

Isabel Maria da Cruz Ferreira

**Instruments used to characterize skin type and skin aging: a scoping review**

Faculty of Health Sciences

University Fernando Pessoa

Porto, 2023



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I certify the originality of this work,

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(Isabel Maria da Cruz Ferreira)

Dissertation presented to University Fernando Pessoa as part of the requirements to obtain a Master's Degree in Pharmaceutical Sciences, under the guidance of Professor Rita Oliveira and co-advisor Professor Isabel Martins de Almeida

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## **Abstract**

Aging is a gradual and varying deterioration that affects all organs, including the skin. Skin aging can be intrinsic or chronological, appearing with age and influenced by genetic factors, or extrinsic or actinic, which arises due to external factors such as tobacco, pollution, lifestyle habits, and predominantly solar radiation (photoaging). Biochemical changes lead to clinical manifestations at the cutaneous level, such as wrinkles, increased thickness, and pigmentation.

Skin type and skin aging assessment are crucial in clinical decision-making and research in Dermatology and Cosmetology. Skin type classification and evaluation of skin aging are essential to tailoring individualized care, enhancing treatment efficacy, and facilitating the development of groundbreaking skincare products and therapies.

Instruments such as non-invasive bioengineering tools, visual and tactile methods, classification scales, and psychometric instruments are commonly used for skin type and aging assessment. Understanding the importance of these assessments and the tools used is essential for healthcare professionals, researchers, and cosmetic formulators to provide evidence-based care and advance the field of skin care interventions.

A comprehensive search was conducted across several databases to identify relevant articles that gather scientific evidence of instruments that characterize skin type and aging.

A total of 1336 studies were identified in the search, with 27 articles included in the final review. Various assessment scales were used in dermatology research, with the Fitzpatrick Scale being the most frequently utilized (9 studies). The Fitzpatrick Scale is widely used, followed by Griffiths, Glogau, and questionnaires. No significant trends in scale usage over time were observed. Despite its popularity, the Fitzpatrick Scale has limitations in assessing skin cancer risk, particularly for people of color. Most studies are observational or quasi-experimental, each with distinct strengths and limitations. Transparent reporting is crucial.

Most of the studies were quasi-experimental (12) or observational (10) and randomized controlled trials (5). Some studies do not specify the scale used, indicating the need to

improve the transparency of reporting results in future research. Improvements are needed for broader-scale adoption and more inclusive scales.

Keywords: classification methods, skin hydration, sebum production, skin sensitivity, wrinkle

## **Resumo**

O envelhecimento cutâneo caracteriza-se por uma deterioração gradual e variável que afeta todos os órgãos, e a pele não é indiferente a ela. O envelhecimento da pele pode ser intrínseco ou cronológico, aparecendo com a idade, influenciado por fatores genéticos, ou extrínseco ou actínico, influenciado por fatores externos como tabaco, poluição, hábitos de vida e radiação predominantemente solar (fotoenvelhecimento). Com a idade, surgem alterações bioquímicas que levam a manifestações clínicas a nível cutâneo, como rugas, aumento da espessura, pigmentação, entre outras. A avaliação do tipo de pele e do grau de envelhecimento é crucial na tomada de decisões clínicas e na investigação em Dermatologia e Cosmetologia. Estas avaliações permitem que os profissionais de saúde e estética ofereçam cuidados personalizados, otimizem os resultados dos tratamentos e contribuam para o desenvolvimento de produtos e terapias inovadoras.

Instrumentos como metodologias de bioengenharia não-invasiva, métodos visuais e tácteis, escalas de classificação e instrumentos psicométricos são comumente usados para avaliar o tipo de pele e o seu grau de envelhecimento. Compreender a importância dessas avaliações e das ferramentas utilizadas é essencial para profissionais de saúde, investigadores e indústria cosmética, e contribui para a prestação de cuidados baseados em evidências científicas e avanços no campo das intervenções dos cuidados com a pele.

Foi realizada uma pesquisa aprofundada recorrendo a várias bases de dados científicas para identificar artigos relevantes e com evidência científica relativamente a instrumentos de caracterização do tipo de pele e grau de envelhecimento cutâneo.

Um total de 1336 estudos foram identificados na pesquisa, com 27 artigos incluídos na revisão final. Diversas escalas de avaliação foram utilizadas em pesquisas dermatológicas, sendo a Escala de Fitzpatrick a mais utilizada (9 estudos), seguida da Escala de Griffiths, Glogau e questionários. Não foram observadas tendências significativas no uso das escalas ao longo do tempo. Apesar da grande popularidade mostrada, a Escala de Fitzpatrick apresenta limitações na avaliação de risco de cancro da pele, principalmente em indivíduos de pele mais escura. A maioria dos estudos foi avaliada como quasi-experimental (12), observacional (10), ou como ensaios clínicos

randomizados controlados (5), cada um com as suas vantagens e desvantagens. Alguns estudos não especificaram a escala utilizada, indicando a necessidade de melhorar a transparência do reporte de resultados em pesquisas futuras e a utilização de escalas mais amplas e inclusivas.

Palavras-chave: métodos de classificação, hidratação da pele, produção de sebo, sensibilidade da pele, ruga

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**List of abbreviations/acronyms**

**PRISMA-ScR:** Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews

**SCINEXA:** Score for Intrinsic and Extrinsic Skin Aging

**JBI:** Joanna Briggs Institute

**MeSH:** Medical Subject Headings

**TEWL:** Transepidermal Water Loss

**BSTS:** The Baumann Skin Type System

**BSTI:** The Baumann Skin Type Indicator

**LAST:** Lactic Acid Sting Test

## I. Introduction

The body's largest organ, the skin, is a crucial barrier to protecting the internal organs and tissues from external environmental factors (Walker, 2022).

Understanding an individual's skin type and its characteristics is essential in personalizing skincare interventions while assessing the degree of skin aging aids in evaluating treatment outcomes and disease progression.

Every skin type is unique, and its classification is essential once it allows guiding professionals and cosmetics consumers in selecting the most appropriate skin routine, cosmetic products, and the most appropriate treatment, if necessary. It will enable to predict and avoid any severe skin reactions, but it is also essential in clinical research to treat patients most effectively with new and innovative therapies (Torre *et al.*, 2017).

The most common parameters used to classify skin typology are stratum corneum hydration, the type of hydrolipidic film, sun reaction, pigmentation and skin color, sensitivity, and skin aging signs (Oliveira *et al.*, 2023).

The **stratum corneum** is the skin epidermis's outermost layer. It comprises a dense layer of dead skin cells (corneocytes) embedded in a lipid-rich matrix. This layer acts as a protective barrier, providing strength, flexibility, and impermeability to the skin (Das *et al.*, 2016). The stratum corneum is crucial in maintaining skin hydration by preventing water loss. When this is compromised or imbalanced, it can lead to various skin conditions such as dryness, flakiness, roughness, or increased susceptibility to irritants and infection (Del Rosso *et al.*, 2011).

The **hydrolipidic film** is a thin protective layer covering the skin's surface and lies above the stratum corneum. It is a mixture of sweat, a hydrophilic secretion, sebaceous and epidermal lipids, and other natural substances secreted by the skin, forming a spontaneous emulsion (Elkhyat *et al.*, 2017). The hydrolipidic film is decisive in regulating the skin's pH level. It has a slightly acidic pH, typically 4 to 6 (Zlotogorski, 1987; Schmid *et al.*, 2009), which creates an unfavorable environment for the growth of harmful microorganisms. Different skin types have distinct physiological and structural properties, such as variations in sebum production, hydration levels, lipid composition,

and barrier function. Sebum production varies with age, gender, and topographical variations of the skin (Mukherjee *et al.*, 2016).

**Skin color** results from the combination of melanin, a pigment synthesized in the epidermis, and hemoglobin. Skin color is determined genetically and depends on the melanin distribution in the epidermis. However, environmental and hormonal factors can also influence skin color (de Rigal *et al.*, 2007; Markiewicz *et al.*, 2020).

Each person has a different response to the **sun exposition**, depending on the sensitivity to the sun, the tanning ability, and the frequency of solar erythema's appearance. These characteristics will determine its phototype (Passeron *et al.*, 2021).

**Aging skin** presents wrinkles, pigmentation defects, uneven texture and color, and lack of elasticity. It is a complex and multifactorial process involving intrinsic, genetically controlled, and extrinsic components, hormonal changes, sun exposure, smoking, pollution, and lifestyle habits (Baumann, 2007).

Various instruments and methods have been developed in clinical practice and research to classify skin types and evaluate skin aging correctly.

## 1. Classification Methods of Skin Type and Skin Aging

For **skin type**, the classification methods encompass non-invasive bioengineering tools, visual and tactile methods, scales, color charts, and questionnaires/surveys known as self-report instruments, which depend on biophysical principles and skin-imaging techniques that impartially assess skin parameters. To assess **biological skin parameters**, various non-invasive biometric methods were developed (Mercurio *et al.*, 2013; Bielfeldt *et al.*, 2018; Logger *et al.*, 2020; Seo *et al.*, 2022):

1. Stratum corneum water content: Corneometer<sup>®</sup>.
2. Transepidermal water loss: Tewameter<sup>®</sup>.
3. Lipid content: Sebumeter<sup>®</sup>, Sebutape<sup>®</sup>.
4. Skin color: DermaSectometer<sup>®</sup>, Mexameter<sup>®</sup>, Chromameter<sup>®</sup>, Erythema Meter<sup>®</sup>.
5. Skin Mechanical properties: Indentometer<sup>®</sup>, Cutometer<sup>®</sup> (Courage + Khazaka electronic), CutiScan<sup>®</sup>, DermaLab<sup>®</sup>, Elastimeter<sup>®</sup>, Durometer<sup>®</sup>, DynaSkin<sup>®</sup>.

Assessing an individual's skin type through **imaging techniques** enables a comprehensive evaluation of surface-level and deeper skin structure. These methods play a crucial role in diagnosing and evaluating skin conditions and include clinical photography, dermatoscopy, surface microscopy, confocal microscopy, ultrasound, and magnetic resonance imaging, which provide valuable information that aids in understanding the skin's characteristics and identifying potential abnormalities (Mercurio *et al.*, 2013; Ilişanu *et al.*, 2023).

**Visual methods** and observation involve carefully examining the skin, paying attention to its overall appearance, texture, and potential irregularities (wrinkles, acne, comedones, flaking, redness, rosacea, uneven pigmentation). On the other hand, **tactile methods** evaluate the texture, thickness, temperature, elasticity, pliability, and firmness of the skin (Tobin, 2017; Humphrey *et al.*, 2021). Every method has advantages and disadvantages; these two methods are subjective and depend on the evaluator's expertise. Combining these methods allows the categorization of the skin into different types known as normal, dry, oily, sensitive, and aging skin, which can be identified when applying questionnaires/surveys, visual rating scales, and self-report instruments.

Specific analysis instruments are commonly used to categorize skin types, divided according to their categorization.

## 1.1 Questionnaires

### 1.1.1 The Baumann Skin Type System (BSTS)

**The Baumann Skin Type System (BSTS)** is a type of classification that results in a combination of skin parameters. The combination of the parameters yields 16 possible skin types. BSTS assigns specific designations to each skin type category, determined using a comprehensive questionnaire called the Baumann Skin Type Indicator (BSTI). This questionnaire comprises 64 items designed to assess and identify an individual's skin type. It is used both as a baseline assessment and to track changes in skin type following significant life events or environmental factors (Baumann, 2014).

BSTI utilizes a 4-letter skin type designation code to classify individuals based on their skin characteristics. Each letter corresponds to a different aspect of the skin:

#### **Dry (D) or Oily (O)**

Skin type can be categorized as dry or oily primarily based on the amount of sebum or oil the skin produces. Sebum forms a lipid-based film on the skin's surface, crucial in maintaining skin hydration. The condition of the stratum corneum also influences whether one's skin is classified as dry or oily, as it helps retain moisture within the skin.

Dry skin is characterized by reduced sebum production, resulting in a rough texture, diminished light reflection, and a sensation of tightness, particularly following cleansing. On the other hand, oily skin is distinguished by adequate or increased sebum production, leading to a lesser need for additional moisturization.

#### **Sensitive (S) or Resistant (R)**

Skin type can be categorized as sensitive or resistant based on the skin's tendency towards inflammation. Sensitive skin is more prone to reacting negatively to skincare products, often exhibiting symptoms such as redness, burning, or acne.

On the other hand, resistant skin rarely experiences adverse reactions to skincare products. Resistant skin is characterized by a robust stratum corneum, the outermost layer of the skin, which can make it less receptive to the beneficial effects of skincare

ingredients due to reduced absorption. Consequently, individuals with resistant skin types often require more potent products to achieve desired results.

### **Pigmented (P) or Non-Pigmented (N)**

Skin can be categorized as either pigmented or non-pigmented based on its disposition to develop unwanted pigment, leading to an uneven skin tone. This pigmentation can arise from various factors, including sun exposure, resulting in melasma or solar lentigos (sunspots). Additionally, injury to the skin can lead to post-inflammatory hyperpigmentation, where pigmentation develops as a response to inflammation.

### **Wrinkle-prone (W) or Tight (T)**

Various factors influence this distinction. Age, ethnicity, and lifestyle habits determine whether the skin is prone to wrinkles or retains tightness. While genetics do have some influence on this parameter, external factors that contribute to an aging appearance are within control.

Sun exposure is the primary cause of skin aging among these external factors. The destructive impact of sunlight on vital skin proteins, such as collagen and elastin, accelerates the formation of wrinkles and contributes to skin elasticity loss.

Using the BSTI questionnaire in the Baumann Skin Type System allows for a more comprehensive understanding of an individual's skin type, enabling professionals to tailor skincare recommendations and interventions based on their specific needs and circumstances. It acknowledges that skin type is not a static characteristic and can be influenced by various life events and environmental factors (Baumann, 2006; Baumann, 2008; Leslie, 2008).

### 1.1.2 The Fitzpatrick Skin Phototype Classification (FSPC)

**The Fitzpatrick Skin Phototype Classification** system categorizes individuals based on their skin's reaction to sun exposure. It considers factors such as the propensity to experience sunburn and tanning. This classification is determined through a questionnaire that evaluates genetic predisposition, response to sun exposure, and tanning habits. By assessing these factors, the Fitzpatrick Skin Phototype Classification provides insights into an individual's skin sensitivity to sunlight and natural tanning abilities (Roberts, 2009b; Gupta *et al.*, 2019; Fors *et al.*, 2020).

At any rate, FSPC has some limitations due to its subjective nature and inconsistent correlation with a minimum erythema dose. Results from skin prototyping may vary based on the evaluator, the survey method (interview or self-report), and how the questions are formulated, potentially leading to different answers (Gupta *et al.*, 2019).

Additionally, the FSPC seems more suitable and validated for the white population than the non-white skin type. The system's effectiveness in accurately assessing skin types and sensitivity may differ across different racial and ethnic backgrounds, leading to potential inaccuracies in its application for individuals with non-white skin (Wilkes *et al.*, 2015; Sommers *et al.*, 2019; Ware *et al.*, 2020; Goon *et al.*, 2021).

Table 1 - The Fitzpatrick Skin Phototype Classification (Fors *et al.*, 2020).

Type	Description
I	Pale white skin, always burns, never tans.
II	White skin, burns easily, minimal tan.
III	Medium white skin, sometimes burns, tans slowly.
IV	Moderate brown skin, burns minimally, tans easily.
V	Brown skin, rarely burns.
VI	Dark brown skin, never burns.

### 1.1.3 The Roberts Skin Type Classification System

**The Roberts Skin Type Classification System** is a system that comprises four elements, each of which is assigned a numeric value or feature based on well-defined guidelines and skin boundaries (Roberts, 2008; Roberts, 2009b; Roberts, 2018).

Developing a comprehensive tool to communicate essential concepts related to skin characteristics became necessary, especially considering the unique requirements, risks, and tendencies of ethnically diverse skin. Two scales were created to address this need, working with the Fitzpatrick and Glogau scales, which aimed to evaluate the capacity for pigmentation and describe the morphology of scarring experienced by patients (Roberts, 2008):

**The Roberts Hyperpigmentation Scale (H)** was introduced as a 7-point system designed to assess the natural progression of post-inflammatory pigmentation in individuals and their predisposition to pigmentation issues. Determining this value considers the patient's medical history, clinical examination, and ancestral background.

**The Roberts Scarring Scale (S)** provides a classification system for an individual's scarring patterns on a 6-point scale. The scores obtained through this scale assist in determining the short-term and long-term effects of various medical treatments and procedures related to scarring (Roberts, 2008; Roberts, 2009a; Oliveira *et al.*, 2023).

This straightforward assignment relies on the patient's medical history, physical examination, and ancestral background. Considering these elements, a comprehensive profile of the patient's skin type can be determined, facilitating more personalized and effective treatment approaches.

## 2. Visual Rating Scales

### 2.1 The Glogau Scale

**The Glogau Scale** is a widely used tool for classifying the extent of photoaging and the presence of wrinkles. It involves evaluating the characteristics of photoaged skin and associated wrinkles (Glogau, 1996; Roberts, 2009a).

The scale categorizes the level of photoaging as follows:

*Table 2 - The Glogau Scale (Glogau, 1996).*

Group	Classification	Typical Age	Description	Skin Characteristics
<b>I</b>	Mild	28-35	No wrinkles	Mild pigment changes, no keratosis, minimal wrinkles, minimal or no make-up required
<b>II</b>	Moderate	35-50	Wrinkles in motion	Early brown spots visible, keratosis, palpable but not visible, parallel smile lines begin to appear, wears some foundation.
<b>III</b>	Advanced	50-65	Wrinkles at rest	Discoloration, visible capillaries, visible keratosis, wearing heavier foundation
<b>IV</b>	Severe	60 and above	Only wrinkles	Yellow/grey skin color, prior skin malignancies, wrinkles throughout, no normal skin, cannot wear make-up because it cracks and cakes.

However, there are limitations to this scale:

1. Subjectivity, as it relies on the assessment of the clinical researcher.
2. Culture-dependent: the perception of wrinkles and aging can vary across cultures (which makes the scale restricted).
3. Limited facial areas: the scale only covers wrinkles in some regions of the face.
4. No standardization: no universal standard for using the scale, conducting inconsistent results.

Furthermore, it is essential to consider the impact of photoaging on individuals with different racial and ethnic backgrounds. Although it has its limitations, the Glogau Scale continues to be a widely recognized and valuable tool for assessing skin photoaging. This

classic method becomes particularly useful in efficacy studies involving various antiaging treatments such as laser procedures, surgery, radiofrequency therapy, skin rejuvenation treatments, and cosmetic interventions (Oesch *et al.*, 2022).

## 2.2 The Griffiths Photonumeric Scale

**The Griffiths Photonumeric Scale** is a valuable tool for classifying the severity of cutaneous photodamage in photoaged skin. It utilizes a 9-point visual scale consisting of photographs that depict incremental degrees of photodamage. The scale ranges from 0, representing no severity of photoaging, to 8, indicating a high severity of photoaging.

Additionally, specific scales are available to assess hypertrophic and atrophic facial photoaging (Ayer *et al.*, 2018), where the scale ranges from 0 (no photoaging) to 8 (very severe), with intermediate levels of severity represented by scores between 2 (mild), 4 (moderate), and 6 (severe).

These scales provide a standardized approach to visually evaluate the level of photodamage and aid in assessing the extent of facial aging (Griffiths *et al.*, 1992).

## 2.3 The Score of Intrinsic and Extrinsic Aging – SCINEXA

**The Score of Intrinsic and Extrinsic Aging (SCINEXA)** is a unique scale that assesses intrinsic and extrinsic skin aging separately, enabling a clear distinction between these two aging processes (Vierkötter *et al.*, 2009). This wide scale considers signs of intrinsic aging, such as pigmentation irregularities, fine wrinkles, decreased fat tissue, and benign skin tumors. It also includes indicators of extrinsic aging, like yellowness, deep wrinkles, elastosis, telangiectasias, and malignant skin tumors. Each parameter is scored independently through a clinical examination, with a total possible score of 69 points (15 for intrinsic and 54 for extrinsic photoaging) (Vierkötter *et al.*, 2010; Fors *et al.*, 2018).

This versatile scale has proven to be a valuable tool for accurately assessing and quantifying the effects of intrinsic and extrinsic factors on skin aging, making it an asset in dermatological research and clinical practice.

Table 3 – Applied skin aging score of SCINEXA (Vierkötter *et al.*, 2010).

<b>Skin aging signs</b>	<b>Localization</b>	<b>Scoring</b>
<i>Extrinsic signs</i>		
<b>Pigment spots<sup>1</sup></b>	On forehead	0 (0), 1-10 (5), 11-50 (30), >50 (75)
	On cheeks	0 (0), 1-10 (5), 11-50 (30), >50 (75)
	On the upper side of the rearm	0 (0), 1-10 (5), 11-50 (30), >50 (75)
	On the back of the hand	0 (0), 1-10 (5), 11-50 (30), >50 (75)
<b>Coarse wrinkles<sup>2</sup></b>	On forehead	Grades 0 to 5
	Wrinkles in crow's feet area	Grades 0 to 5
	Under the eyes	Grades 0 to 5
	On upper lip	Grades 0 to 5
	Nasolabial fold	Grades 0 to 5
<b>Solar elastosis</b>	On cheeks	Yes/no
<b>Telangiectasia</b>	On cheeks	Grades 0 to 5
<i>Intrinsic signs</i>		
<b>Laxity<sup>2</sup></b>	Ovality of the face	Grades 0 to 5
<b>Seborrheic keratosis<sup>1</sup></b>	On the upper part of the body	0 (0), 1-10 (5), 11-50 (30), >50 (75)

<sup>1</sup>Scoring of spots and seborrheic keratosis with counts in paratheses, <sup>2</sup>Grading with photoreference scales; 0 = sign not present, up to 5 = sign very severely present.

#### 2.4 Sensitive Skin – Lactic Acid Stinging Test (LAST)

Sensitive skin is often self-diagnosed, meaning individuals perceive and label it as sensitive based on their subjective experiences. Interestingly, sensitive skin isn't typically accompanied by visible physical signs of irritation, making it a somewhat elusive condition to identify objectively (Inamadar *et al.*, 2013).

The measurement of skin sensitivity and the evaluation of therapeutic effects have been enhanced by introducing a Sensitive Scale, which has become a novel method.

The subjective evaluation relies on an individual's self-reported responses to various stimuli, including **Lactic Acid Stinging Tests (LAST)**, dimethyl sulfoxide, sodium lauryl sulfate, capsaicin, and menthol. These tests enable subjects to describe their

cutaneous reactions, providing valuable insights into their sensitivity levels (Cho *et al.*, 2012).

On the other hand, the objective assessment involves specialized instruments to measure specific epidermal biophysical properties such as stratum corneum hydration, transepidermal water loss, sebum content, pH levels, and erythema indices. Additional techniques, visual or mechanical observations, can ascertain the presence and severity of skin sensitivity.

There is no universally standardized method for diagnosing sensitive skin, but different approaches may be used. The lack of consistent diagnostic protocol can make accurate and reliable diagnosis challenging.

Further research and development in skin sensitivity diagnosis must establish a standardized and reliable method incorporating subjective and objective measures. By enhancing the understanding of the intricate mechanisms of skin sensitivity and its correlation with the stratum corneum, diagnostic accuracy can be improved and provide targeted treatment approaches for individuals with sensitive skin.

## 2.5 Fabi-Bolton Chest Wrinkle Scale

**The Fabi-Bolton Wrinkle Scale** is a widely used system for assessing the severity of wrinkles on the skin. It consists of 5 levels, ranging from 1 (wrinkles absent) to 5 (very deep with redundant folds), which provide a descriptive classification of wrinkle appearance.

To facilitate objective quantification of chest wrinkles and evaluate the severity of the condition, the Fabi/Bolton chest wrinkle scale has been developed. This photonic scale provides a standardized method for clinicians to assess and measure the wrinkles on the chest. This scale's reliability has been established through measurement evaluation, ensuring consistent and accurate assessment across different patients and practitioners (Fabi *et al.*, 2012).

Table 4 - Fabi-Bolton Wrinkle Scale (Fabi et al., 2012).

Grade	Severity
I	Wrinkles absent
II	Shallow but visible lines
III	Moderately deep lines
IV	Deep with well-defined lines
V	Very deep with redundant folds

## 2.6 Lemperle Wrinkle Scale

**The Lemperle Wrinkle Scale**, also known as the Lemperle Assessment Scale, is a rating system used to evaluate the severity of facial wrinkles. It was developed by Dr. Serge Lemperle, a plastic surgeon, and his colleagues to assess facial wrinkles and their impact on facial aging objectively.

This scale combined a photographic technique with a previously validated six-point photonumeric scale. The scale comprises four grades, ranging from Grade 1 (no wrinkles) to Grade 5 (profound wrinkles, redundant folds). Each grade is further divided into subcategories based on the depth and extent of the wrinkles. The specific criteria for each stage may vary slightly depending on the area of the face being evaluated, such as the forehead, glabella (area between the eyebrows), periorbital region (around the eyes), and so on (Lemperle *et al.*, 2001; Wolff *et al.*, 2005).

The Lemperle Wrinkle Scale provides a standardized method for clinicians and researchers to communicate and quantify the severity of facial wrinkles. It can be used in cosmetics treatments, such as dermal filler injections or botulinum toxin (Botox) treatments (Lemperle *et al.*, 2001), to determine the appropriate intervention for a patient based on their wrinkle grade.

However, it is essential to note that while the Lemperle Wrinkle Scale is a valuable tool, various methods exist. Practitioners and researchers may prefer or use alternative scales, depending on their specific needs and preferences.

Table 5 - Lemperle Wrinkle Scale (Lemperle et al., 2001).

<b>Grade</b>	<b>Severity</b>
<b>0</b>	No wrinkles
<b>1</b>	Just perceptible wrinkles
<b>2</b>	Shallow wrinkles
<b>3</b>	Moderately deep wrinkles
<b>4</b>	Deep wrinkles, well-defined edges
<b>5</b>	Very deep wrinkles, redundant folds

### 3. Other instruments

#### 3.1 Skin color charts/cards/bars

Simple and economic methods are available to determine an individual's skin phototype. That involves selecting the color that closely matches the skin tone on the upper part of their arm. This straightforward approach allows for a quick assessment of an individual's skin phototype, providing a general understanding of their skin's natural pigmentation (Gupta *et al.*, 2019).

This method allows individuals to gain insights into their skin's inherent characteristics without complex or expensive diagnostic procedures (Treesirichod *et al.*, 2014).

## II. Aim

This scoping review aims to investigate and compile the instruments, other than bioengineering tools or visual/tactile evaluation, that are used for classifying skin type and degree of skin aging concerning the following questions:

- What instruments are being used to classify skin type?
- What instruments are being used to classify the degree of skin aging?

## III. Methods

This scoping review was conducted according to The Joanna Briggs Institute's (2020) recommendations for scoping studies. A protocol was already developed and duly registered on the platform Open Science Framework (available at: <https://osf.io/4q58c/>). The PRISMA-ScR Checklist – Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews (Tricco *et al.*, 2018) was used for reporting results.

### 3.1 Eligibility criteria

The eligibility criteria were based on original research articles, with no restrictions on the publication date, study design, results, or context, that aims to classify skin typology and aging with methods other than biophysical or visual/tactile evaluation. All studies were grouped according to a purpose:

- a. Studies using instruments to classify skin type – considering oiliness/dryness, sensitivity, skin color and pigmentation, sun reaction, and hydrolipidic film.
- b. Studies using instruments to classify the degree of skin aging according to cutaneous aging signs such as wrinkles, lack of elasticity, uneven pigmentation, and texture.
- c. Studies using instruments will also be grouped according to their methodological characteristics, such as rating scales, questionnaires/surveys, and psychometric instruments.

As recommended for scoping reviews, no study was excluded based on methodological quality.

### 3.2 Search strategy

This review was carried out from September 2022 to July 2023 and will aim to locate both published and unpublished studies and adopt a three-step research strategy (The Joanna Briggs Institute, 2020). The PRISMA guidelines also conducted it.

An initial limited search in online databases such as MEDLINE, PubMed, Scopus, SciELO, and Web of Science was undertaken to identify articles on the topic.

A secondary search was conducted by hand-searching references cited by the eligible articles from the initial investigation. The text words in the titles and abstracts of relevant articles and index terms used to describe the papers were used to develop a complete search strategy for MEDLINE PubMed, SciELO, Web of Science, and Scopus. Full search terms, filters applied, and the number of articles found for each database are summarized in Appendix I.

More information was extracted from other sources: online press, books, Dermatology and Cosmetology Scientific Societies, and the Association of Cosmetics Industries.

### 3.3 Source of evidence selection

After the search, all identified citations and articles were selected through the analysis by title, collated, and exported into EndNote 20. After this protocol step was ready, all the duplicates were removed.

Following the pilot test, 50 random titles and abstracts were screened by two independent reviewers for assessment to refine the inclusion criteria for the review. Relevant sources were retrieved, and their citation details were imported into Rayyan, where abstracts and titles were screened. Two independent reviewers assessed the full text of selected citations against the inclusion criteria.

Reasons for excluding sources of evidence in full text that do not meet the inclusion criteria were recorded and reported in the scoping review. Any disagreements between the reviewers at each stage of the selection process were resolved through discussion by a third part. The search results and the study inclusion process were reported in full in the final of the scoping review and presented in a Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) flow diagram (see Appendix II).

### 3.4 Data extraction

The following review characteristics were extracted from the full-text articles: document categorization, author(s) and year, article category, origin, aim or purpose, population (region, sample size), study design (qualitative or quantitative), assessment instruments (questionnaires or surveys, rating scales, psychometric tools), results, and their details, limitations, and conclusions.

A draft extraction form is provided (see Appendix III). Before proceeding to data extraction, the pilot phase was conducted using 15 random records. The results of this random record were discussed, and after a high consensus among the two reviewers, the team independently performed the complete data extraction. Any disagreements and discrepancies between the reviewers were discussed and solved.

### 3.5 Data analysis

This stage's main objective was to investigate and group which instruments exist for the classification of skin type and skin aging.

To report this selection process's sequence, a flowchart was constructed where the total number of records, duplicates, and screening results and records were included in this scoping review (see Appendix II).

The studies were grouped into tables according to their data items, which summarize the number of records and their distribution by categories (see Appendix III).

## IV. Results

### 4.1 Included results

The search strategy identified 1336 studies. After excluding 527 duplicate citations from EndNote, 809 studies were selected for reading the abstract and determining relevance to the inclusion criteria after the exportation to the platform Rayyan. Subsequently, 147 articles were excluded since they were again detected as duplicate citations. After this exclusion, the articles' titles and abstracts were read and later selected 292 studies, while 372 were excluded.

Finally, the reading in full of 292 studies, of which 131 were excluded for not having access to the article or authorization of the author (Reason 1), one was excluded because of the idiom (language not accessed by the reviewers) (Reason 2), 133 were excluded because they did not fit the inclusion criteria (since they only focused on bioengineering methods) (Reason 3) and 27 were included in the review.

The research results are presented in the Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) flow diagram (see Appendix II).

### 4.2 Study characteristics

Various assessment scales were utilized to quantify skin parameters in the analysis of dermatology research studies. The frequency of scale usage among the reviewed studies was as follows:

Table 6 – Study Characteristics.

Instrument	Number of Studies (where the instrument was used)	References
Lemperle Wrinkle Scale	2	(Wolff <i>et al.</i> , 2005; Prado <i>et al.</i> , 2008)
Glogau Scale	3	(Ozturk <i>et al.</i> , 2013; Gold <i>et al.</i> , 2014a; Zahr <i>et al.</i> , 2019)

<b>Questionnaires</b>	3	(Chan <i>et al.</i> , 2010b; Roberts <i>et al.</i> , 2015; Aguirre <i>et al.</i> , 2017b)
<b>Baumann Skin Type System</b>	1	(Ahn <i>et al.</i> , 2017)
<b>Fitzpatrick Skin Phototype Classification Scale</b>	9	(Brazil <i>et al.</i> , 2003; Nouveau-Richard <i>et al.</i> , 2005; Aquilina <i>et al.</i> , 2007; Lee <i>et al.</i> , 2010a; Piccioni <i>et al.</i> , 2011; Van Der Wal <i>et al.</i> , 2013; Quattrone <i>et al.</i> , 2017; Gold, 2019; Gold <i>et al.</i> , 2020a)
<b>Griffiths Photonumeric Scale</b>	4	(Manuskiatti <i>et al.</i> , 1999; Geronemus <i>et al.</i> , 2016; Jones <i>et al.</i> , 2018; Kelm <i>et al.</i> , 2020)
<b>Fabi-Bolton Wrinkle Scale</b>	2	(Fabi <i>et al.</i> , 2013b; Nam <i>et al.</i> , 2017)
<b>Studies that did not specify the scale used</b>	3	(Doshi <i>et al.</i> , 2006; Bazin <i>et al.</i> , 2010a; Lee <i>et al.</i> , 2015a)

Regarding study designs, most of the research falls into three categories: observational, quasi-experimental, and randomized controlled trials (RCT). Out of the total studies analyzed (27 articles), 10 were observational, 12 were quasi-experimental, and 5 were randomized controlled trials.

## **V. Discussion**

Dermatology research is crucial in understanding skin conditions, aging, and therapeutic interventions. Scales are widely used in this field of skin conditions, allowing researchers to obtain standardized and comparable data.

The analysis of relevant literature revealed the utilization of multiple scales to assess various skin parameters. The Fitzpatrick Skin Phototype Classification Scale is the most frequently employed among the rankings mentioned, used in nine studies. This widespread use of the Fitzpatrick Skin Phototype Classification Scale might be attributed to its simplicity, effectiveness in assessing skin type and response to UV exposure, and established reliability and validity. It was followed by the Griffiths' Photonumeric Scale, used in four studies. Additionally, the Glogau Scale and questionnaires were each employed in three studies. At the same time, the Lemperle Wrinkle Scale and Fabi-Bolton Wrinkle Scale were used in two studies each. Ultimately, Baumann Skin Type System was only used in one study. Notably, three studies should have specified the scales utilized in their research, highlighting the need for transparent reporting to facilitate future meta-analyses and comparative assessments.

Despite the diverse range of scales available for dermatological assessments, the analysis revealed no significant trends indicating a noticeable increase or decrease in specific scales over time. This observation suggests that researchers might choose scales based on the specific objectives of their studies and the parameters they intend to measure rather than following a uniform pattern.

However, the dominant usage of the Fitzpatrick Skin Phototype Classification Scale could indicate its continued popularity and acceptance in the dermatology community. As the review showed, it is utilized primarily by laser and aesthetic technicians in laser skin treatments to assess the efficacy of lasers on different skin types. Dermatologists also employ this scale to evaluate the risk of skin cancer, although its outdated and subjective nature may not accurately reflect the actual risk. Due to its problematic history, the Fitzpatrick Scale offers limited options for people of color. Misclassification of race by some professionals may occur, particularly among dermatologists who do not identify as having skin of color, leading to potential misuse of the Fitzpatrick Classification System. Despite its limitations, it remains widely employed.

Most studies analyzed in this review were observational or quasi-experimental with control groups or randomization. Of these studies, it is important to note that the following article reported using validated scales (Fabi *et al.*, 2013a). Both study types hold unique strengths and limitations that researchers must consider when designing and interpreting their investigations.

Observational studies investigate phenomena in natural settings, providing valuable insights into real-world behaviors and interactions. These studies are often more feasible and ethical, requiring minimal interference with participants' lives. They also offer a broader scope, as researchers can examine various variables and complex interactions that might be challenging to manipulate in experimental settings. Observational studies' ecological validity enhances the findings' applicability to real-life situations (Andrade, 2018).

Despite their strengths, observational studies have inherent limitations. The lack of manipulation of variables prevents them from establishing causality definitively. The presence of confounding variables can lead to inaccurate or misleading conclusions. Since random assignment is absent, selection biases can impact the validity of results. Additionally, reliance on self-report or imperfect measures might affect the accuracy of data collected (Assimon, 2021).

On the other hand, experimental studies are characterized by their ability to establish cause-and-effect relationships between variables through controlled manipulation. Researchers have significant control over the study environment, allowing for precise measurements and the elimination of potential confounding factors. The random assignment of participants to experimental and control groups enhances internal validity and reduces selection bias (Bonell *et al.*, 2012). The ability to replicate experiments adds to the reliability of findings, and the results can often be generalized to the broader population under controlled conditions.

However, experimental studies have their limitations. Some designs may raise ethical concerns (Helmchen, 2011), as they involve exposing participants to potentially harmful or uncomfortable conditions. Moreover, the artificiality of the controlled setting may limit the generalizability of findings to real-world scenarios (Monti *et al.*, 2018).

It is essential to mention that the research revealed significant limitations since it presented 131 articles without access and another report whose language was not

accessible to the reviewers. This high number should not be usual nor presented in this type of research. This is another area for improvement since only one study used the Baumann Skin Type System. It makes the results limiting since it is a widely used scale.

While valuable for their comprehensive nature, Scoping reviews may present some limitations, including longer timeframes, the need for multiple structured searches instead of a single search, and the requirement for larger teams to handle the extensive volume of literature involved.

## **VI. Conclusion**

The scoping review yielded valuable insights into using assessment scales and study designs. The Fitzpatrick Skin Phototype Classification Scale was employed in nine studies among the various scales to assess skin parameters. This broad range can be attributed to its simplicity, efficacy in determining skin type and response to UV exposure, and established reliability and validity.

The analysis showed a diverse array of scales utilized in dermatological assessments, with no discernible trends indicating a notable increase or decrease in specific scales over time. Researchers select scales based on their study objectives and the parameters they wish to measure rather than adhering to a standardized approach. Nonetheless, the consistent utilization of the Fitzpatrick Scale indicates its enduring popularity and acceptance in the dermatology community. Laser and aesthetic technicians commonly use it for laser skin treatments and by dermatologists to assess the risk of skin cancer.

Despite its widespread use, the Fitzpatrick Scale has limitations, particularly in its application to individuals with skin of color due to its outdated and subjective nature. Misclassification of race by some professionals, especially among dermatologists who do not identify as having the skin of color, may lead to potential misuse of the Fitzpatrick Classification System. Despite these drawbacks, it continues to be widely employed in dermatological research and practice.

Regarding study designs, most of the studies analyzed were observational or quasi-experimental with control groups or randomization. Both study types possess unique strengths and limitations that researchers must consider when designing and interpreting their investigations.

Observational studies offer valuable insights into real-world contexts and are less invasive, making them helpful in generating hypotheses and exploring real-world scenarios. However, they fall short of establishing causality definitively and are susceptible to biases and confounding factors.

On the other hand, experimental studies with control or randomization provide more robust evidence for causality and enhance reproducibility, making them vital for informing practical decision-making. Nevertheless, some experimental designs may raise

ethical concerns, and the controlled conditions may limit generalizability to real-world settings.

The scoping review also revealed some limitations, including many articles that needed authorized access and language barriers. Additionally, the limited usage of the Baumann Skin Type System, despite its wide recognition, calls for improved reporting transparency in future research.

In conclusion, dermatology research, supported using assessment scales and different study designs, plays a critical role in understanding skin health, aging, and therapeutic interventions. Researchers must continue to weigh the strengths and limitations of various scales and study designs to ensure the accuracy and applicability of their findings.

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## Appendices

### Appendix I

Table 7 - Search strategy (most relevant databases).

Databases	Strategy (MeSH Terms)	Results	Filters
<b>MEDLINE (via PubMed)</b>	(tool[TIAB] OR instrument[TIAB] OR scale[TIAB] OR survey[TIAB] OR questionnaire[TIAB]) AND (assess*[TIAB] OR evaluation[TIAB] OR classification[TIAB]) AND ("Skin typ*" [TIAB] OR oil*[TIAB] OR "sebum production"[TIAB] OR sensitiv*[TIAB] OR pigment*[TIAB]) AND ("Skin aging"[TIAB] OR "cutaneous aging"[TIAB] OR photoaging[TIAB] OR wrinkle[TIAB] OR sunspot[TIAB] OR hyperpigment*[TIAB])	314	None
<b>Scopus</b>	(TITLE-ABS (tool) OR TITLE-ABS (instrument) OR TITLE-ABS (scale) OR TITLE-ABS (survey) OR TITLE-ABS (questionnaire)) AND (TITLE-ABS (assess*) OR TITLE-ABS (evaluation) OR TITLE-ABS (classification)) AND (TITLE-ABS ("Skin typ*") OR TITLE-ABS (oil*) OR TITLE-ABS ("sebum production") OR TITLE-ABS (sensitiv*) OR TITLE-ABS (pigment*)) AND (TITLE-ABS ("Skin aging") OR TITLE-ABS ("cutaneous aging") OR TITLE-ABS (photoaging) OR TITLE-ABS (wrinkle) OR TITLE-ABS (sunspot) OR TITLE-ABS (hyperpigment*))	486	None
<b>SciELO</b>	((((((((((((ti:(tool)) OR (ti:(instrument)) OR (ti:(scale)) OR (ti:(survey)) OR (ti:(questionnaire)))) AND (ti:(assess*)) OR (ti:(evaluation)) OR (ti:(classification)))) AND (skin typ*)) OR (oil*)) OR (sebum production)) OR (sensitiv*)) OR (pigment*)) AND (skin aging)) OR (cutaneous aging)) OR (photoaging)) OR (wrinkle)) OR (sunspot))	40	Health Sciences
<b>Web of Science</b>	((TS=((tool OR instrument OR scale OR survey OR questionnaire))) AND TS=((assess* OR evaluation OR classification))) AND TS=(("Skin typ*" OR oil* OR "sebum production" OR sensitiv* OR pigment*)) AND TS=(("Skin aging" OR "cutaneous aging" OR photoaging OR wrinkle OR sunspot OR hyperpigment*))	494	None

Appendix II

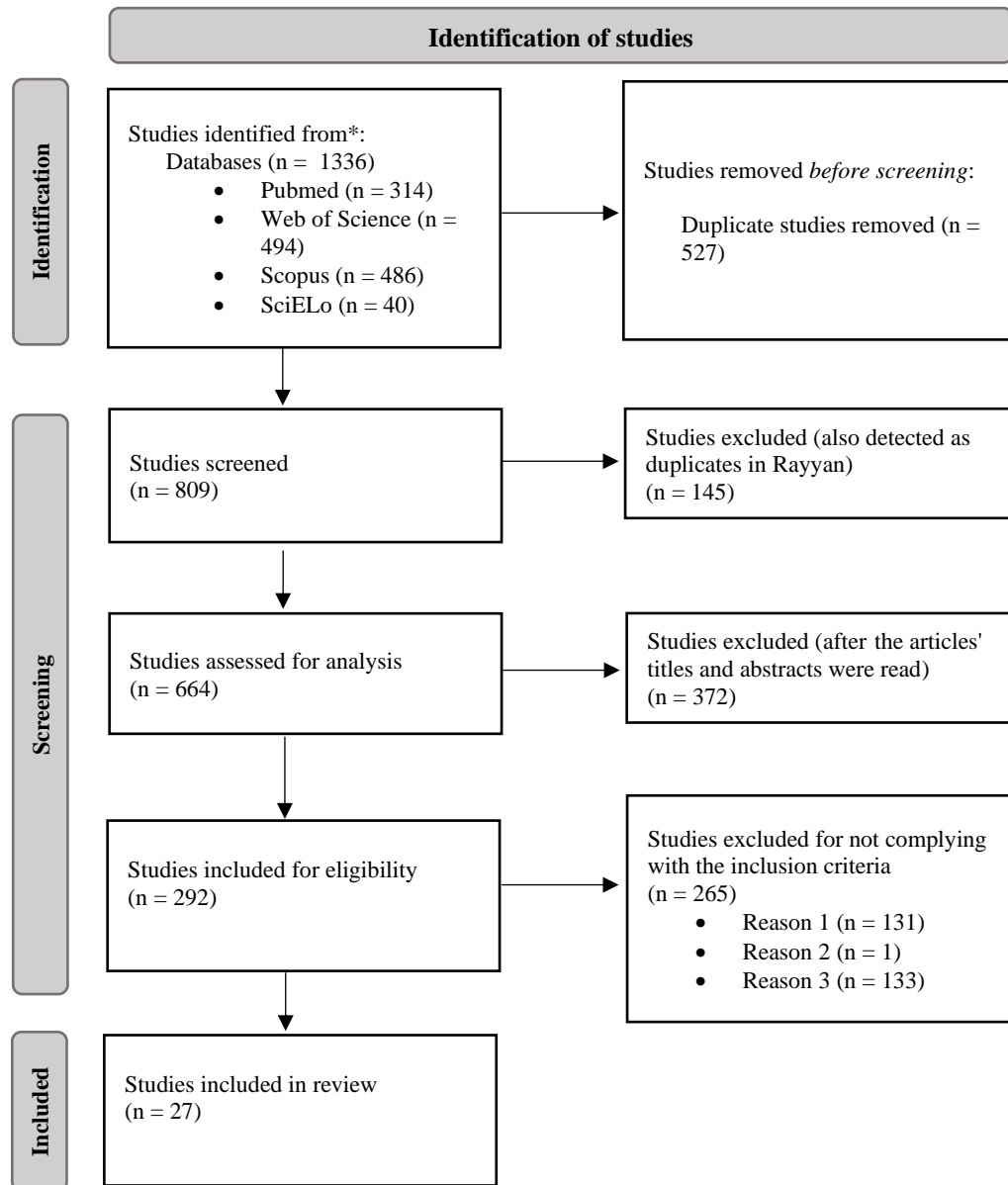


Figure 1 - PRISMA 2020 flow diagram for new systematic reviews, which included searches of databases and registers only (Page et al., 2021).

Reason 1: not having access to the article or authorization of the author; Reason 2: language not accessed by the reviewers; Reason 3: did not fit the inclusion criteria (since they only focused on bioengineering methods).

Appendix III

Table 8 – Data extraction.

Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
(Aguirre <i>et al.</i> , 2017a)	Journal Article	Dietary Supplements	Journal of Dietary Supplements	Evaluate the efficacy of oral supplementation with Ovoderm on various skin biophysical parameters related to cutaneous aging.	Spain 25 adults, healthy and Caucasian.	Quantitative Observational Study	Self-Assessment Questionnaire	<b>Pilot Study 1</b> Facial skin softness (100%), facial skin hydration (94%), body skin hydration (89%), facial skin brightness (83%), and the smoothness of facial skin (72%).	-	Facial skin softness (100% satisfaction) and hydration (94% satisfaction), as well as body skin hydration (89% satisfaction).
(Ahn <i>et al.</i> , 2017)	Journal Article	Dermatology and Skin Physiology	Annals of Dermatology	Evaluate the distribution and characteristics of Baumann skin types and investigate the influence of various factors on skin type distribution.	Korea 1000 women of different age groups.	Quantitative Observational Study	Baumann Skin Type Questionnaires	The most common skin types are OSNT, DSNT, DRNT, and OSNW (55.3%). The O, S, P, and W types accounted for 46.6%, 68.8%, 23.2%, and 31.9%, respectively. The O and S type proportion was the highest in Gyeongsangbuk-do (55.0%) and Seoul (77.2%). The balance of the P and W types was the highest in Gyeongsangbuk-do	The subjective interpretation could cause bias, especially in parts 3 and 4 of the questionnaire.	OSNT was Korean women's most common skin type.

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
								(33.0%) and Chungcheong-do (39.0%). The O type decreased (in the higher age group). The P and W types showed a reversed tendency. The W type was significantly higher in smokers and non-smokers (66.3% vs. 24.1%).		
<b>(Aquilina et al., 2007)</b>	Journal Study	Dermatology	Journal of the European Academy of Dermatology and Venereology	Estimate the distribution of skin phototypes among the Maltese population and assess their inherent risk of sunburn and skin cancers.	Malta 756 patients (372 male and 384 female) with skin infections or skin tags	Quantitative Observational Study	Fitzpatrick Skin Phototype Classification	The commonest reported skin phototype in both sexes was type III: 48.0% (52.4% in males, 43.8% in females). Type IV in males: 30.4%. Type II in females: 32.3%. Skin type I: 1.2%.	Fitzpatrick Classification System limitations (which remains very economical as it needs no special equipment).	That SPT III is the most common phototype in the Maltese population.
<b>(Nouveau-Richard et al., 2005)</b>	Journal Article	Dermatology	Journal of Dermatological Science	Evaluate the influence of age and sun exposure are the main clinical signs of Asian skin aging.	France & China 320 healthy women (160 in France and 160 in	Quantitative Observational Study	Fitzpatrick Skin Phototype Classification	French women: 11% of Phototype II, 74% phototype III, and 15% phototype IV. 35% of the Chinese women in the	Lack of elements to support clinical evidence as regards	Consistent and relevant data to support previous hypotheses suggesting skin-aging differences between

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
					China), distributed by age decade into four identical sub-groups of 40 volunteers in each center.			The study had a fair skin complexion, 57.5% an intermediate skin complexion, and 7.5% a dark skin complexion.	wrinkle development.	European and Asian populations.
(Jones <i>et al.</i> , 2018)	Journal Article	Dermatology	Journal of Cosmetic Dermatology	Evaluate the efficacy of a combination of IPL with a daily topical skincare and sunscreen regimen for treating facial photodamage and improving IPL treatment tolerability.	USA, 20 females, aged 18-65 with Fitzpatrick skin phototype I-IV with moderate-to-severe facial hyperpigmentation.	RCT	Modified Griffiths' Scale	20 female patients aged 42-62 presenting with a mean $\pm$ SD score of $5 \pm 0.86$ for facial hyperpigmentation and a mean $\pm$ SD score of $5.6 \pm 1.4$ for facial photodamage.	Small sample size, lack of blinding and randomization, and the absence of a control group.	Improving facial pigmentation and photodamage.
(Fabi <i>et al.</i> , 2013b)	Journal Article	Dermatology	Journal of the American Academy of Dermatology	Evaluate efficacy and safety of micro-focused ultrasound with visualization treatment of décolletage laxity and rhytides.	24 subjects with moderate to severe rhytides.	RCT	Fabi/Bolton Chest Wrinkle Scale	<b>Day 0:</b> All the participants had an FBCWS score of 3 or higher. <b>On day 90:</b> 11 of 24 subjects had an FBCWS score of 1 or 2.	The single-center study had a small sample size and only Fitzpatrick skin types I and II.	Improvement of wrinkle reduction.

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
								Day 180: 13 of 21 subjects scored 1 or 2.		
(Nam <i>et al.</i> , 2017)	Journal Article	Dermatology	Lasers in Medical Science	Evaluate the efficacy of combination with HIFU and low-fluence Q-switched Nd: YAG (LQSNY) laser on the aging neck and décolletage	20 women between 40 and 70 years of age	Quasi-Experimental Study	Fabi/Bolton Chest Wrinkle Scale	At week 16, the FBCWS score indicated improvement; on Day 0, the mean (SD) score at day 0 was 1.89 (0.33) and decreased to 1.56 (0.35) at week 16.	Sample size could have impacted the reliability of the conclusions. Second, a relatively short follow-up period can be misleading. Third, weight change in subjects was not measured in this study.	Over 80% of treated subjects noticed improved chest wrinkles concordant with reduced FBCWS scores.
(Geronemus <i>et al.</i> , 2016)	Journal Article	Dermatology	Journal of Cosmetic and Laser Therapy	Evaluate and compare the efficacy and tolerance of a home-use laser the device when used alone or combined with an antioxidant facial treatment for moderate photodamage.	49 females aged 40–65 years	RCT	Modified Griffiths' Scale	In the 12-week study, the home-use laser improved hyperpigmentation, lentigenes, and wrinkles. The test products enhanced these improvements. At week 14, the test products group showed further improvement, while the laser-alone side	-	The test products–support materials combination prolongs improvement in photodamaged skin more than support materials alone.

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
								did not. At week 24, the test products group continued to improve, but the laser-alone side showed no progress.		
<b>(Manuskiatti <i>et al.</i>, 1999)</b>	Journal Article	Dermatology	Journal of the American Academy of Dermatology	Evaluate the effectiveness and side effects of carbon dioxide laser resurfacing for photoaged facial skin.	104 patients (100 women and 4 men) aged 55 years	Quasi-Experimental Study	Modified Griffiths' Scale	Pre-treatment periorbital photodamage scored 6.12, whereas the post-treatment score was 4.21 (improvement) at an average follow-up of 24 months. Pre-treatment perioral photodamage scored 5.90, whereas the post-treatment score was 3.65, resulting in a mean improvement of 38% at an average follow-up of 24 months.	-	The current study has demonstrated that improvement from cutaneous laser resurfacing persists up to 44 months postoperatively with a low risk of long-term side effects. Both have confirmed the long-lasting persistence of the wrinkling score improvement and a high patient satisfaction rating.
<b>(Bazin <i>et al.</i>, 2010b)</b>	Journal Article	Dermatology	Skin Research & Technology	Characterize the skin of the chests of 64 women with various grades of skin photoaging.	64 female volunteers in good health (19–74 years), distributed into 3 groups.	Quantitative Observational Study	The photoaging score was evaluated according to a six-point scale	<b>Group 1:</b> 1.2 <b>Group 2:</b> 1.5 <b>Group 3:</b> 3.9	-	The 3 groups of volunteers were set up so that they were separate in age and score. Statistics allow us to check that Group 1 differs from Groups 2 and 3

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
										according to age and score, while Groups 2 and 3 vary according to score only. These findings are not surprising considering the inclusion criteria of the volunteers.
(Gold <i>et al.</i> , 2014b)	Journal Article	Dermatology	Journal of Cosmetic and Laser Therapy	Evaluate how a non-ablative fractional Q-switched 1,064-nm laser would treat photoaged and photodamaged skin, looking at various parameters associated with photodamaged skin.	10 healthy female subjects (age range: 35 – 53 years, mean: 44.3) and skin types I-IV	Quasi-Experimental Study	Glogau Classification Scale	6 subjects were evaluated as Skin Type II with wrinkles in motion, and 4 as Skin Type III, with wrinkles at rest.	-	60% of the subjects were graded with at least a one-point improvement in the overall Glogau global assessment.
(Prado <i>et al.</i> , 2008)	Journal Article	Dermatology	Plastic and Reconstructive Surgery	Compare the 1-, 5-and 10-year cosmetic outcomes of full-face carbon dioxide laser resurfacing using the SilkTouch technology, and analyze its advantages, disadvantages, and long-term results.	46 subjects	Quantitative Observational Study	Lemperle Modified Wrinkle Scale	The mean Lemperle pre-operative rhytide severity scale was found to be 3.7. Taking the face as one unit, rhytides improved by a decrease in the Lemperle Scale of 0.9 points in one year, equivalent to a 60% improvement.	-	After 5 and 10 years, the advantages were maintaining good skin texture, ablation of fine wrinkles, and long-term skin pigmentation correction.

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
<b>(Wolff <i>et al.</i>, 2005)</b>	Journal Article	Obstetrics, Gynecology, and Reproductive Sciences	Fertility and Sterility Journal	To evaluate the effects of long-term hormone therapy (HT) on skin rigidity and wrinkling	65 long-term HT users underwent menopause at most minuscule five years before evaluation and have either consistently or never used HT.	Quantitative Observational Study	Lemperle Modified Wrinkle Scale	The average score was 2.2 in the non-HT users and 1.5 in the HT users.	Small size, differences between the study group demographics, and cross-sectional design that lacks randomization of subjects.	Average wrinkle scores were lower in hormone users than nonhormone users (1.5 vs. 2.2).
<b>(Van Der Wal <i>et al.</i>, 2013)</b>	Journal Article	Plastic, Reconstructive, and Hand Surgery	Journal of Burn Care & Research	Investigate the clinimetric properties and clinical feasibility of the Mexameter, Colorimeter, and the DSM II ColorMeter for objective measurements of skin and scars.	Netherlands, 50 scars with a mean age of 6 years (2 months to 53 years)	Quantitative Observational Study	Fitzpatrick Skin Type Classification Scale (to determine validity)	Fitzpatrick Skin Type III: 64%	The Fitzpatrick Scale has its limitations. Hence, not all items included relate directly to the color of the skin. Second, a larger sample size will be needed to determine cut-off points that discriminate between	The convergent validity analysis on normal skin demonstrated a strong relationship between at least one parameter of each instrument and the Fitzpatrick skin type classification.

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
									the different skin types.	
<b>(Lee et al., 2010b)</b>	Journal Article	Dermatology	American Society for Dermatological Surgery	To evaluate the clinical efficacy of a 2,790-nm YSGG laser for treating periorbital wrinkles	Korea 10 Korean patients (Fitzpatrick skin type II–V)	Quasi-Experimental Study	Fitzpatrick Wrinkle Classification System	The mean treatment efficacies for the right and left using the FWCS were 1.85, 0.82, and 1.70, respectively, indicating clinical improvement.	-	Comparisons of before and after photographs show noticeable improvement of periorbital wrinkles.
<b>(Lee et al., 2015b)</b>	Journal Article	Dermatology	American Society for Dermatological Surgery	Examine the system's clinical efficacy and safety for treating periorbital wrinkles in Korean patients.	Korea, 20 Korean patients (Fitzpatrick skin Type IV–V) with varying degrees of periorbital wrinkles	Quasi-Experimental Study	Wrinkle Assessment Scale (WAS)	The mean treatment efficacy was -1.075. Two patients (Fitzpatrick skin Type IV–V) reported mild hyperpigmentation.	The improvement in wrinkle appearance reduction was superior to that afforded by another non-ablative fractionated lasers, which resulted in limited and inconsistent cosmetic improvement	Improvements in periorbital wrinkles.
<b>(Piccioni et al., 2011)</b>	Journal Article	Dermatology	Journal of Dermatological Treatment	Evaluate the efficacy and safety of PDT using a novel 0.5% liposome-	30 healthy volunteers aged	Quasi-Experimental Study	Modified Fitzpatrick Wrinkle Scale	For periorbital wrinkles, the average MFWS evaluation was 1.52 baseline, 1.02 at the	-	An overall improvement of at least one class

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
				encapsulated 5-ALA spray and an intense pulsed light (IPL) system in the reduction of periorbital and nasolabial wrinkles	35–65 years, skin type I–III			end-of-treatment visit, and 0.55 3 months after the end-of-treatment visit. For nasolabial wrinkles, the mean scoring was 1.37 at baseline, 1.12 at the end-of-treatment visit, and 0.78 at the final visit. No significant difference between the depth of periorbital and nasolabial wrinkles at baseline ( $p = 0.20$ ) and the end-of-treatment visit ( $p = 0.28$ ), whereas a significant difference was detected at the final visit.		of the MFWS was observed in 100% of the participants for periorbital wrinkles and 90% for nasolabial wrinkles
(Chan <i>et al.</i> , 2010a)	Journal Article	Dermatology	Lasers in Surgery and Medicine	Evaluate the efficacy and side effects of a new fractional CO2 ablative device (Fraxel Re: pair) for skin rejuvenation and acne scars in Asians.	9 Chinese patients (5 males and 4 females, Fitzpatrick skin types III and IV)	Quasi-Experimental Study	Questionnaires /surveys	42.8% of patients reported mild, moderate, to excellent wrinkle improvement; 28.6% of patients sustained this improvement at 6 months, and the lower eyelids persisted for less than a week. The post-	All the patients were only treated once, and the small sample size.	Significant improvement was obtained for acne scars and skin texture without long-term complications. Clinical advances in acne scarring, pigmentation, and rhytides were seen up

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
								inflammatory hyperpigmentation (PIH) rate at 1-month post-treatment was 55.5%. Most cases were considered moderate in severity. By 3 months, the PIH rate decreased to 37.5%, with most issues graded as mild. At 6 months, only one patient (11.1%) had persistent PIH		to three months post-treatment.
<b>(Doshi et al., 2006)</b>	Journal Article	Ophthalmology	Ophthalmology	Determine the clinical course of periocular hyperpigmentation after bimatoprost use in a large group of Caucasian patients.	37 patients with periocular hyperpigmentation	Quantitative Observational Study	Subjective grading for hyperpigmentation	The average hyperpigmentation grade at the examination was first noted at 1.27, ranging from 1 to 2.5. Twenty-seven patients had a mild degree of hyperpigmentation of 1; 7 patients had moderate severity of hyperpigmentation of 2, and two patients had severe hyperpigmentation of 2.	Retrospective nature, the difficulty in determining the valid dates of onset and resolution of hyperpigmentation, and the subjective assessment of pigmentation grade	The periocular hyperpigmentation appears gradually, but in this series, it was completely reversible on discontinuation of bimatoprost.

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
(Roberts <i>et al.</i> , 2015)	Journal Article	Dermatology	Clinical, Cosmetic, and Investigational Dermatology	Assess the effects of a multifunctional facial primer (cosmetic correction, UV/IR protection and pigmentation treatment) when used by patients with mild-to-moderate hyperpigmentation and fine lines associated with photodamage.	31 women, aged 40–64 years, with Fitzpatrick skin types II-IV, who were regular users of the foundation and in good general health	RCT	Questionnaires	Statistically significant 38.4% improvement in clinical grading scores for hyperpigmentation	-	The subjects in this study had both mild-to-moderate hyperpigmentation along with fine lines of the face. 96.4% of subjects stated that age spots/dark spots/sunspots/dyschromias improved at 12 weeks, whereas 89.3% considered that the appearance of fine lines/wrinkles improved.
(Ozturk <i>et al.</i> , 2013)	Journal Article	Cosmetics	Plastic and Reconstructive Surgery	evaluate the change in the appearance of the patients included, a validated patient satisfaction questionnaire, an evaluation of apparent age and an assessment of perioral wrinkles by independent reviewers using a validated model.	47 consecutive patients underwent simultaneous facelift and perioral peel	Quantitative Observational Study	Glogau Classification System	Demonstrated a mean reduction was 1.15 (3.3 pre-operatively compared with 2.15 post-operatively).	-	Outcomes measurements including patient satisfaction, objective evaluation of wrinkle improvement, and a significant reduction in apparent age document the power of this technique. The perioral phenol-croton oil peel resulted in significant and objective wrinkle improvement, as shown by the

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
										reduction in the Glogau score.
(Quattrone <i>et al.</i> , 2017)	Journal Article	Cosmetics	-	Evaluate the effects of the test product on skin hydration, tone, and aging.	62 female healthy volunteers, aged between 21 and 65 years old	RCT	Fitzpatrick Scale and Glogau Scale	Most subjects presented a skin type III based on the Fitzpatrick scale and showed mild photo-aged skin based on the Glogau scale.	-	Fitzpatrick Photo Type: I 1.6%, II - 22.6%, III -43.5%, IV - 25.8%, V - 1.6%, VI - 4.9%. Glogau Scale: Mild – 89%; Moderate – 8%; Obvious – 3%.
(Gold, 2019)	Research article	Dermatology	Journal of Cosmetic and Laser Therapy	Use a dual-wavelength picosecond laser for facial wrinkle improvement and overall skin appearance.	20 subjects ranging from 41–66 years	Quasi-Experimental Study	Fitzpatrick Classification and Degree of Elastosis	Fitzpatrick Skin Types II-IV; ES was 5.7, with 75% of subjects having fine to moderate depth wrinkles and a moderate number of lines (ES 4–6) and 25% having fine to deep wrinkles with numerous lines (ES 7–9).	Short-term follow-up of 3 months and treatment assessments were limited to improvement in Fitzpatrick scores and did not reflect other aspects of photoaged skin.	Our clinical study demonstrated that a dual-wavelength picosecond laser treatment protocol significantly improved facial wrinkling for those individuals seeking a treatment procedure with minimal downtime and complications.
(Gold <i>et al.</i> , 2020b)	Research article	Dermatology	Journal of Cosmetic and Laser Therapy	Evaluate the safety and efficacy of the VoluDerm technology with 100 ultrathin electrodes gen100 tip to improve skin	Twelve Caucasian females aged 39-58 (mean age 45.5 ± 5.2) and	Quasi-Experimental Study	Fitzpatrick Elastosis Scale	The baseline physician-assessed FES was 4.83 ± 0.69. One and three months after the last treatment session, the mean physician-rated	-	Blinded evaluation of the baseline photographs compared with the 3-month follow-up photographs

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
				texture and wrinkles.	Fitzpatrick skin types II-III.			FES was $2.67 \pm 1.18$ and $2.33 \pm 1.03$ , respectively.		showed a mean reduction of 1.63 points in FES from baseline.
<b>(Brazil <i>et al.</i>, 2003)</b>	Journal Article	Dermatology	Journal of Cosmetic and Laser Therapy	Evaluate quantitatively the short-term and long-term clinical effectiveness of multiple full-face IPL treatments for non-ablative facial photo rejuvenation.	47 patients with varying degrees of photodamaged skin and rosacea dermatitis	Quasi-Experimental Study	Fitzpatrick's Photographic Classification of Rhytids and Solar Elastosis Scale (SE)	Most patients were Fitzpatrick skin type III (70%), with the remainder in skin types II, IV, and V. All patients had some degree of facial rhytids noted for evaluation.	The lack of long-term improvement in wrinkle class I is partially due to the difficulty in measuring subtle wrinkling and the fact that SE scores of 1 cannot improve (there is any score of 0).	Overall, for all wrinkle classes, there was an average improvement in SE, a score of 1.47 at week 6 and 1.0 at month 6.
<b>(Zahr <i>et al.</i>, 2019)</b>	Journal Article	Dermatology	Journal of Cosmetic Dermatology	Evaluate the tolerability, safety, and efficacy of a multi-ingredient anti-aging facial moisturizer when applied pre- and post-procedure consisting of a single RF micro-needling treatment	USA, 15 female patients, aged 37-60, Fitzpatrick skin types I-IV, with mild-to-moderate wrinkles	Quasi-Experimental Study	Glogau Wrinkle Scale	Among the four visits, a more significant percentage of patients, 80% vs. 60%, scored two at Visits 3 and 4 compared to Visits 1 and 2, respectively.	A placebo or control arm was not utilized.	80% of patients showed an improvement in Glogau Wrinkle Scale.

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Author & Year	Document Categorization	Article Category	Origin	Aim	Population	Study Design	Assessment Instruments	Results	Limitations	Conclusion
(Kelm <i>et al.</i> , 2020)	Journal Article	Dermatology	Journal of Cosmetic Dermatology	Assess the efficacy and tolerability of twice daily application of a novel, highly potent, non-irritating 30% THD ascorbate serum in combination with 100% mineral-based sunscreen in treating melasma during the summer months.	110 female subjects of ages ranging from 18 to 60 years	Quasi-Experimental Study	Griffiths Photonumeric Scale	Improvement in hyperpigmentation, with an average gain of 33.7%. 70% of subjects showed improved skin tone evenness (redness). The average improvement was 33.3%	Small sample size. Lack of a control arm. Subjective nature of clinician ratings with possible inter- and intra-rater variability.	Improvement ranged from 20% to 53% by the end of the study.