	0.200)	0.200)	0.200)	0.200)
A4	$S_{3.67}$(0.400; 0.300; 0.300)	$S_{4.67}$(0.500; 0.300; 0.200)	$S_{4.33}$(0.500; 0.300; 0.200)	$S_{4.33}$(0.400; 0.400; 0.200)

Step 3: Establishing the weighted SVNL decision information

Applying the criteria weights($C1$: 0.20, $C2$: 0.30, $C3$: 0.25, $C4$: 0.25):

For weighting, we use the operation: $\lambda * x = \left(1 - \left(1 - T_x\right)^{\lambda}, (I_x)^{\lambda}, (F_x)^{\lambda}\right)$

Detailed calculation for weighted A1-C1:

- Linguistic component: $6.333 \times 0.20 = 1.267$
- $T: 1 - (1 - 0.700)^{0.20} = 1 - (0.300)^{0.20} = 1 - 0.757 = 0.243$
- $I: (0.167)^{0.20} = 0.735$
- $F: (0.200)^{0.20} = 0.725$

Table 6: Weighted collective SVNL decision matrix

Consequence	C1 (Prevalence)	C2 (Severity)	C3 (Duration)	C4 (Treatability)
A1	$S_{1.27}$(0.243; 0.735; 0.725)	$S_{1.70}$(0.273; 0.843; 0.843)	$S_{1.33}$(0.159; 0.778; 0.725)	$S_{1.17}$(0.159; 0.778; 0.725)
A2	$S_{1.07}$(0.200; 0.725; 0.725)	$S_{2.00}$(0.360; 0.704; 0.464)	$S_{1.42}$(0.211; 0.725; 0.629)	$S_{0.83}$(0.087; 0.841; 0.725)
A3	$S_{0.93}$(0.159; 0.778; 0.725)	$S_{1.30}$(0.148; 0.933; 0.843)	$S_{0.83}$(0.087; 0.841; 0.725)	$S_{1.42}$(0.200; 0.725; 0.725)
A4	$S_{0.73}$(0.148; 0.778; 0.778)	$S_{1.40}$(0.159; 0.778; 0.843)	$S_{1.08}$(0.159; 0.778; 0.725)	$S_{1.08}$(0.148; 0.933; 0.725)

Step 4: Determining the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS)

PIS (A^+):

- $C1$: (0.243, 0.735, 0.725)
- $C2$: (0.360, 0.704, 0.464)
- $C3$: (0.211, 0.725, 0.629)
- $C4$: (0.200, 0.725, 0.725)

NIS (A^-):

- $C1$: (0.148, 0.778, 0.778)
- $C2$: (0.148, 0.933, 0.843)

- $C3$: $(0.087, 0.841, 0.725)$
- $C4$: $(0.087, 0.841, 0.725)$

Step 5: Calculating distances with SVNLOWAD

The specialists determined the OWA operator weight vector as $W = (0.30, 0.25, 0.25, 0.20)$, reflecting their attitudes toward the relative importance of the criteria.

Using the neutrosophic distance formula $d(x_1, x_2 v) = \left[|s_{\theta(x1)}T_{x1} - s_{\theta(x2)}T_{x2}|^{\mu} + |s_{\theta(x1)}\, I_{x1} - s_{\theta(x2)}\, I_{x2}|^{\mu} + |s_{\theta(x1)}F_{x1} - s_{\theta(x2)}F_{x2}|^{\mu}\right]^{\frac{1}{\mu}}$, where μ = 2.

Detailed distance calculation for A1:

Distance A1 to PIS by criteria:

- $C1: d = \sqrt{[(1.27 \times 0.243 - 1.27 \times 0.243)^2 + (1.27 \times 0.735 - 1.27 \times 0.735)^2 + (1.27 \times 0.725 - 1.27 \times 0.725)^2]} = 0.000$

- $C2: d = \sqrt{[(1.70 \times 0.273 - 2.00 \times 0.360)^2 + (1.70 \times 0.843 - 2.00 \times 0.704)^2 + (1.70 \times 0.843 - 2.00 \times 0.464)^2]} = 0.456$

- $C3: d = \sqrt{[(1.33 \times 0.159 - 1.42 \times 0.211)^2 + (1.33 \times 0.778 - 1.42 \times 0.725)^2 + (1.33 \times 0.725 - 1.42 \times 0.629)^2]} = 0.088$

- $C4: d = \sqrt{[(1.17 \times 0.159 - 1.42 \times 0.200)^2 + (1.17 \times 0.778 - 1.42 \times 0.725)^2 + (1.17 \times 0.725 - 1.42 \times 0.725)^2]} = 0.098$

Applying the OWA weights ordered from greatest to least distance: $SVNLOWAD(A1, A^{+}) = 0.30 \times 0.456 + 0.25 \times 0.098 + 0.25 \times 0.088 + 0.20 \times 0.000 = 0.183$

Table 7: Calculated SVNLOWAD distances

Consequence	SVNLOWAD(A_i, A^+)	SVNLOWAD(A_i, A^-)

Consequence	SVNLOWAD(A_i, A^+)	SVNLOWAD(A_i, A^-)
A1	0.183	0.297
A2	0.125	0.342
A3	0.264	0.156
A4	0.278	0.089

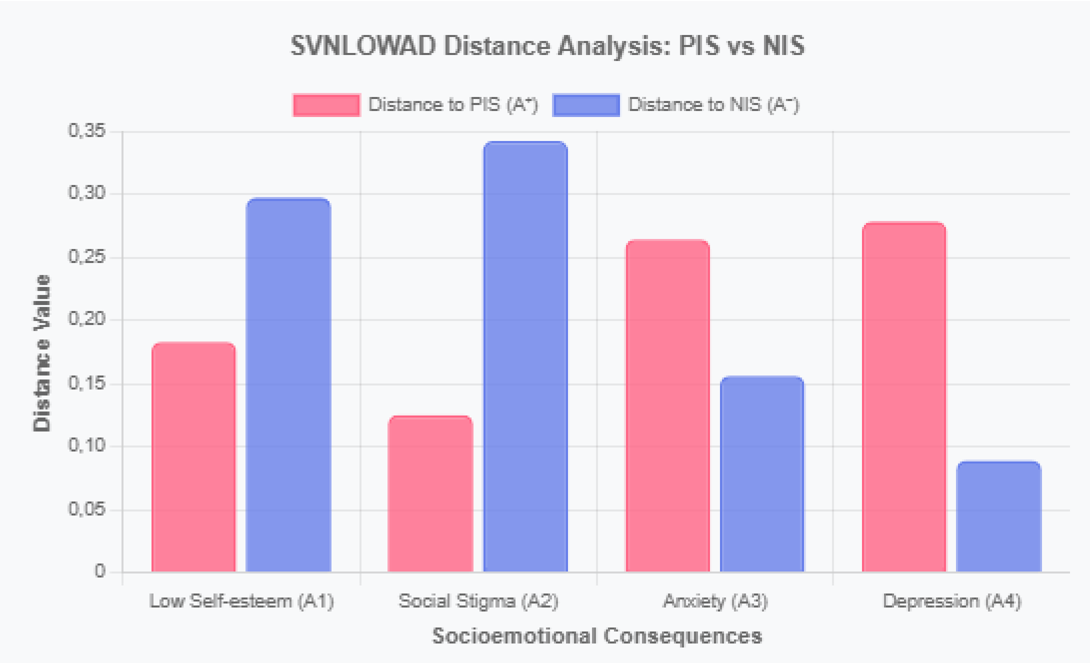


Chart 2: SVNLOWAD Distance Analysis

Step 6: Calculation of the proximity coefficient .

Using the formulas:

- $SVNLOWAD\_max(A_i, A^-) = max(0.297, 0.342, 0.156, 0.089) = 0.342$
- $SVNLOWAD\_min(A_i, A^+) = min(0.183, 0.125, 0.264, 0.278) = 0.125$

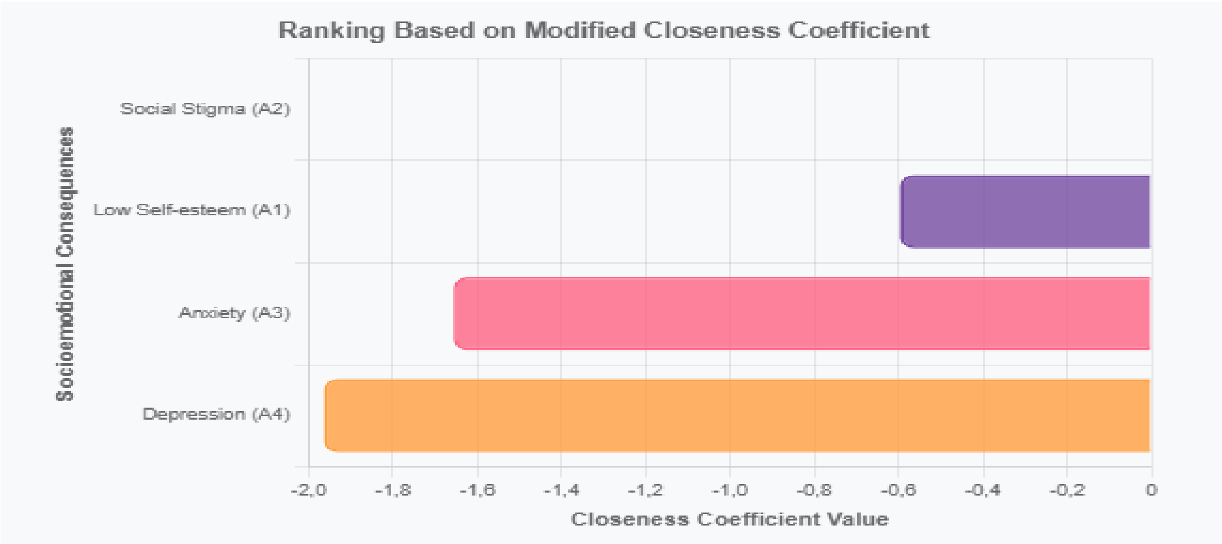
Applying the modified proximity coefficient formula: $C'(A_i) = \frac{SVNLOWAD(A_i,A^-)}{SVNLOWAD_{\max(A_i,A^-)}} - \frac{SVNLOWAD(A_i,A^+)}{SVNLOWAD_{\min(A_i,A^+)}}$

Detailed calculations:

- $C'(A1) = 0.297/0.342 - 0.183/0.125 = 0.868 - 1.464 = -0.596$
- $C'(A2) = 0.342/0.342 - 0.125/0.125 = 1.000 - 1.000 = 0.000$
- $C'(A3) = 0.156/0.342 - 0.264/0.125 = 0.456 - 2.112 = -1.656$
- $C'(A4) = 0.089/0.342 - 0.278/0.125 = 0.260 - 2.224 = -1.964$

Table 8: Final results of the neutrosophic OWA-TOPSIS analysis

Consequence	SVNLOWAD(A_i, A^+)	SVNLOWAD(A_i, A^-)	C'(A_i)	Ranking
A1 (Low self-esteem)	0.183	0.297	-0.596	2
A2 (Social stigma)	0.125	0.342	0.000	1
A3 (Anxiety)	0.264	0.156	-1.656	3
A4 (Depression)	0.278	0.089	-1.964	4



Graph 3: Final Ranking of Socioemotional Consequences

Analysis of results

The results obtained through the neutrosophic OWA-TOPSIS model provide a systematic and objective assessment of the socio-emotional consequences of visible pigmentary alterations.

The SVNLOWAD distances(A_i, A^+) represent the proximity of each consequence to the positive ideal point, where lower values indicate greater proximity to the optimal situation. Social stigma (A2) presents the smallest distance (0.125), followed by low self-esteem (A1) with 0.183, anxiety (A3) with 0.264, and depression (A4) with 0.278.

SVNLOWAD distances(A_i, A^-) measure the distance between each consequence and the negative ideal point, where higher values are more desirable . Social stigma shows the highest value (0.342), followed by low self-esteem (0.297), anxiety (0.156), and depression (0.089).

The modified relative closeness coefficient C'(A_i) integrates both measures to generate a unified evaluation index . Social stigma (A2) reaches the highest value (0.000), establishing itself as the most significant socio-emotional consequence according to the evaluated criteria. It is followed by low self-esteem (A1) with -0.596, anxiety (A3) with -1.656, and depression (A4) with -1.964.

4. Discussion

The findings of the present study reveal important patterns in the manifestation of the socioemotional consequences of visible pigmentary changes. The prioritization of social stigma as the most relevant consequence is consistent with existing literature emphasizing the fundamental role of social perception in the experience of patients with visible dermatological conditions.

The prominent position of low self-esteem(2) in the ranking suggests a close relationship between external perception and self-perception, which supports the need for interventions that address both individual and social aspects. It is notable that anxiety and depression, although present, occupy lower positions in the ranking, which could indicate that these manifestations are secondary consequences of the primary impacts of stigma and self-esteem.

The application of the neutrosophic OWA-TOPSIS method has allowed us to capture the uncertainty inherent in psychosocial assessments, providing a robust framework for clinical decision-making. The indeterminacy and falsity components of the neutrosophic model have proven particularly useful in representing the ambiguity characteristic of psychological phenomena.

From a methodological perspective, the integration of multiple assessment criteria (prevalence, severity, duration, and treatability) has enriched the analysis, allowing for a multidimensional understanding of each socioemotional consequence. The differential weighting of these criteria reflects current clinical priorities in the comprehensive management of patients with PVA.

Limitations of this study include the small size of the expert panel and the specific application to a specific cultural context. Future research could benefit from expanding the evaluation panel and cross-cultural validation of the model. Proposed neutrosophic OWA-TOPSIS.

5. Conclusions

The results of the analysis demonstrate that , for this specific case study, the most significant socioemotional consequence of visible pigmentary changes is social stigma (A2), followed by low self-esteem (A1), anxiety (A3), and depression (A4). This ranking reflects the complex interaction between social and individual factors in the experience of patients with VCT.

The model effectively considered the levels of uncertainty associated with each type of consequence, as it addresses not only degrees of truth but also levels of indeterminacy and falsity. The neutrosophic approach is especially valuable in the context of psychosocial consequences, where there is often ambiguity in the manifestation and evaluation of symptoms.

Therefore, the neutrosophic OWA-TOPSIS model constitutes an effective tool for healthcare authorities and mental health professionals to make informed decisions, as it provides a systematic and apparently efficient approach to evaluate competing criteria in the most effective decision-making in the context of comprehensive care for patients with visible pigmentary disorders.

These findings contribute significantly to the design of targeted psychosocial intervention protocols, prioritizing the areas of greatest impact identified through this innovative multicriteria assessment methodology in uncertain environments.

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