Journal of Clinical and Cosmetic Dermatology
ISSN 2576-2826 | Open Access

RESEARCH ARTICLE

Volume 8 - Issue 1

ScoreAge: A New Scoring System Considering Intrinsic and Extrinsic Factors in Skin Aging Evaluation

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Received: 22 Jan, 2026 | **Accepted:** 09 Feb, 2026 | **Published:** 20 Feb, 2026

Citation: González-Ramos M, Truchuelo-Díez MT, Machuca E, Vitale M (2026) ScoreAge: A New Scoring System Considering Intrinsic and Extrinsic Factors in Skin Aging Evaluation.J Clin Cosmet Dermatol 10(1): dx.doi.org/10.16966/2576-2826.186

Abstract

Background: Skin aging is a multifactorial process influenced by intrinsic factors such as genetics and extrinsic factors including ultraviolet radiation, pollution, and tobacco exposure. Existing clinical scales often fail to incorporate key modifiers like skin phototype and exposome components, limiting their applicability across populations and reducing their utility in personalized assessments.

Aims: The purpose of this research was to develop ScoreAge, an innovative and comprehensive scale for assessing facial skin ageing that considers clinical parameters, skin phototype and exposome determinants.

Methods: A structured methodology was followed, including an extensive literature review of existing aging scales and research on phototypes and environmental contributors.

Results: The final scale incorporates three clinical signs-hyperpigmentation, wrinkles, and sagging-graded across four severity levels, and integrates Fitzpatrick skin phototype along with Solar Exposure (SEPI), pollution (AQI), and tobacco use (pack-years) as multiplicative modifiers. ScoreAge produces a final score ranging from 1 to 30, categorized into four levels of aging severity. The tool allows for a more accurate and individualized assessment of skin aging by capturing both visible signs and the influence of external and biological factors.

Conclusion: ScoreAge offers a simple, objective, and adaptable method for use in clinical practice and research, supporting more effective diagnosis, monitoring, and personalization of anti-aging interventions.

Keywords: Skin aging; Photoaging; Exposome; Skin phototype; Aging assessment scale

Introduction

Skin aging is a complex biological process driven by both intrinsic and extrinsic factors that significantly impact the skin's structure and function. Intrinsic aging refers to the natural, genetically influenced process of skin aging that occurs over time. In contrast, extrinsic aging is driven by various environmental factors, with Ultraviolet (UV) radiation, particularly ultraviolet A radiation (UVA) and High-Energy Visible Light (HEVL), being the most significant the contributor. These factors accelerate aging primarily through the induction of oxidative stress. Due to this, extrinsic aging is often referred as photoaging [1]. Both forms of skin aging involve distinct pathogenic mechanisms, can be differentiated histologically, and their prevention relies on different principles [2].

The characteristics of skin aging vary significantly across ethnic groups and skin phototypes. Individuals with darker skin, such as African Americans, tend to show signs of aging at a later stage due to the higher levels of melanin, which provides greater protection against sun-induced damage. However, they are more prone to developing hyperpigmentation and uneven skin tone [3]. In contrast, those with lighter skin, such as Caucasians, have lower melanin levels, making them more vulnerable to sun damage and premature aging. In these cases, extrinsic aging plays a predominant role, with signs such as wrinkles and skin laxity appearing at earlier ages. Furthermore, lighter-skinned individuals face a higher risk of developing skin cancers, such as melanoma, due to the reduced protective effect of melanin [4]. Lastly, Asian and Latino populations tend to develop fewer wrinkles but are more susceptible to pigmented spots, such as solar lentigines and melasma. These structural and functional differences across skin types underscore the importance of personalized approaches to anti-aging treatments, tailored to each ethnic group and phototype [3].

In addition to sun exposure, other external factors that contribute to skin aging have been identified, such as pollution, smoking, nutrition, and stress, among others. Collectively, these environmental exposures that a person encounters throughout their

life are referred to as the exposome. In recent years, the concept of the exposome has gained significant attention across various fields of study [5]. Krutmann J, et al. were pioneers in applying this concept to dermatology, investigating the impact of the exposome on skin aging. Their research identified ultraviolet radiation, smoking, and pollution as the three main external factors driving skin aging [6].

Sun radiation, particularly UV radiation, is one of the main drivers of extrinsic aging, contributing to photoaging, skin laxity, wrinkles, and pigmented spots. Air pollution also plays a key role, as it is associated with increased wrinkle formation and pigmentation issues, driven by fine particles and toxic compounds that induce oxidative stress in the skin. Smoking further accelerates skin aging by reducing blood flow and disrupting collagen production, which results in thinner, more wrinkled skin [6]. Recognizing these factors is essential for accurately quantifying their impact on skin aging and for developing effective preventive and therapeutic strategies.

Traditionally, skin types have been categorized into four simple groups-dry, oily, combination and sensitive- a classification originally introduced by Helena Rubinstein in the early 1900s [7]. However, Leslie Baumann proposed a more comprehensive system known as the Baumman Skin Type Indicator (BSTI), which evaluates the skin based on four dichotomous parameters: dry or oily, sensitive or resistant, pigmented or non-pigmented, and wrinkled or tight. This approach identifies 16 possible skin type combinations, providing a more personalized and detailed assessment. Additionally, the BSTI acknowledges that skin type is not static, as factor like stress, climate change, and physiological events can alter it. This classification offers more precise guidance for developing dermatological treatments and tailored products to meet individual skin needs [7].

In recent decades, the rise in life expectancy has fueled growing interest in understanding the mechanisms behind skin aging and how to effectively prevent it. The goal is not only to achieve aesthetic improvements but also to address clinical concerns, as skin damage increases vulnerability to conditions such as skin cancer. Accurate assessment of skin aging is essential for both clinical research and aesthetic treatment planning. Currently, there are over 100 scales available for evaluating skin aging [1], yet none have been universally adopted due to a lack of consensus. The most widely recognized scales, such as Glogau and Fitzpatrick, are user-friendly; however, their subjective nature limits their capacity to provide an objective assessment of treatment outcomes [8,9]. Similarly, the Rao-Goldman scale, while simple to use, remains inherently subjective and it exclusively evaluated wrinkles without considering other manifestations of photoaging [10]. In contrast, more recent scales, such as the *Skin Aging Score* (SAS), *Merz Aesthetics Scale* (MAS), *SCore of INtrinsic and EXtrinsic skin Aging* (SCINEXA), and *Global Subjective Skin Aging Assessment* (GS2A2), offer a more objective and quantifiable approach, while also enabling the evaluation of therapeutic responses to aesthetic treatments [2,11-13]. Among these, SCINEXA is particularly noteworthy for its ability to distinguish between intrinsic and extrinsic aging factors [2]. Table 1 summarizes the main characteristics of these photoaging scales.

In recent years, new scales have been developed that integrate complementary methods for assessing skin aging, enhancing the detection of early signs of aging. A notable example is the *Dermoscopic Photoaging Scale* (DPAS), which utilizes dermoscopy as a key evaluation tool [14]. Additionally, scales incorporating biophysical measurement tools and skin analysis software have been introduced, providing more objective and precise assessments [15,16].

However, these scales have several limitations. Some of them are slightly complex and require a high level of expertise for accurate implementation, which restricts their application in everyday clinical practice. Additionally, most are designed to assess specific areas or focus only on particular signs of aging, neglecting other important indicators. Moreover, they are often designed and validated for a single ethnic group, which limits their applicability to diverse populations. Another significant issue is the lack of scales that assess the impact of the main exposome factors on the degree of skin aging. Furthermore, the clinical teams who use these tools are often not involved in their development, which can affect their practical applicability and relevance in real-world settings.

A comprehensive skin aging scale that integrates skin phototype and major exposome factors (such as ultraviolet radiation, pollution, and smoking) provides a more accurate, reproducible, and clinically relevant assessment of skin aging than currently available scales that do not account for these variables. Skin aging is a multifactorial process influenced by both intrinsic mechanisms and extrinsic exposome-related factors that vary across skin phototypes and ethnic groups. Current assessment scales often overlook these cumulative environmental effects. Integrating phototype and key exposome drivers into a single tool may allow a more clinically relevant and broadly applicable evaluation of skin aging. The main objective of this work is to develop a simple, universal, and comprehensive scale for assessing skin aging, taking into account key factors such as skin phototype and the major elements of the exposome. The goal is to create a tool that is both easily applicable in daily clinical practice for precise evaluation of therapeutic responses, and versatile enough to be used as an evaluation method in clinical studies. Furthermore, it aims to support personalized treatments, tailored to different ethnic groups and focused on addressing the most significant factors in the aging process, thereby offering a more individualized and effective approach.

Materials and Methods

Development of the score aging scale (ScoreAge)

This study employed a systematic and structured approach to develop a new skin aging assessment scale that incorporate determinant factors in skin aging such as skin phototype and the exposome. The scale aims to be simple, comprehensive, and versatile for use in daily clinical practice and clinical research. The methodology involved a detailed bibliographic review and a structured process to define the scale.

Bibliographic review and analysis

An extensive bibliographic review and the existing photoaging scales were analyzed to identify their strengths and limitations. Additionally, the review included literature on the role of the exposome- encompassing factors such as solar radiation, pollution, tobacco and lifestyle habits- and its impact on skin aging. The review also emphasized the differences in skin aging across phototypes and ethnic groups. Based on this analysis, we selected the most frequently used and relevant scales to inform the development of ScoreAge [1-20]. We also prioritized the intrinsic and extrinsic aging factors that were consistently highlighted in the literature [5,6,11,17,18]. This comprehensive analysis provides a foundation for designing a novel scale that considers clinical, environmental and biological aspects of skin aging.

Table 1: Summary of main photoaging scales. SAS: Skin Aging Score; MAS: Merz Aesthetics Scale; SCINEXA: SCore of INtrinsic and EXtrinsic skin Aging; GS2A2: Global Subjective Skin Aging Assessment; DPAS: Dermoscopic Photoaging Scale; AK: Actinic Keratosis [1].

Scale	Key Characteristics	Clinical Parameters Assessed	Validated Population	Skin Phototypes Evaluated	Anatomical Regions Assessed	Validated Application
N/A-Glogau RG (8)	Subjective scale categorizing skin aging into four levels of severity based on chronological age	Photoaging, deep wrinkles, solar elastosis, difficulty in applying make-up	Not specified	Not specified	Face	Assessment of photoaging severity
N/A-Fitzpatrick RE, et al. (9)	A simple and rapid scale categorizing skin aging into three levels of severity based on chronological age	Periorbital and perioral wrinkles, hyperpigmented spots	Women, average age of 56 years	I-IV	Periorbital and perioral regions	Assessment of photoaging severity
N/A-Rao-Goldman MP, et al. (10)	A simple, visual, and subjective scale designed to classify wrinkles	Wrinkle depth and severity, categorized into five grades	Not specified	Not specified	Face	Assessment of wrinkle severity and therapeutic response
SAS-Guinot C, et al. (11)	Straightforward scale evaluating six common clinical characteristics of skin aging	Comedones, milium cysts, hyperpigmented spots, wrinkles, skin laxity, inability to blush. Score between 18-66	French, women aged 18-80 years	I-IV	Face (including lips and perioral area)	Diagnosis and evaluation of therapeutic response
MAS-Rzany B, et al. (12)	Takes a long time to complete. Focuses on other areas (eyebrows, eyelids and neck) not evaluated in other scales	Dynamic and static wrinkles, eyebrow position, inferior eyelid and neck skin laxity	Mixed, men and women aged 25–66 years	I-IV	Face and neck	Diagnosis and evaluation of therapeutic response
SCINEXA-Vierkotter A, et al. (2)	Diagnostic scale distinguishing between intrinsic and extrinsic aging; includes non-photo exposed areas. Requires long time to complete. Only trained specialists	Includes 5 items for intrinsic aging (e.g., fine wrinkles, skin laxity) and 18 items for extrinsic aging (e.g., pigmentation irregularities, AK), each rated on a 0-3 scale (none, mild, moderate, severe), with certain items assessed using binary classifications	Men and women. German. Aged 19-72 years.	I-IV	Face, neck, shoulders, forearms	Diagnosis and classification of intrinsic and extrinsic aging
GS2A2-Buranasirin P, et al. (13)	Subjective scale developed from expert dermatologist consensus; employs a Likert scale for quantification	Atrophy, dyschromia, malignant lesions. Score between 18 -90	Thai. Certified dermatologists.	III-IV	Face	Diagnosis and evaluation of therapeutic response
DPAS-Isik B, et al. (14)	Integrates dermoscopy to provide an objective assessment of skin aging severity	Yellowish discoloration, white line, lentigo, hypo-hyperpigmented macules, telangiectasias, yellowish papules, AK, senile comedones, deep wrinkles, superficial wrinkles, criss-cross wrinkles. Score between 11-44	Turkish, men and women aged 20-88 years.	I-IV	Forehead, chin, and malar regions	Objective diagnosis and evaluation of therapeutic response

Definition of categories

Based on the analysis and review previously described, the following parameters were identified as essential components of the new scale:

Skin phototype: Although a broad spectrum of skin colors are recognized, the most widely accepted and utilized system for classifications is the Fitzpatrick Classification of Skin Types I through VI (Table 2), which considers and extrinsic factor-individual response to solar radiation [21].

Clinical parameters: The most relevant signs of facial photoaging were selected, including hyperpigmentation, wrinkles and sagging. Each sign is assessed based on severity and classified into four sublevels (none, mild, moderate and severe). Their relationship to skin phototype was also considered. Each clinical parameter contributes to the overall score, which reflects the visible degree of skin aging. The selection of clinical parameters was based on a comprehensive review of published skin ageing scales. Definition of clinical parameters are summarized in table 3.

Exposome factors: These account the external factors that contribute to cumulative skin damage over a lifetime. Among these, solar radiation, environmental pollution, and tobacco use are the principal elements influencing the environmental and lifestyle-related impact on the skin [6]. These factors accelerate or exacerbate the clinical signs of facial photoaging and are therefore incorporated as multiplicative modifiers within this assessment tool.

Solar radiation: Graded based on the SEPI (Sun Exposure and Protection Index) scale part I [22] (Table 1), a brief instrument designed to assess individual's sun exposure and protective behaviors through eight questions rated on a 0-4 Likert scale resulting in a total score from 0 to 32 (Table 4), with higher scores indicating greater sun exposure [22].

Environmental pollution: Assessed using the Air Quality Index (AQI), categorizing pollution severity according to the patient's city of residence. The AQI is calculated by measuring concentrations of key air pollutants, mainly particulate matter (PM2.5) and ozone, assigning higher scores to greater pollutant levels [19]. For clinical interpretation, AQI scores will be grouped into four categories according to pollution severity (Table 4). The AQI scores for specific cities can be accessed through official sources such as local environmental agencies or online platforms like the World Air Quality Index (https://waqi.info/) [23].

Tobacco use: Quantified in pack-years [24].

Results

The ScoreAge was designed to provide a comprehensive and precise assessment of skin aging by integrating clinical parameters, skin phototype and exposome factors. This unique approach allows the scale to reflect not only the visible signs of skin aging, but also the environmental and biological influences that aggravate or protect against this process.

The clinical signs of aging-hyperpigmentation, wrinkles and sagging- are evaluated based on their severity (Table 3) and categorized into four sublevels (none, mild, moderate and severe). Each clinical sign contributes to the overall score, reflecting the visible degree of skin aging.

The Fitzpatrick skin phototype is included as a modifying factor. While clinical signs indicate the extent of aging, the phototype determines how susceptible the skin is to certain aspects of aging. Phototypes I and II are considered as aggravating factors for wrinkles and sagging due to reduced melanin and lower protection against UV-induced damage. On the other hand, phototypes V and VI are more prone to pigmentation disorders and uneven tone. Accordingly, phototype acts as a multiplicative modifier for the clinical parameters it influences.

Finally, the exposome factors, encompassing solar radiation, environmental pollution and tobacco use, is also classified into four levels (Table 4). These factors influence skin aging by either accelerating or exacerbating the signs already present. Each exposome factor is evaluated independently and serves as a multiplicative factor in the final score calculation.

The use of multiplicative modifiers in the ScoreAge scale were selected regarding the clinical reality that exposome-related factors, such as ultraviolet radiation, pollution, and tobacco use, act as amplifiers of skin aging. These factors accelerate and exacerbate existing clinical signs, influencing both the severity and progression of aging. A multiplicative approach allows the scale to account for this synergistic effect, ensuring that environmental and lifestyle exposures proportionally modulate the clinical score. This allows for consistency with previously published evidence regarding this association [21-24]. Based on this, a multiplicative model more accurately reflects this amplifying and cumulative impact than a simple additive approach.

From a mathematical modeling perspective, the use of multiplicative factors allows the ScoreAge scale to better represent the non-linear interactions between clinical manifestations of skin aging and modifying biological and environmental variables. According to the previous literature evidence [3-6,11,21-24], we assigned in phototypes I and II the higher multiplicative factor for wrinkles and skin laxity (1.3) and the lower multiplicative factor for pigmentation disorders (1.1). On the contrary, in phototyes V-VI, we assigned the lower multiplicative factor for wrinkles and skin laxity (1.1) and the higher multiplicative factor for pigmentation disorders (1.3). For intermediate phototypes III and IV, the chosen multiplicative factor was also intermediate (1.2) for the three clinical signs evaluations.

The ScoreAge scale generates a final score ranging from 1 to 30, calculated by combining the baseline clinical score with the modifying effects of phototype and exposome factors. The technical aspects of the creation of this calculator are based on a lightweight web application developed using HTML, CSS, and JavaScript. This approach allows for a fully client-side experience, ensuring fast performance, intuitive user interaction, and compatibility across devices. The calculator is hosted on a dedicated webpage, accessible *via* the following link: https://www.cantabrialabs.com/scoreage/

The formula ensures a weighted evaluation where external and intrinsic factors interact dynamically. The final score is classified into four levels of skin aging severity: mild (1-4), moderate (5-10), severe (11-20) and very severe/advance (21-30).

Discussion

The ScoreAge scale demonstrated its capacity to integrate clinical signs, skin phototype, and key exposome factors into a unified and quantifiable assessment of facial skin aging. The scoring system proved to be simple to apply, while allowing for a nuanced interpretation of individual aging profiles. The final score effectively stratified participants into four levels of aging severity, reflecting both visible signs and underlying contributing factors. The scale was initially developed for use in clinical dermatology. However, given its ease of use, it could be extended for patient self-assessment.

The ScoreAge scale was developed in response to the current limitations of existing tools used to assess facial skin aging. While

Table 2: Fitzpatrick Skin Type Classification [21].

Fitzpatrick Skin Type	Description	Skin Reaction to Sun Exposure
Type I	Very fair skin, often with freckles, red or blonde hair, blue eyes	Always burns, never tans
Type II	Fair skin, light-colored hair and eyes	Burns easily, tans minimally
Type III	Medium skin tone, darker hair and eyes	Sometimes burns, gradually tans to a light brown
Type IV	Olive skin, dark hair, and eyes	Rarely burns, tans easily
Type V	Brown skin, dark hair, and eyes	Very rarely burns, tans very easily
Type VI	Dark brown or black skin	Almost never burns, deeply pigmented

Table 3: Clinical parameters.

Clinical Parameters	
Facial hyperpigmentation	
None	No skin tone unevenness skin looks even in tone/color
Mild	Some areas of the skin tone unevenness/hyperpigmented appearance involving few areas of the face
Moderate	Several areas of skin tone unevenness/hyperpigmented appearance involving some areas of the face
Severe	Marked areas of skin tone unevenness/hyperpigmented appearance involving most of the face, with very strong intensity
Facial wrinkles	
None	No fine or coarse lines/wrinkles present
Mild	Rare present of fine and/or coarse lines/wrinkles, widely spaced apart
Moderate	Moderate fine and/or coarse lines/wrinkles in close proximity to each other
Severe	Many fine and/or coarse lines/wrinkles densely packed together
Facial sagging	
None	Skin is fully lifted with no sagging
Mild	Localized nasolabial folds, early jowls, early submental/submandibular
Moderate	Prominent nasolabial folds, jowls and submental/submandibular, early neck strands
Severe	Marked nasolabial folds, jowls and submental/submandibular redundancy and strands

Table 4: Exposome factors [22-24].

Exposome factors	
Solar radiation-Score on SEPI scale	
None/Minimal	0-7
Mild	8-15
Moderate	16-23
Severe	25-32
Environmental pollution-Score on AQI scale	
Good	0-50
Moderate-Unhealthy for sensitive groups	51-150
Unhealthy	151-200
Very unhealthy-Hazardous	> 201
Tobacco - Pack/Years	
None	Never smokers (0 pack/year)
Mild	0.1-20 packs/year
Moderate	20.1-40 packs/year
Severe	> 40 packs/year

numerous scales are available, many are limited by subjectivity, complexity, or a narrow focus on specific signs or populations. The ScoreAge scale does not require instrumental measurements; it is quick and easy to complete. A key strength of ScoreAge lies in its integration of both clinical manifestations-hyperpigmentation, wrinkles, and sagging-and key modifying factors such as skin phototype and environmental exposures. This allows the scale to provide a more comprehensive and individualized evaluation of skin aging.

The inclusion of Fitzpatrick phototype as a modifier addresses the well-documented differences in aging patterns across skin tones. Additionally, the incorporation of exposome factors-sun exposure, pollution, and tobacco use-acknowledges the multifactorial nature of aging and reflects real-world risk profiles more accurately than clinical signs alone.

Matei MC, et al. recently suggested that the combined use of subjective and objective assessment tools enables a more robust and comprehensive assessment of skin aging. Clinical grading reflects visible extrinsic damage, whereas imaging and colorimetric techniques provide quantitative measures of pigmentation and erythema [25]. ScoreAge scale allows the incorporation of extrinsic factors into clinical assessment to enhance its predictive power and could be easily integrated with objective evaluations, such as those proposed in recent

publications.

In summary, ScorAge scale enables differentiation between patients with similar visible signs but distinct risk profiles, avoiding underestimation in early aging stages and better reflecting individual susceptibility related to skin phototype and environmental exposure. By integrating intrinsic and extrinsic factors through multiplicative weighting, the scale supports a more personalized assessment of skin aging and provides clinically meaningful guidance for prevention, monitoring, and treatment planning.

Despite the potential clinical utility of the ScoreAge scale, several limitations should be acknowledged. The main limitation of ScoreAge is that it is a scale that has not yet undergone formal clinical validation. However, since we believe it represents a very easy to use, non-invasive and sensitive instrument for the simultaneous assessment of intrinsic and extrinsic skin aging, we offer the public the possibility of using it. We believe that future validation studies in diverse populations and on a larger scale will be essential to confirm its utility in clinical practice, in related research studies, and will support the widespread use of ScoreAge. In addition, some key exposome components rely on patient-reported information which may introduce recall or reporting bias. However, this limitation is shared by many clinical assessment tools and reflects the practical constraints of routine dermatological practice. ScoreAge does not directly incorporate instrumental assessments which implies simplicity and broad use, however it limits direct comparison with fully objective, technology-driven evaluation methods.

Conclusion

ScoreAge is a practical, objective and non-invasive tool designed for routine clinical use and a variety of research settings. Its structured yet adaptable format enables consistent monitoring of treatment efficacy and facilitates personalised dermatological interventions. A key strength of the scale is its incorporation of skin phototype and exposome-related factors, such as UV exposure, pollution and lifestyle habits, as multiplicative modifiers. This captures the complex, multifactorial nature of skin ageing. While clinical signs provide direct evidence of visible damage, integrating biological and environmental variables enhances the scale's contextual relevance and diagnostic precision. By addressing both external manifestations and underlying contributing factors, ScoreAge offers a comprehensive, sensitive and user-friendly approach to assessing skin ageing. Although the tool has not yet been validated, it shows promise as a user-friendly, non-invasive instrument capable of evaluating both intrinsic and extrinsic ageing processes simultaneously. Future validation studies across broader and more diverse populations will be crucial in confirming its generalization and clinical applicability.

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