TAHUN 2024 *[MANUJU: MALAHAYATI NURSING JOURNAL, ISSN CETAK: 2655-2728 ISSN ONLINE: 2655-4712, VOLUME 6 NOMOR 12 TAHUN 2024] HAL 4816-4833*

PARTIAL LEAST SQUARES REGRESSION ANALYSIS BETWEEN BODY MASS INDEX, ABDOMINAL CIRCUMFERENCE, HIP CIRCUMFERENCE, HEMOGLOBIN, BODY COMPOSITION, URIC ACID, BLOOD SUGAR, HEMOGLOBIN AND HEMATOCRIT WITH FACE ANALYZER IN ADULTS

Sukmawati Tansil Tan[1*], Farell Christian Gunaidi[2], Cindy Christella Chandra[3], Yohanes Firmansyah[4]

[1-4]Faculty Of Medicine, Universitas Tarumanagara

Email Korespondensi: sukmawati@fk.untar.ac.id

Disubmit: 27 Juni 2024 Diterima: 17 November 2024 Diterbitkan: 01 Desember 2024
Doi: https://doi.org/10.33024/mnj.v6i12.15873

ABSTRACT

Skin is an important aspect of the human body. Many factors may influence skin health and its characteristics, including physiological and metabolic conditions such as obesity, blood sugar, hemoglobin and hematocrit, and uric acid. To establish a correlation between physiological and metabolic health parameters with skin-face analysis (roughness and wrinkles). This research was conducted in Kalam Kudus Foundation, West Jakarta, targeting individuals ≥17 years old, both men and women, following the inclusion and exclusion criteria. Skin health parameters used were roughness and wrinkles. The metabolic parameters studied were body mass index (BMI), waist circumference (WC), hip circumference (HC), body composition, blood sugar, hemoglobin (Hb), hematocrit (Ht), and uric acid. Our research shows negative coefficient results of BMI (-0,076 and –0,059), WC (-0,844 and -0,795), Hb (-0,069 and -0,074), Ht (-0,112 and -0,161), and uric acid (-0,155 and -0,170) with skin roughness and wrinkle. Other parameters such as HC (0,294 and 0,323), blood glucose (0,141 and 0,058), total body fat mass (0,321 and 0,345), visceral fat (0,234 and 0,203), total subcutaneous fat (0,319 and 0,391), and total muscle mass (0,725 and 0,890) result in a positive coefficient with skin roughness and wrinkle. An increase in BMI, WC, Hb, Ht, and uric acid is associated with better skin roughness and wrinkles while higher hip circumference, total body fat mass, visceral fat, total subcutaneous fat, total muscle mass, and blood sugar may worsen the skin condition.

Keywords: Obesity, Blood Sugar, Hemoglobin, Hematocrit, Uric Acid, Skin Roughness, Wrinkles

INTRODUCTION

The skin is the largest organ in the human body, covering the entire outer surface. It serves as a mechanical barrier (physical trauma), an immunological barrier (invasion of pathogens and microorganisms), and a chemical barrier (chemicals and toxins) between the external environment and the tissues in the human body. In addition, the skin serves as a member of the five senses, allowing it to detect sensations such as pain and temperature, regulate body temperature, assist in the production of vitamin D, and prevent

damage from sunlight exposure (Dąbrowska et al., 2018; Jansen van Rensburg et al., 2019; Lopez-Ojeda et al., 2024).

Normal, healthy skin is flexible, elastic, and resilient. These properties are caused by the stratum corneum's cohesion and its degree of keratinization (organized in a brick-and-mortar pattern), the consistency of the collagen and elastic fibers, and the level of hydration. Hyaluronic acid, one of the glycosaminoglycans in the dermis, plays a crucial role in preventing evaporation and ensuring deeper hydration. This is because the degree of impermeability of the epidermis, which is characterized by the presence of hydrophobic lipids and functional groups with water affinity, correlates with the water-binding capacity (Linda Yulianti W et al., 2024; Oliveira et al., 2023).

Constant shedding of the stratum corneum and sebaceous and secretions of perspirations maintain the physiological pH and the skin microbiota, both are essential for a normal appearance and to prevent dermatological pathologies. The sebum is responsible for the epidermis' lubrication, dehydration prevention, and fungistatic and bactericidal properties. The perspiration glands maintain the skin's acidity (pH 4–6.8) by producing apocrine and eccrine sweat (Banyś et al., 2023; Gidado et al., 2022; W et al., 2024).

To maintain skin health, it is essential to understand the intricate relationship between the physiological and metabolic examination parameters of the facial skin analyzer. Face skin analysis is a sophisticated diagnostic tool that employs imaging technology to evaluate and analyze a variety of facial skin characteristics and conditions, including hydration levels, sebum production, pore size, pigmentation, elasticity, texture, porphyrins, wrinkles, and skin damage caused by ultraviolet light exposure. Facial skin analyzers can offer a comprehensive understanding of the skin's condition by quantitatively measuring these skin parameters, which can identify potential issues such as dryness, oiliness, symptoms of aging, sun damage, and other dermatological problems. The significance of sustaining healthy facial skin is undeniable, as any action can result in an enhanced quality of life (Cook et al., 2022; Du-Harpur et al., 2020; Li et al., 2022).

Looking for a correlation between facial skin analysis and Body Mass Index (BMI), waist circumference, hip circumference, body composition, hemoglobin, hematocrit, blood sugar, and uric acid can offer an opportunity to determine facial skin health. Hemoglobin and hematocrit levels, as indicators of blood's ability to transport oxygen, can influence skin color by affecting oxygen delivery and viscosity. When there is a lot of uric acid and body fat (found by measurements of body mass index, waist circumference, hips, and body composition), inflammation and too much oxidative stress can change the looks of the skin on the face. Elevated sugar levels can also compromise the elasticity and firmness of the epidermis. Lifestyle changes and pharmaceutical therapy can prevent all of these (Ezure, 2023; Gupta et al., 2022; Moraes et al., 2023; Mori et al., 2017; Rodriguez et al., 2022; Wollina et al., 2017).

Understanding the interaction between these variables using a facial skin analyzer has a beneficial impact by significantly improving the quality of life and preventing facial skin aging. Due to its distinctive socio-economic and environmental

characteristics, The Kalam Kudus Foundation area is a very suitable location for conducting the research. Despite the influence of systemic factors on dermatological conditions, technological facial analysis reveals a lack of research on the relationship between certain systemic health parameters and facial features.

The research question of this study is: "How is the correlation between physiological and metabolic health parameters with skin face?". Therefore, the objective of this investigation is to establish a correlation between the results of skin facial analysis and physiological and metabolic health parameters.

LITERATURE REVIEW

Obesity

Obesity is characterized by an anomalous or excessive accumulation of adipose tissue or fat in the body. The Body Mass Index (BMI) is a non-specific method of evaluating body fat that divides body weight in kilograms by body height in square meters (kg/m^2), regardless of an individual's age or gender. Obesity is defined as a body mass index (BMI) of 25 kg/m^2 or higher, as per the World Health Organization's Asia Pacific region. The limitations of BMI include its inability to accurately determine the distribution of fat and muscle mass or the composition of fat, such as visceral fat. It is crucial to recognize that numerous individuals with a normal body mass index may still possess an excessive quantity of visceral fat, which presents metabolic risks. The distribution of body fat is more significant than the overall body weight, or BMI alone, in terms of metabolic impact. Additional measurements like waist circumference, waist-to-hip ratio, or imaging techniques like computed tomography (CT) or magnetic resonance imaging (MRI) are recommended to understand fat distribution more precisely. These methods can assist in the identification of individuals who may be at a higher metabolic risk despite having a normal body mass index. A comprehensive approach that considers the distribution of body fat, particularly visceral fat, is necessary to address the health concerns associated with obesity, in addition to body weight or BMI. With this comprehensive perspective, healthcare professionals can more effectively identify individuals who may benefit from targeted interventions and ongoing monitoring to mitigate the metabolic risks associated with excessive visceral fat levels. (Alexander Halim Santoso, Firmansyah, et al., 2023; Gosal et al., 2020)

Waist circumference (WC) and waist-to-hip ratio (WHR) are frequently employed as substitute metrics for visceral adipose tissue (VAT), a critical component of abdominal obesity. The waist circumference serves as an indicator of the quantity of visceral fat located in the abdominal region. The World Health Organization (WHO) has identified Asian individuals as at risk if their waist circumference measurements exceed 90 cm for men and 80 cm for women. (Alexander Halim Santoso, Ernawati Ernawati, et al., 2023; Gunaidi et al., 2020)

Hip circumference, an anthropometric measurement, represents the fat in the lower body (gluteofemoral region), typically located beneath the skin. Compared to visceral fat, subcutaneous fat's metabolic activity in the hip area may be more involved in lipid storage and less inflammatory. The waist-to-hip ratio (WHR) is calculated by dividing the waist circumference by the hip

circumference. A higher WHR indicates a greater accumulation of central or abdominal fat compared to hip fat, thereby increasing the risk of metabolic syndrome, including obesity. The WHR of 0.90 in men and 0.85 in women is considered to be hazardous (Cameron et al., 2020; Destra et al., 2023).

There are two categories of compartments in the body: fat mass and fat-free mass (muscle, bone, and water). This is the foundation of body composition assessment. Bioelectrical impedance analysis (BIA) is a non-invasive, rapid, and highly accurate method for estimating the body's adipose mass and fat-free mass. Increased fat mass, including fat distribution, significantly influences obesity, a health hazard (Firmansyah & Santoso, 2020; Holmes & Racette, 2021).

Visceral adipose tissue (VAT), a metabolically active component located around the organs in the abdominal cavity, may contribute to the adverse effects of obesity on cutaneous health. VAT releases inflammatory substances, including TNF-α, IL-6, and C-reactive proteins (CRPs). This process initiates chronic low-grade inflammation and oxidative stress. This may interfere with the proper functioning of the skin's epidermal barrier. Increased transepidermal water loss (TEWL), reduced moisture content of skin surface corneocytes (ceramide), higher skin pH, and impaired lipid synthesis in the stratum corneum disrupt the function of the skin epidermal barrier. As a result, the skin loses its ability to retain hydration, leading to a rough texture. Furthermore, central adiposity can induce oxidative stress, which accelerates the degradation of collagen and elastin in the skin, leading to premature aging, as demonstrated by the accumulation of creases (Papaccio et al., 2022; Zhu et al., 2023).

Pro-inflammatory cytokines induce long-term tissue inflammation, which is the primary cause of skin wrinkles, a classic indicator of aging. The principal reason for the glycation of collagen is the presence of advanced glycation end-products (AGEs). Interleukins (ILs), cyclo-oxygenase 2, inhibitors of apoptosis (IAP), and tumor necrosis factors (TNFs) are the inflammatory cytokines most frequently produced from visceral fat (Alsaadoun, 2024).

Blood Sugar

Hormonal action, primarily insulin and glucagon, regulates blood sugar, or glucose, the principal energy source for bodily functions. In conditions such as diabetes, where insulin production or response is impaired, elevated blood glucose levels (hyperglycemia) can have a series of systemic effects, including alterations in microvascular and macrovascular circulation, inflammation, and oxidative stress. These systemic alterations root the relationship between blood sugar levels and a variety of health complications, including skin (Nakrani et al., 2023).

In addition to glycated hemoglobin (HbA1c), hyperglycemia induces the production of glycated low-density lipoprotein (LDL), which accelerates the glycation of collagen and vascular atherosclerosis, both of which contribute to aging. Additionally, the glycation of myelin compounds in a hyperglycemic environment harms nerve cells, while the glycation of protein compounds produces advanced glycation end products (AGEs). Diabetes patients exhibit biochemical, molecular, and functional changes linked to elevated levels of advanced

glycation end products (AGEs). Inflammation and oxidative stress are the results of the accumulation of AGEs, which in turn result in micro- and macrovascular dysfunction and tissue injury. The accumulation of advanced glycated products also triggers the release of hormones, various cytokines, and free radicals. These substances subsequently bind to receptors for AGEs (RAGE) in blood vessels, resulting in intracellular oxidative stress (Choi et al., 2022; Khalid et al., 2022).

Reduced skin elasticity, or sagging, is caused by elastin glycation. Oxidative stress also intensifies the glycation reaction. The horny layer undergoes keratin glycation, which reduces skin transparency and alters optical properties. K10 protein production, which can also serve as a target for glycation, is a corollary of keratinocyte differentiation, which proceeds from the basal layer to the epithelial layer. In addition to elastic fibers, collagen fibers play an important role in skin elasticity preservation and have a triple-helical structure. Lysine and arginine, amino acid residues that are part of collagen proteins, are susceptible to glycation. The loss of collagen mobility is a result of glycated lysine and arginine residues cross-linking the fibers. Pentosidine is an additional glycation stress pathway that induces inflammatory changes in the epidermis by activating NF-κB and releasing pro-inflammatory cytokines. Photoaging and other forms of oxidative stress can intensify the effects of AGE accumulation, resulting in the development of deep wrinkles on the face, neck, and other sun-exposed areas of the body. The skin may also be slightly yellow and have a rough, stiff texture (Yoshikazu et al., 2015).

Hemoglobin and Hematocrit

Red blood cells contain hemoglobin, a critical protein that facilitates the transportation of oxygen from the lungs to the tissues and the return of carbon dioxide from the tissues to the lungs. This oxygen delivery is essential for cell metabolism and energy production. In adults, the normal range of hemoglobin is 13.5 to 18 grams per deciliter (g/dL) for men and 12.0 to 15.0 g/dL for women. Inadequate oxygenation and nutrient delivery can disrupt skin cell regeneration and collagen synthesis, potentially leading to alterations in skin texture and color. This also has the potential to increase AGE production (Baker et al., 2023; Ughasoro et al., 2017).

As individuals age, their accumulation of AGEs increases. Anemia is one of the many systemic declines that AGEs contribute to as we age. Anaemia is a significant cause of morbidity and mortality, and it is one of the primary characteristics of hemostatic aging. Anaemia manifests as the human age increases. Despite the increased diagnostic possibilities, the underlying pathophysiology remains incompletely understood. We suspect a link between anemia and AGEs, given that AGEs trigger a cascade of pro-inflammatory signals, potentially implicating inflammation-induced anemia (with higher levels of AGEs in patients with inflammatory anemia). However, the majority of cases of anemia in the elderly remain unexplained. AGEs may improve interactions with the endothelial surface by contributing to membrane modifications and alterations in erythrocyte deformability. Reduced tissue oxygenation associated with anemia may facilitate the formation and accumulation of low levels of AGEs. SAF, a non-invasive method of skin autofluorescence, was

positively associated with tissue AGE accumulation in anemic patients (b = 0.021, p < 0.001), according to research (Wouters et al., 2020).

Uric Acid

Uric acid is a waste product in the blood that is produced through the process of breaking down (catabolism) of purine compounds. The upper limit for uric acid levels in men is 7 mg/dl, while in women it is 6 mg/dl. An increase in uric acid levels above normal is called hyperuricemia.

Elevated levels of UA have also been associated with prevalent and well-known inflammatory dermatological diseases. High levels of several inflammatory markers, such as neutrophils, CRP, interleukin-6, interleukin-18, interleukin-1 receptor antagonist, and tumor necrosis factor-alpha, were linked to higher levels of UA and hyperuricemia. Keratinocyte hyperproliferation and increased epidermal cell turnover are believed to be associated with elevated serum uric acid. Increased keratinocyte cell production induces increased purine metabolism, leading to elevated serum uric acid levels in patients (Karaosmanoglu et al., 2020; Monica & Nurrachmat Mulianto, 2023).

Hyperuricemia may elevate oxidative stress. The final product of purine metabolism is uric acid (UA). Xanthine oxidoreductase (XOR), which divides into two distinct isoforms: xanthine dehydrogenase (XDH) and xanthine oxidase (XO), subsequently dializes purines. The activity of xanthine oxidoreductase (XOR) will generate reactive oxygen species, nitrogen, and uric acid. This causes cell injury by disrupting the body's equilibrium between antioxidants and free radicals. This can accelerate the breakdown of collagen and elastin, which are essential proteins for the firmness and elasticity of the skin. This process contributes to the development of wrinkles and other symptoms of aging. Therefore, examining facial characteristics, particularly those associated with aging, can indirectly observe an increase in uric acid levels. Furthermore, the contribution of gout to systemic inflammation may affect the health of the epidermis. Inflammatory cytokines can disrupt the protective function of the skin, leading to an increase in transepidermal water loss, ultimately causing the skin to become dry (Baker et al., 2023; Gherghina et al., 2022; Papaccio et al., 2022).

METHOD

Literature Review

A literature search was conducted in various databases, including PubMed, Scopus, Web of Science, and Google Scholar. This search strategy involved combining terms related to facial skin analyzers such as “skin roughness” and “skin wrinkles” with each health parameter. Filters were applied to focus the search on open-access and peer-reviewed articles in English. The selection criteria were specifically designed to identify studies that provide in-depth quantitative or qualitative data regarding the relationships studied or explore the complex mediating role of skin facial analyzers in the framework of dermatological health. Variables from our study that were specifically included in the literature search criteria included demographic factors (age, gender), body mass index, waist and hip circumference, body composition, hemoglobin and hematocrit levels, blood sugar, and uric acid. Each of these variables was cross-referenced

with skin roughness and skin wrinkles to ensure a comprehensive understanding of how these conditions interact with various aspects of health in the working-age population.

The aim of this study was to establish a correlation between physiological and metabolic health parameters (between Body Mass Index, Abdominal Circumference, Hip Circumference, Hemoglobin, Body Composition, Uric Acid, Blood Sugar, Hemoglobin and Hematocrit) with facial skin analysis (roughness and wrinkles).

Study Population

The study population consisted of individuals aged ≥17 years, reflecting the target demographic of the adults population that is important for the purposes of this research. Participants consisted of men and women, to ensure balanced gender representation thereby enriching the data collection and reliability of the analysis. This research was conducted at the Kalam Kudus Foundation, Duri Kosambi, West Jakarta.

Selection Criteria

In order to guarantee the inclusion of a representative and appropriate sample, the selection criteria for this research were meticulously defined. The inclusion criteria stipulated that participants must be ≥17 years old. Male and female participants are both eligible to participate in research, thereby fostering gender inclusivity. The most critical requirement is that all participants must provide informed consent, a standard that not only ensures that subjects are cognitively capable of comprehending and agreeing to the research procedures and objectives but also upholds ethical principles. Instead, exclusion criteria aim to safeguard the data integrity and participants' well-being. We excluded individuals with diagnosed mental disorders to ensure they could provide sincere and informed consent and adhere to the study protocol, thereby preventing potential complications associated with their participation. We also excluded participants who did not speak Indonesian to prevent language barriers that could potentially impede comprehension of the research requirements and compromise the reliability of the data collected. Furthermore, we excluded individuals who declined to participate, emphasizing that participation was entirely voluntary and that only fully informed and willing individuals would provide the collected data. Collectively, these criteria guarantee the preservation of scientific rigor and research ethical standards.

Data Analysis

Statistical analysis in this study was used to explain the complex interactions between various health indicators and their influence on the face skin analyzer in the form of roughness and skin wrinkles. We implement a multifaceted analytical approach by employing a robust data set that includes demographic variables and assessments of facial skin health.

We measure body mass index using a weight scale and a stature meter to measure height, a measuring tape to measure waist and hip circumference. To examine body composition, this study used the Karada-Scan tool which can assess fat mass and fat-free mass. Apart from that, blood tests in the form of hemoglobin, hematocrit, blood sugar and uric acid levels are measured using the For-A brand Point Of Care Testing (POCT) tool. Then, the skin roughness and skin

wrinkles parameters are assessed using the Skin Analyzer.

We used descriptive statistical methods to analyze the demographic and clinical characteristics of the participants, resulting in a comprehensive understanding of the sample population. We calculated age, hemoglobin, hematocrit, uric acid, blood sugar, body mass index, waist circumference, hip circumference, and body composition to determine the mean values, standard deviation, range, and distribution of the population with SPPS program version 27. We implemented multivariable regression analysis and partial least squares (PLS) path modeling for inferential analysis. This method is optimal for managing the diverse nature of data, investigating intricate model structures, even in the presence of non-normal data distributions. Particularly, the PLS method showed its robustness in modeling latent constructs derived from multiple indicators. This is particularly relevant for assessing constructs such as skin roughness and wrinkling. We implemented Pearson or Spearman correlation coefficients to investigate the correlation between health outcomes and demographic variables. We employed the Partial Least Squares Structural Equation Modeling (PLS-SEM) method to conduct group comparisons. Logistic regression models then identify the risk factors associated with significant health conditions, pinpointing the demographic or physiological factors that contribute to a higher risk profile.

The proportion of variance in skin roughness and wrinkle scores that can be attributed to the independent variables was determined by calculating R-squared (R^2) and adjusted R-squared values, which were used to assess statistical significance and model fit. This comprehensive approach ensures the research findings stem from rigorous and scientifically valid methods, which facilitates the appropriate interpretation and investigation of effective interventions to improve the health and well-being of the working-age population. The study was conducted following ethical standards and participant confidentiality, as informed consent was obtained from all participants and ethical approval was obtained.

RESULTS

Based on the inclusion and exclusion criteria established for this study, a total of 115 respondents were identified as meeting these criteria and were subsequently included in the analysis. These criteria were carefully designed to ensure that the sample accurately and relevantly represents the adult population at Kalam Kudus Foundation, Duri Kosambi, West Jakarta. These data provide a detailed summary of the demographic, health, and clinical characteristics of selected respondents, allowing for a comprehensive investigation of various aspects of health and their impact on skin roughness and wrinkles in this group. (Table 1).

Table 1. Demographic, Health, and Clinical Characteristics of Selected Respondents

Description	N (%)	Mean (SD)	Med (Min - Max)
Age (year)		39,5 (11,7)	39 (17 – 75)
Gender			
• Man	29 (25,2%)		
• Woman	86 (74,8%)		
Hemoglobin (g/dL)		12,7 (2)	12,9 (4,7 – 17)
• Man (<13,5)	10 (8,7%)		
• Woman (<12)	40 (34,78%)		
Hematocrit (%)		37,4 (5,9)	38 (14 – 50)
Uric Acid (mg/dL)		5,1 (1,3)	4,8 (3 – 11,5)
• Man (>7)	2 (1,74%)		
• Woman (>6)	10 (8,7%)		
Blood Sugar (mg/dL)		92,9 (18,5)	89 (65 – 162)
• Risk for Diabetes	-		
• Normal	15 (100%)		
Body Mass Index (Kg/m^2)		25,6 (4,4)	24,9 (16,5 – 37,2)
• Underweight (<18,5)	3 (2,6%)		
• Normal (18,5 – 22,9)	30 (26,1%)		
• Overweight (23 – 24,9)	25 (21,7%)		
• Obesity gr. I (25 - 29,9)	35 (30,4%)		
• Obesity gr. II (≥30)	22 (19,1%)		
Waist Circumference (cm)		86,8 (10,5)	86 (65 – 116)
• Man (>90)	18 (15,65%)		
• Woman (>80)	58 (50,43%)		
Hip Circumference		101 (7,9)	100 (81 – 123)
Body Composition			
• Total Body Fat Mass (%)		32,5 (5,4)	33,5 (14,4 – 41,7)
• Visceral Fat (%)		9,2 (4,9)	9 (1,5 – 20)
• Subcutaneous Fat (%)		27 (6,8)	27,8 (9,6 – 40,8)
• Muscle Mass (%)		25,5 (3,5)	24,8 (19,4 – 36,9)

This data set provides a comprehensive overview of the demographic, health, and clinical characteristics of an adult population with a mean age of 39.5 years (SD = 11.7), comprised primarily of women (74.8%). Examination of hemoglobin levels showed an average of 12.7 (SD = 2), of which 50 respondents with anemia were found (43.48%). Hematocrit levels showed an average of 37.4 (SD = 5.9). Examination of uric acid levels showed an average of 5.1 (SD = 1.3), of which 12 respondents with hyperuricemia were found (10.44%). Examination of blood sugar levels showed an average of 92.9 (SD = 18.5) and all respondents had normal blood sugar levels. The Body Mass Index showed an average of 25.6 (SD = 4.4), where overweight and obese respondents were 25 people (21.7%) and 57 people (49.5%) respectively. Waist circumference measurements showed an average of 86.8 (SD = 10.5), of which 76 respondents at risk of central obesity were found (66.08%). Body composition examination showed an average total body fat mass of 32.5 (SD = 5.4), visceral fat of 9.2 (SD = 4.9), total subcutaneous fat of 27 (SD =

6.8), and lastly mass total muscle 25.5 (SD = 3.5).

Table 2. R Squared Parameters of Rough and Wrinkle

	R Square	R Square Adjusted
Rough	0.250	0.17
Wrinkle	0.284	0.207

Table 2 presents the R-squared and Adjusted R-squared parameters for rough and wrinkled skin, offering insight into the models used to analyze the respective data sets. It is known that the Adjusted R Square values for roughness and wrinkles are 0.17 and 0.204 respectively, which shows that the independent variables (BMI, WC, HC, Body Composition, Hb, HT, GDS, and Uric Acid) influence the dependent variable (rough skin and wrinkles) simultaneously are 17% and 20,7% respectively.

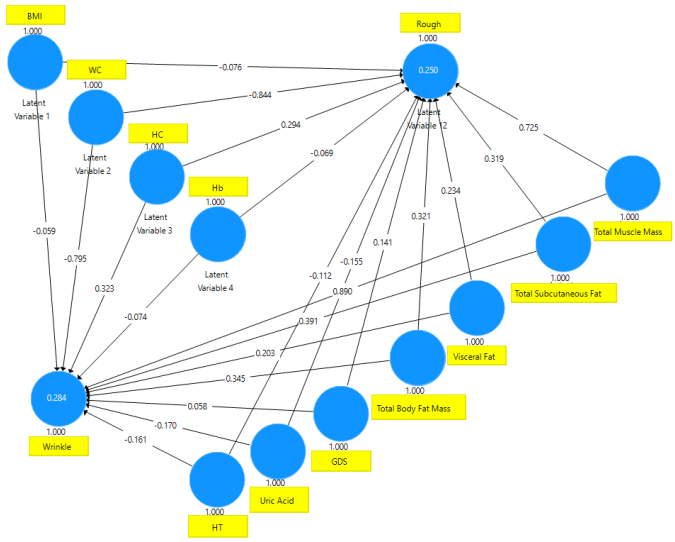

Figure 1. PLS-SEM Parameters of Skin Face Analyzer

The data presented in the diagram appears to come from a statistical analysis that investigates the relationship between various health parameters, skin face analyzer rough skin texture, and wrinkles. This provides coefficients that can represent standardized regression weights or correlations between these variables. (Figure 1)

Table 3. Path Coefficients Parameters of Skin Rough and Wrinkle

Parameter	Rough	Wrinkle
Body Mass Index (BMI)	-0,076	-0,059
Waist Circumference (WC)	-0,844	-0,795
Hip Circumference (HC)	0,294	0,323
Hemoglobin (Hb)	-0,069	-0,074
Hematocrit (HT)	-0,112	-0,161
Glucose Profile (GDS)	0,141	0,058

Uric Acid	-0,155	-0,170
Total Body Fat Mass	0,321	0,345
Visceral Fat	0,234	0,203
Total Subcutaneous Fat	0,319	0,391
Total Muscle Mass	0,725	0,890

Table 3 presents the path coefficients for various variables that influence facial skin analysis based on rough skin texture and wrinkles, which illustrates the direct influence of each variable in the respective models.

1. Body Mass Index (BMI)
   a) Skin Rough: Negative coefficient (-0,076) implies that increasing body mass index is associated with lower severity of skin roughness.
   b) Skin Wrinkle: Negative coefficient (-0.058) indicates that increasing body mass index is associated with lower severity of skin wrinkles.
2. Waist circumference (WC)
   a) Skin Rough: A negative coefficient (-0.844) suggests higher waist circumference might decrease the severity of skin roughness.
   b) Skin Wrinkle: A negative coefficient (-0.795) suggests that higher waist circumference might also reduce the severity of skin wrinkles.
3. Hip Circumference (HC)
   a) Skin Rough: A positive coefficient (0.294) shows that higher hip circumference is associated with higher severity of skin roughness.
   b) Skin Wrinkle: A positive coefficient (0.323) indicates that higher hip circumference might increase the severity of skin wrinkles.
4. Glucose Profile
   a) Skin Rough: A positive coefficient (0.141) suggests that disturbances in glucose metabolism correlate with poorer skin roughness.
   b) Skin Wrinkle: A positive coefficient (0.058) suggests that glucose metabolism disturbances also increase the severity of skin wrinkles.
5. Hemoglobin
   a) Skin Rough: A notably negative coefficient (-0.069) highlights the favorable impact of hemoglobin levels on skin roughness.
   b) Skin Wrinkle: A negative coefficient (-0.074) suggests that higher hemoglobin contributes to the lower severity of skin wrinkles.
6. Hematocrit
   a) Skin Rough: Negative coefficient (-0.112) indicates improved skin roughness with increasing hematocrit.
   b) Skin Wrinkle: Negative coefficient (-0.161) indicates that increasing hematocrit might reduce the severity of skin wrinkles.
7. Uric Acid
   a) Skin Rough: A negative coefficient (-0.155) implies that higher uric acid levels are associated with a decrease in skin roughness.
   b) Skin Wrinkle: A negative coefficient (-0.170) suggests that higher uric acid levels are associated with a decrease in skin wrinkles.
8. Total Body Fat
   a) Skin Rough: A positive coefficient (0.321) indicates that as body fat increases, skin roughness tends to increase.
   b) Wrinkle: A positive coefficient (0.345) indicates that high body fat is also associated with increased severity of skin wrinkles.

9. Visceral Fat
    a) Skin Rough: A positive coefficient (0.234) indicates that higher visceral fat is associated with higher levels of skin roughness.
    b) Wrinkle: A negative coefficient (0.203) indicates that higher visceral fat may increase the severity of skin wrinkles.
10. Total Subcutaneous Fat
    a) Skin Rough: A negative coefficient (0.319) indicates that high levels of subcutaneous fat correlate with poor skin roughness.
    b) Skin Wrinkle: A negative coefficient (0.391) indicates that high levels of subcutaneous fat also increase the severity of skin wrinkles
11. Total Muscle Mass
    a) Skin Rough: A positive coefficient (0.725) indicates that higher levels of muscle mass correlate with worse skin roughness.
    b) Skin Wrinkle: A positive coefficient (0.890) suggests that higher levels of muscle mass correlate with worse skin wrinkles.

DISCUSSION

Body Mass Index is negatively correlated with skin roughness and wrinkles, with coefficients of -0.076 and -0.059 respectively. Meanwhile, waist circumference measurements also found a negative correlation with skin roughness and wrinkles with coefficients of -0.844 and -0.795 respectively, indicating that increasing body mass index and waist circumference can reduce the severity of skin roughness and wrinkles. The body composition measurements consisting of total body fat, visceral fat, and total subcutaneous fat were positively correlated with skin roughness and wrinkles, with coefficients of 0.321 and 0.345, 0.234 and 0.203, 0.319 and 0.391 respectively. The Body Mass Index (BMI) is a non-specific method of assessing body fat that involves dividing body weight in kilograms by body height in square meters (kg/m^2). We use waist circumference as an indicator of the amount of visceral fat in the body. Abdominal obesity (VAT) is a crucial component of abdominal obesity. Bioelectrical impedance analysis (BIA) is a non-invasive, rapid, and highly accurate method for estimating the body's fat mass and fat-free mass (body composition). Obesity is characterized by an anomalous or excessive accumulation of adipose tissue or fat in the body. Even though these results are inconsistent with the findings of Papaccio et al. and Zhu et al., which were based on measurements of body mass index and waist circumference, they are consistent with those obtained through body composition examination. This examination indicates that obesity can increase the likelihood of skin roughness and wrinkles. Systemic inflammation and oxidative stress, known to have a detrimental impact on skin health, are associated with excessive fat accumulation in the body, particularly in the context of obesity (Papaccio et al., 2022; Zhu et al., 2023).

Mori et al. conducted research that indicates obesity is a contributing factor to the reduction of skin characteristics, including dehydration and roughness. Pro-inflammatory adipokines cause an increase in TEWL and a decrease in moisturizing factors in the epidermis (Mori et al., 2017). Ma et al. conducted a study that revealed that

the physiological parameters of facial skin differed between the thin and overweight groups. The overweight group exhibited an increase in TEWL, sebum content, and hemoglobin content, as well as a decrease in skin pH and skin hydration in the stratum corneum. Obesity has been linked to a variety of changes in barrier integrity, including alterations in TEWL and dry skin (Ma et al., 2024). Furthermore, oxidative stress can accelerate the degradation of collagen and elastin, critical components of the skin's extracellular matrix that contribute to its firmness and elasticity. This can lead to wrinkles as the epidermis loses its structural support.

Skin roughness and wrinkles showed a positive correlation with hip circumference measurements, with coefficients of 0.294 and 0.323, respectively. This suggests that the severity of skin roughness and wrinkles will increase as the hip circumference increases. These findings are inconsistent with the findings of Oh et al., who demonstrate that a high hip circumference can mitigate adverse effects on facial skin health, including skin roughness and creases. Hip circumference frequently links to the distribution of subcutaneous fat, acting as a protective factor against metabolic syndrome. Compared to visceral fat, subcutaneous fat's metabolic activity in the hip area may be more involved in lipid storage and less inflammatory. A better metabolic profile, as indicated by a relatively larger hip circumference, may suggest a higher proportion of subcutaneous fat. This could potentially mitigate the adverse influence on facial skin health commonly observed in central obesity (Oh et al., 2022). However, Ezure et al. conducted a study demonstrating that an increase in body fat percentage, particularly subcutaneously, can affect the formation of wrinkles and texture. Facial expressions correlate the formation of transient wrinkles with an increase in fat infiltration. An increase in fat infiltration also exacerbates the severity of wrinkles. In other words, fat infiltration erodes the physical properties of the dermis and diminishes its elasticity, thereby increasing the formation of transient wrinkles due to the skin's inability to resist facial expression-induced deformation. This ultimately results in an increase of wrinkles on the face (Ezure, 2023).

Skin roughness (0.141) and skin wrinkling (0.058) positively correlated with the glucose profile, indicating a link between impaired glucose metabolism and worse outcomes in skin roughness and increased severity of skin wrinkling. This is indicative of the more extensive influence of metabolic health on cutaneous conditions. In the same vein, Moraes et al.'s research demonstrates that a high concentration of circulating sugar in the blood can lead to greater degradation of collagen, which in turn results in structural and functional changes in the dermis. These changes include a decrease in epidermal thickness, a loss of elasticity, changes in the appearance of wrinkles, and a reduced ability to retain moisture. Furthermore, an individual with diabetes's skin may exhibit an impaired skin barrier as a result of their dysfunctional metabolism, which can result in a decrease in stratum corneum hydration and an increase in transepidermal water loss (TEWL). Even within the same age cohort, the skin of diabetics exhibited higher TEWL values, suggesting that this skin's barrier function is more compromised than

that of healthy skin (Moraes et al., 2023).

Uric acid levels negatively correlated with skin roughness (-0.155) and skin wrinkling (-0.170), suggesting that an increase in uric acid levels was associated with improved skin roughness and skin wrinkling. Karaosmanoglu et al.'s research, which linked elevated UA levels to a number of well-known and prevalent inflammatory dermatological conditions, contradicts these findings. Elevated UA concentrations and hyperuricemia positively correlate with numerous inflammatory markers. Subsequently, this results in tissue destruction and exacerbates the inflammatory responses. Chronic inflammation can disrupt the skin's barrier function, leading to a coarser texture (Karaosmanoglu et al., 2020). Gherghina et al. conducted research that suggests hyperuricemia can exacerbate oxidative stress. This causes cell injury by disrupting the body's equilibrium between antioxidants and free radicals. This can exacerbate the appearance of wrinkles and other aging symptoms by accelerating the breakdown of collagen and elastin, proteins that are crucial for skin firmness and elasticity (Gherghina et al., 2022).

Skin roughness and wrinkles negatively correlate with hemoglobin and hematocrit, with coefficients of -0.069 and -0.074, -0.112, and -0.161, respectively. This suggests that an increase in hemoglobin and hematocrit is associated with enhanced skin roughness and reduced skin wrinkles. Wouters et al. suggest that the reduced tissue oxygenation associated with anemia may influence the formation and accumulation of low levels of AGEs. AGEs disrupt skin barrier function, which is a known risk factor for dry skin because they initiate a cascade of pro-inflammatory signals. The accumulation of AGEs can also result in the degradation of structural collagen in the skin, which in turn increases the likelihood of the formation of skin wrinkles as a result of the increased degradation of structural collagen. (Wouters et al., 2020) Gupta et al. provide additional evidence supporting the correlation between anemia and skin roughness, arguing that inadequate oxygenation and nutrient delivery can disrupt the synthesis of collagen and the regeneration of skin cells, potentially resulting in alterations in skin texture (Gupta et al., 2022).

The limitation of this study is the small sample size (n=115) which may influence the results. In addition, this research was specifically conducted on an adult population so the results may be different if it was conducted on an elderly population. Researchers hope these results can be used for further research on obesity-related health parameters based on body mass index, abdominal circumference, hips and body composition; blood sugar, uric acid, hemoglobin, and hematocrit levels on the skin face analyzer. We suggest in future research blood samples can be taken via vein so that more accurate results will be obtained.

CONCLUSION

The study explores the intricate relationships between various physiological and metabolic parameters and facial skin health among the productive-age population. The findings indicate that higher Body Mass Index (BMI) and waist circumference are significantly associated with reduced skin roughness and wrinkles, while increased hip circumference

correlates with worsened skin conditions. Additionally, elevated hemoglobin and hematocrit levels improve skin texture and reduce wrinkles. Conversely, higher glucose levels are linked to poorer skin health. Surprisingly, increased uric acid levels, typically associated with inflammation, show a negative correlation with skin roughness and wrinkles, suggesting a potential protective role. These insights underscore the importance of comprehensive health management for maintaining optimal skin health.

REFERENCES

Alexander Halim Santoso, B., Firmansyah, Y., Luwito, J., Edbert, B., Kotska Marvel Mayello Teguh, S., Herdiman, A., Shifa Martiana, C., & Valeri Alexandra, T. (2023). Pengabdian Masyarakat - Pengukuran Indeks Massa Tubuh dan Lingkar Perut dalam Upaya Pemetaaan Obesitas Sentral pada Warga Masyarakat di Desa Dalung, Serang, Banten. *SEWAGATI: Jurnal Pengabdian Masyarakat Indonesia*, *2*(2), 01–08. https://doi.org/10.56910/SEWAGATI.V2I2.596

Alexander Halim Santoso, Ernawati Ernawati, Sukmawati Tansil Tan, Yohanes Firmansyah, Alicia Sarijuwita, & Jasmine Syabania Noviantri. (2023). Community Service Activities – Counseling and Waist Circumference Screening in the Context of Early Detection of Obesity in Adolescent Boys. *Jurnal Suara Pengabdian 45*, *2*(2), 01–08. https://doi.org/10.56444/pengabdian45.v2i2.718

Alsaadoun, D. (2024). Deciphering the Hidden Secrets between the Early Skin Wrinkling & the Metabolic (X) Syndrome with the Possible Reversal of This Process at the Molecular Level. *Journal of Cosmetics, Dermatological Sciences and Applications*, *14*(01), 45–68. https://doi.org/10.4236/jcdsa.2024.141004

Baker, P., Huang, C., Radi, R., Moll, S. B., Jules, E., & Arbiser, J. L. (2023). Skin Barrier Function: The Interplay of Physical, Chemical, and Immunologic Properties. *Cells*, *12*(23), 2745. https://doi.org/10.3390/cells12232745

Banyś, A., Hartman-Petrycka, M., Kras, K., Kamińska, M., Krusiec-Świdergoł, B., Popielski, P., Lebiedowska, A., & Wilczyński, S. (2023). The Influence of Sebum on Directional Reflectance of the Skin. *Applied Sciences*, *13*(5), 2838. https://doi.org/10.3390/app13052838

Cameron, A. J., Romaniuk, H., Orellana, L., Dallongeville, J., Dobson, A. J., Drygas, W., Ferrario, M., Ferrieres, J., Giampaoli, S., Gianfagna, F., Iacoviello, L., Jousilahti, P., Kee, F., Moitry, M., Niiranen, T. J., Pająk, A., Palmieri, L., Palosaari, T., Satu, M., … Söderberg, S. (2020). Combined Influence of Waist and Hip Circumference on Risk of Death in a Large Cohort of European and Australian Adults. *Journal of the American Heart Association*, *9*(13), e015189. https://doi.org/10.1161/JAHA.119.015189

Choi, L.-S., Ahmed, K., Kim, Y.-S., & Yim, J.-E. (2022). Skin accumulation of advanced

glycation end products and cardiovascular risk in Korean patients with type 2 diabetes mellitus. *Heliyon*, *8*(6), e09571. https://doi.org/10.1016/j.heliyon.2022.e09571

Cook, M. K., Kaszycki, M. A., Richardson, I., Taylor, S. L., & Feldman, S. R. (2022). Initial validation of a new device for facial skin analysis. *Journal of Dermatological Treatment*, *33*(8), 3150–3153. https://doi.org/10.1080/09546634.2022.2127305

Dąbrowska, A. K., Spano, F., Derler, S., Adlhart, C., Spencer, N. D., & Rossi, R. M. (2018). The relationship between skin function, barrier properties, and body-dependent factors. *Skin Research and Technology*, *24*(2), 165–174. https://doi.org/10.1111/srt.12424

Destra, E., Anggraeni, N., Firmansyah, Y., & Santoso, A. H. (2023). Waist to hip ratio in Cardiovascular Disease Risk : A Review of the Literature. *MAHESA : Malahayati Health Student Journal*, *3*(6), 1770–1781. https://doi.org/10.33024/mahesa.v3i6.10595

Du-Harpur, X., Watt, F. M., Luscombe, N. M., & Lynch, M. D. (2020). What is AI? Applications of artificial intelligence to dermatology. *British Journal of Dermatology*, *183*(3), 423–430. https://doi.org/10.1111/bjd.18880

Ezure, T. (2023). Subcutaneous fat infiltration into the dermal layer induces wrinkle formation. *Skin Research and Technology : Official Journal of International Society for Bioengineering and the Skin (ISBS) [and] International Society for Digital Imaging of Skin (ISDIS) [and] International Society for Skin Imaging (ISSI)*, *29*(3), e13296. https://doi.org/10.1111/srt.13296

Firmansyah, Y., & Santoso, A. (2020). Hubungan Obesitas Sentral Dan Indeks Massa Tubuh Berlebih Dengan Kejadian Hipertensi. *Hearty*, *8*, 1–8. https://doi.org/10.32832/hearty.v8i1.3627

Gherghina, M. E., Peride, I., Tiglis, M., Neagu, T. P., Niculae, A., & Checherita, I. A. (2022). Uric Acid and Oxidative Stress—Relationship with Cardiovascular, Metabolic, and Renal Impairment. *International Journal of Molecular Sciences 2022, Vol. 23, Page 3188*, *23*(6), 3188. https://doi.org/10.3390/IJMS23063188

Gidado, I. M., Qassem, M., Triantis, I. F., & Kyriacou, P. A. (2022). Review of Advances in the Measurement of Skin Hydration Based on Sensing of Optical and Electrical Tissue Properties. *Sensors (Basel, Switzerland)*, *22*(19). https://doi.org/10.3390/s22197151

Gosal, D., Firmansyah, Y., & Su, E. (2020). Pengaruh Indeks Massa Tubuh terhadap Klasifikasi Tekanan Darah pada Penduduk Usia Produktif di Kota Medan. *Jurnal Kedokteran Meditek*, *26*(3). https://doi.org/10.36452/jkdoktmeditek.v26i2.1875

Gunaidi, F. C., Destra, E., Santoso, A. H., & Frisca, F. (2020). Hubungan Indeks Masa Tubuh dan Ligkar Pinggang Dengan Kejadian Hipertensi Pada Orang Dewsa Dengan Aktivitas

Ringan Hingga Sedang. *Jurnal Medika Hutama*, *3*(4), 2992–2996.

Gupta, S., Mujawdiya, P., Maheshwari, G., & Sagar, S. (2022). Dynamic Role of Oxygen in Wound Healing: A Microbial, Immunological, and Biochemical Perspective. *Archives of Razi Institute*, *77*(2), 513–523. https://doi.org/10.22092/ARI.2022.357230.2003

Holmes, C. J., & Racette, S. B. (2021). The Utility of Body Composition Assessment in Nutrition and Clinical Practice: An Overview of Current Methodology. *Nutrients*, *13*(8). https://doi.org/10.3390/nu13082493

Jansen van Rensburg, S., Franken, A., & Du Plessis, J. L. (2019). Measurement of transepidermal water loss, stratum corneum hydration and skin surface pH in occupational settings: A review. *Skin Research and Technology*, *25*(5), 595–605. https://doi.org/10.1111/srt.12711

Karaosmanoglu, N., Karaaslan, E., & Ozdemir Cetinkaya, P. (2020). Evaluation of serum uric acid levels in patients with rosacea. *Archives of Dermatological Research*, *312*(6), 447–451. https://doi.org/10.1007/s00403-020-02033-w

Khalid, M., Petroianu, G., & Adem, A. (2022). Advanced Glycation End Products and Diabetes Mellitus: Mechanisms and Perspectives. *Biomolecules*, *12*(4), 542. https://doi.org/10.3390/biom12040542

Li, Z., Koban, K. C., Schenck, T. L., Giunta, R. E., Li, Q., & Sun, Y. (2022). Artificial Intelligence in Dermatology Image Analysis: Current Developments and Future Trends. *Journal of Clinical Medicine*, *11*(22), 6826.https://doi.org/10.3390/jcm11226826

Linda Yulianti W, Edwin Destra, Farell Christian Gunaidi, Gracienne Gracienne, & Kanaya Fide Kusuma. (2024). Kegiatan Skrining Kadar Air Dan Minyak Kulit Pada Populasi Lanjut Usia. *NUSANTARA Jurnal Pengabdian Kepada Masyarakat*, *4*(2), 57–64. https://doi.org/10.55606/nusantara.v4i2.2835

Lopez-Ojeda, W., Pandey, A., Alhajj, M., & Oakley, A. M. (2024). Anatomy, Skin (Integument). In *StatPearls*. http://www.ncbi.nlm.nih.gov/pubmed/30944614

Ma, L., Zhang, H., Jia, Q., Bai, T., Yang, S., Wang, M., Li, Y., & Shao, L. (2024). Facial Physiological Characteristics and Skin Microbiomes Changes are Associated with Body Mass Index (BMI). *Clinical, Cosmetic and Investigational Dermatology*, *Volume 17*, 513–528.https://doi.org/10.2147/CCID.S447412

Monica, P. W., & Nurrachmat Mulianto. (2023). Correlation between Uric Acid Levels and the Severity of Psoriasis Vulgaris Patients. *Indonesian Journal of Rheumatology*, *13*(3),752759.https://doi.org/10.37275/ijr.v13i3.248

Moraes, V. R., Melo, M. O., & Maia Campos, P. M. B. G. (2023). Evaluation of Morphological and Structural Skin Alterations on Diabetic Subjects by Biophysical and Imaging Techniques. *Life*, *13*(2), 579. https://doi.org/10.3390/life13020579

Mori, S., Shiraishi, A., Epplen, K., Butcher, D., Murase, D.,

Yasuda, Y., & Murase, T. (2017). Characterization of skin function associated with obesity and specific correlation to local/systemic parameters in American women. *Lipids in Health and Disease*, *16*(1), 1–11. https://doi.org/10.1186/S12944-017-0608-1/FIGURES/4

Nakrani, M. N., Wineland, R. H., & Anjum, F. (2023). Physiology, Glucose Metabolism. *StatPearls*.https://www.ncbi.nlm.nih.gov/books/NBK560599

Oliveira, R., Ferreira, J., Azevedo, L. F., & Almeida, I. F. (2023). An Overview of Methods to Characterize Skin Type: Focus on Visual Rating Scales and Self-Report Instruments. *Cosmetics*, *10*(1), 14. https://doi.org/10.3390/cosmetics10010014

Papaccio, F., D'arino, A., Caputo, S., & Bellei, B. (2022). Focus on the Contribution of Oxidative Stress in Skin Aging. *Antioxidants 2022, Vol. 11, Page 1121*, *11*(6), 1121. https://doi.org/10.3390/ANTIOX11061121

Rodriguez, A. J., Boonya-Ananta, M. T., Gonzalez, M., Le, V. N. Du, Fine, J., Palacios, C., McShane, M. J., Coté, G. L., & Ramella-Roman, J. C. (2022). Skin optical properties in the obese and their relation to body mass index: a review. *Journal of Biomedical Optics*, *27*(3),30930903.https://doi.org/10.1117/1.JBO.27.3.030902

Ughasoro, M. D., Madu, A. J., & Kela-Eke, I. C. (2017). Clinical Anaemia Detection in Children of Varied Skin Complexion: A Community-based Study in Southeast, Nigeria. *Journal of Tropical Pediatrics*, *63*(1), 23–29.https://doi.org/10.1093/TROPEJ/FMW044

W, L. Y., Kurniawan, J., Gunaidi, F. C., Alifia, T. P., & Syarifah, A. G. (2024). Kegiatan Penapisan Kadar Air Dan Minyak Kulit Pada Populasi Dewasa Di SMP Kalam Kudus Jakarta. *Jurnal Kabar Masyarakat*, *2*(2), 16–23. https://doi.org/10.54066/JKB.V2I2.1764

Wollina, U., Wetzker, R., Abdel-Naser, M. B., & Kruglikov, I. L. (2017). Role of adipose tissue in facial aging. *Clinical Interventions in Aging*, *12*, 2069.https://doi.org/10.2147/CIA.S151599

Wouters, H. J. C. M., van der Klauw, M. M., Wolffenbuttel, B. H. R., Huls, G., & van Zeventer, I. A. (2020). The Association Between Anemia and Skin Autofluorescence, a Marker for Advanced Glycation End Product Accumulation. *HemaSphere*, *4*(6), e470. https://doi.org/10.1097/HS9.0000000000000470

Yoshikazu, Y., Takabe, W., & Masayuki, Y. (2015). Photoaging and Glycation of Elastin: Effect on Skin. *Glycative Stress Research*, *2*(4),182190.https://doi.org/10.24659/gsr.2.4_182

Zhu, T., Yang, S., Mauro, T. M., & Man, M.-Q. (2023). Association of Epidermal Biophysical Properties with Obesity and Its Implications. *Skin Pharmacology and Physiology*, *36*(4),165173.https://doi.org/10.1159/000533587