



Subjective Evaluation of the Results of Injectable Hyaluronic Acid Fillers for the Face

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Background: Skin ageing is a physiological process, progressive and irreversible. Hyaluronic acid injection treatments are used to correct the signs of skin ageing.

Material and Methods: Hyaluronic acid was implanted in the area of the cheek and the forehead aesthetic units in 57 women, aged 35–55 years. Apart from the clinical observation, self-assessment of the therapeutic results was conducted. The “My skin” questionnaire was used for subjective evaluation of the treatment results.

Results: Mean wrinkle score in the pre-menopausal group changed after the treatment, from 3.2 ± 0.6 to 1.1 ± 0.3 and from 3.2 ± 0.6 to 0.8 ± 0.6 for the forehead and the cheek esthetic units, respectively. In the post-menopausal group, the score decreased from 3.8 ± 0.4 to 1.7 ± 0.7 and from 3.2 ± 0.617 to 0.8 ± 0.6 for the forehead and the cheek esthetic units, respectively. The changes were age-dependent. Improved appearance of the facial skin – higher satisfaction with skin tone and scent – was reported after hyaluronic acid injections. Higher subjective perception of improvement corresponded to older age, irrespectively of the menopausal status. Correlations between age and the effect of the treatment on maintaining proper skin hydration as well as between improved appearance of the forehead area and feelings of autonomy and well-being were found.

Conclusion: Hyaluronic acid injections significantly improved the subjective perception and overall assessment of the scent and appearance of the facial skin.

Keywords: hyaluronic acid fillers, skin, women, subjective evaluation

Introduction

The skin performs a number of vital physiological functions and its condition is a source of reliable, albeit indirect, information about the well-being of the entire body.^{1,2} Dermal changes (temperature, tone, muscle tension, and hydration) are not only indicative of the somatic well-being, but also the emotional condition of an individual, as signs manifested by the skin are outside their conscious control. The skin is also believed to play a role in a number of psychological and social functions,^{3,4} which are associated with the realization of developmental tasks in the course of a lifespan.

Skin ageing is a physiological, progressive and irreversible process which is associated with biochemical, morphological and biophysical changes in the body.⁵ Esthetic dermatology offers a variety of skin treatments to correct age-related changes, including injectable hyaluronic acid-based fillers (HAFs).⁶ Satisfaction with skin appearance in different areas of the face and the body may increase after esthetic dermatology treatments, thus being indicative of their effectiveness. To the best of our knowledge, only a few studies so far have focused on the subjective

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evaluation of HAF effectiveness by patients, as most researchers investigate objective and measurable changes in the biophysical parameters.

Objectives

The aim of the study was to evaluate the effects of injectable HAF on patient satisfaction with skin appearance, tone and scent, as well as perception of skin function and its connection with physical and psychosocial well-being, before and after treatment, among females undergoing esthetic dermatology treatment.

Materials and Methods

A total of 57 women (aged 35–55 years), pre-menopausal and post-menopausal, who reported for esthetic dermatology treatment were randomly recruited for the study. The difference in mean patient age was considerable ($d=1.8$) and statistically significant ($t(10.1) = 4.3$, $p < 0.001$). All subjects were healthy and did not take any medicine throughout the entire observation period (30 days \pm 1 day). The patients received detailed information about the aim and the scope of the treatment, possible adverse effects, and the study protocol. Written informed consent was obtained. The inclusion criteria were as follows: informed consent, no history of esthetic dermatology or plastic surgery facial treatments, and no contraindications to treatment. Non-animal stabilized hyaluronic acid (NASHA) was used for facial skin rejuvenation. Restylane[®] Lyft (formerly Perlane) with Lidocaine is a sterile gel of hyaluronic acid generated by Streptococcus species of bacteria, chemically cross-linked with BDDE, stabilized and suspended in phosphate-buffered saline at pH=7 and concentration of 20 mg/mL with 0.3% lidocaine.

Hyaluronic acid (HA) was injected into facial esthetic units: the cheeks (0.2 mL in 5 lines; 1 mL for each cheek) and the forehead (0.1 mL in 10 lines, 1 mL in total, symmetrically on both sides). HA injections were free of charge.

An original Polish questionnaire known as “My skin”,⁷ a popular tool in esthetic dermatology, was used for subjective evaluation of the treatment results. Section AB focused on the satisfaction with the following: 1. skin condition in various areas of the body; 2. skin tone, scent and structure; 3. appearance and condition of the hair and the nails. Section C included questions about the perception of physiological and psychosocial skin functions, as well as the relationship between the condition of the skin and physical and emotional well-being. A 5-point Likert scale was used (section AB: “I do not like it at all”, “I do

not like it”, “No opinion”, “I like it”, “I absolutely like it”; section C: “I disagree”, “I absolutely disagree”, “No opinion”, “I agree”, “I absolutely agree”). The questionnaire was completed twice – before and 30 days after the treatment. A questionnaire “My skin” is included in the [Supplementary materials](#).

Wrinkle formation on the cheeks and the forehead was measured using the scale from 1 to 5, as proposed by Lemperele et al,⁸ and assessed before and 30 days after the treatment.

The study was designed to investigate changes in the perception of skin appearance after HA administration. The control variables included age and menstruation. As these variables are connected, a mixed model analysis of covariance (ANCOVA), with age as the covariate, was applied. Jamovi v. 0.8.1.5 [jamovi project (2017)]⁹ was used for the analysis. Type II sum of squares was used in the analysis due to unequal sample size.

As both groups were unequal in size and age and the variables in section C of the questionnaire are expressed on the weak end of the ordinal scale (the most common scores were 4 or 5), Pearson’s chi-square test with Yule’s correction was used to analyze the differences in the evaluation of skin function after HA injections among pre-menopausal and post-menopausal women. For the same reason, Spearman’s rank was used to evaluate the strength of the relationship between the age of the respondents and their perception of skin function.

Written informed consent was obtained from all subjects. The study was conducted in accordance with the Declaration of Helsinki. Bioethics Committee at the Poznan University of Medical Sciences approved of the study protocol (No. 740/11).

Results

Mean age of the pre-menopausal participants ($n=48$; 84%) was 41.8 ± 3.9 years (range: 35–51 years) and was significantly lower ($g = 1.77$, $CI_{.95}[0.99-2.56]$) as compared to their post-menopausal peers ($n=9$; 16%) – 49 ± 4.7 years (range: 39–55 years).

Mean wrinkle score changed after HAF from 3.8 ± 0.4 to 1.7 ± 0.7 for the forehead esthetic unit in the post-menopausal group and from 3.2 ± 0.6 to 1.1 ± 0.3 in the pre-menopausal group. Mean wrinkle score decreased after HAF from 3.8 ± 0.4 to 1.9 ± 0.3 in the post-menopausal group and from 3.2 ± 0.6 to 0.8 ± 0.6 in the pre-menopausal group. A strong relationship was observed between age and the scores of the wrinkle scale for the forehead unit (before treatment: $r = 0.610$, $p < 0.001$; after treatment: $r = 0.429$, $p < 0.001$) and the cheek (before

treatment: $r = 0.527$, $p < 0.001$; after treatment: $r = 0.588$, $p < 0.001$). Repeated measures ANOVA revealed a statistically significant change in the forehead scores ($F(1, 54) = 803.5$, $p < 0.001$, $\eta^2_p = 0.937$). The change was age-related. Higher age corresponded to higher improvement, irrespectively of the menopausal status ($F(1, 54) = 1.35$, $p = 0.251$). A similar set of results was observed for the cheek scores. The change was high and statistically significant ($F(1, 54) = 1009$, $p < 0.001$, $\eta^2_p = 0.949$), although no relationship with age ($\rho = -0.163$, $p = 0.225$) or the menopausal status ($F(1, 54) = 3.14$, $p = 0.082$) was found.

The main outcome of the treatment, i.e. improved skin appearance in the subjective evaluation of the study participants – proved to be statistically significant ($F(1.54) = 350.2$, $p < 0.001$, $\eta^2_{part} = 0.866$, $CI_{.95}[0.785-0.897]$). Higher level of satisfaction with skin appearance in different areas of the body was observed in both groups, demonstrating that entering the period of menopause does not affect the perception of large improvement in skin appearance after injectable HAF therapy ($F(1.54) = 0.86$, $p = 0.358$) (Figure 1). Age turned out to be a significant factor affecting the mean scores of skin appearance ($F(1.54) = 6.77$, $p = 0.012$). Based on the benchmarks suggested by Cohen (1988), we found that age variable has a significant effect ($\eta^2_{part} = 0.11$, $CI_{.95}[0.005-0.265]$) on the average score of skin appearance, and that the score decreased with age ($r_{before} = -0.40$, $p = 0.001$; $r_{after} = -0.32$, $p = 0.007$) (Figure 2).

The respondents evaluated the skin tone and scent. A significantly larger number of the participants reported higher satisfaction with their skin tone and scent after HAF, and fewer women were satisfied with the appearance

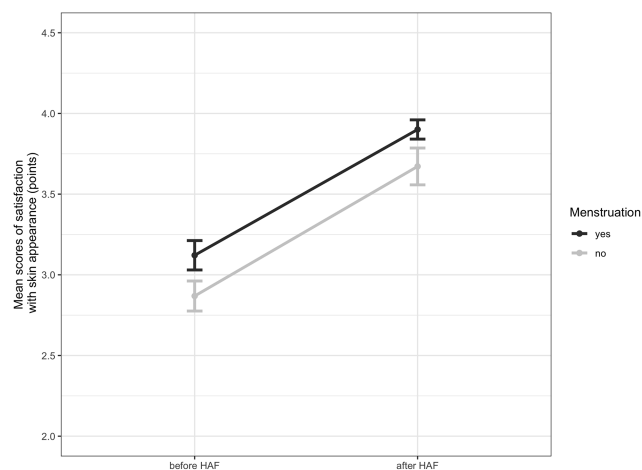


Figure 1 Mean subjective evaluation of the satisfaction with the skin appearance before and 30 days after HAF among pre-menopausal and post-menopausal women.

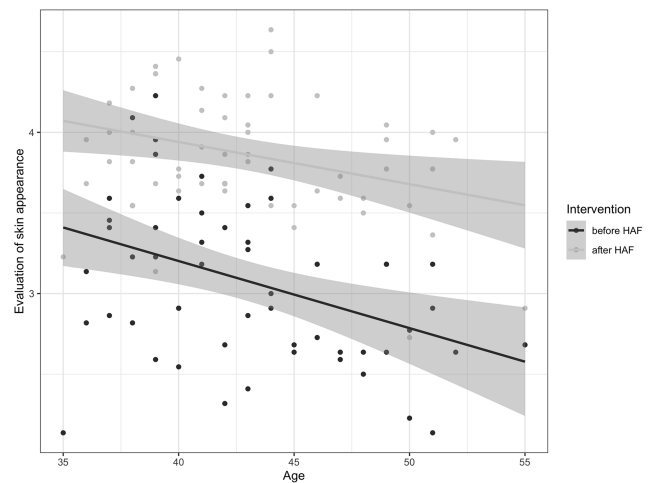


Figure 2 Subjective evaluation of the skin appearance depending on the patient age before and 30 days after the HAF.

of their hair. No relationship was found between the treatment and the appearance of the fingernails, but more women reported improved appearance of the toenails after treatment (Table 1).

No statistically significant relationship between the treatment and the total subjective score of skin functions ($F(1.54) = 2.52$, $p = 0.118$) was found. Age also did not significantly lower the scores ($F(1.54) = 2.31$, $p = 0.135$), although minimal correlations between the variables were observed ($\rho_{before} = -0.24$, $p = 0.036$; $\rho_{after} = -0.28$, $p = 0.017$) (Figure 3).

At the same time, a correlation was found between improved appearance of the forehead area and psychological functions of the skin. The change in skin appearance was positively correlated with the feelings of autonomy (My skin makes me unique; Spearman's $Rho = -0.292$; $p = 0.028$) and well-being (My skin affects my well-being; Spearman's $Rho = -0.347$; $p = 0.008$). Attempts have been made to investigate whether pre-menopausal and post-menopausal women differed in their perception of skin function after HA treatment among. No significant changes in the perception of the physiological, psychological and social skin functions, responsible for physical and mental well-being, reaction to external stimuli, a sense of autonomy, detachment, and social acceptance, were observed in the majority of cases. Most women, pre-menopausal as well as post-menopausal, did not differ significantly in their perception of the relationship between skin condition and physical and mental well-being before and after the treatment.

In both groups of women, significant differences were found in the perception of the following skin functions: maintaining proper hydration ($p < 0.001$), and the ability to

Table 1 Changes in the Evaluation of Individual Skin Parameters and Its Appendages Before and 30 Days After HAF

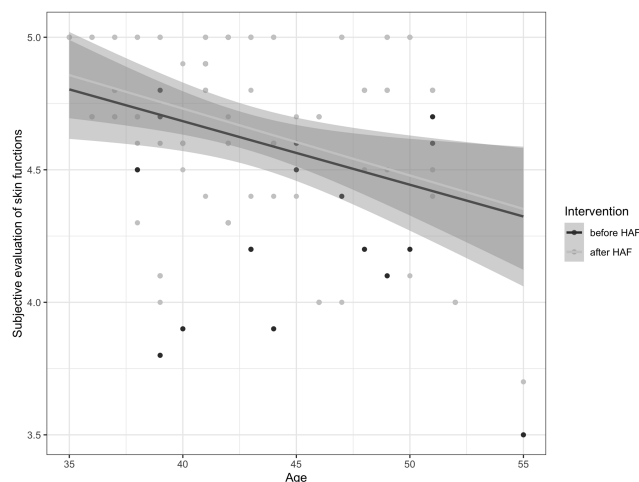
Parameter	Deterioration	No Change	Improvement	Significance	Effect Size
Skin tone	2 (4%)	22 (39%)	33 (58%)	$W = 827.50, z = 5.22, p < 0.001$	$r = 0.691$
Skin scent	3 (5%)	22 (39%)	32 (56%)	$W = 844.50, z = 4.93, p < 0.001$	$r = 0.653$
Hair	23 (40%)	28 (49%)	6 (11%)	$W = 911.00, z = 5.31, p < 0.001$	$r = -0.703$
Fingernails	5 (9%)	40 (70%)	12 (21%)	$W = 1490.00, z = 1.62, p = 0.127$	–
Toenails	4 (7%)	39 (68%)	14 (25%)	$W = 1480.50, z = 2.37, p = 0.026$	$r = 0.314$

regenerate ($p < 0.001$). The distribution in the post-menopausal group was even – the treatment did not affect the pre- and post-test scores and the same number of women reported deterioration, or no change, or improved skin appearance, while in the pre-menopausal group, a significant majority of the subjects reported no change after the treatment. Importantly, it needs to be emphasized that the results are necessarily speculative due to lack of sample size balance (the post-menopausal group was relatively small). A similar analysis was conducted in relation to age, with 45 years as the point of division. A statistically significant correlation was found between age and the effect of the treatment on maintaining proper skin hydration ($p < 0.001$), with younger women, more frequently reporting deteriorated skin hydration. In the group of the older women, 3 categories (improvement, no change, deterioration) were identified, with no statistically significant differences in the frequency of the scores. As far as the remaining skin functions are concerned, no significant changes between pre- and post-treatment scores were observed.

Discussion

The condition of the skin reflects the functioning of the entire body as changes in skin temperature, tone, muscle

tension and hydration level is not only a source of information about somatic health, but also about the emotional well-being.^{1,2} Signals transmitted by the appearance of the skin remain beyond the conscious control of the host. Psychological and social functions connected with creating attachment in the childhood and autonomy and identity in the adolescence, shaping self-image, establishing intimate bonds, developing social communication, as well as accepting age-related changes, have long been linked with the condition of the skin.^{3,4,10} Middle and late adulthood are typically associated with characteristic changes in skin appearance, which are related to the perception of biological age of an individual. The ageing of skin is a multifactorial and progressive process which includes skeletal reabsorption, ligament loosening, muscle atrophy as well as fat pad displacement, consequently leading to overall facial laxity and contour change. Changes in skin appearance may constitute a source of considerable psychological stress, which in turn adversely affects the quality of life in late adulthood.^{11,12} These changes are usually perceived as unfavorable and have a negative impact on self-esteem and psychosocial well-being. They also have a symbolic significance as they place an individual in the group of “the elderly”, stereotypically associated with undesirable physical, mental and behavioral features. The face is the key determinant of the overall physical attractiveness for both, men and women. Faces with average^{13,14} values of anthropometric characteristics of a given population as well as symmetric faces^{15,16} are perceived as highly attractive. Moreover, a positive relationship has been reported between attractiveness and lack of fluctuating asymmetry (FA) in case of both sexes,¹⁷ and – in case of women – strongly feminized facial features,¹⁸ as well as clear and bright skin.¹⁹ Susceptibility to FA is connected with age and varies for different parameters. FA is associated with pigmentation and skin wrinkles as well as with adipose tissue, and develops throughout the entire life, whereas FA of mimic muscle tone is characteristic of ageing and old age.²⁰

**Figure 3** Subjective evaluation of skin functions depending on patient age before and 30 days after HAF.

Appleton et al,¹⁹ found a positive correlation between attractiveness of the female facial skin and healthy (unblemished) skin and facial symmetry. Skin tone and texture also play key roles in the perceived attractiveness of the face. Matts et al,²¹ revealed a relationship between skin tone and color homogeneity and health, age and attractiveness of the female facial skin. According to Fink et al,²² homogeneous skin, i.e. smooth and with even color and regular texture, correlates positively with attractiveness of a woman as perceived by men. Faces with even skin color were also perceived as healthier and younger.^{21,22} Skin lacking color and texture homogeneity, with visible hypo or hyper-pigmentations, negatively affects the perceived physical attractiveness of a female.^{20,23}

A gradual decrease in HA concentration and structural changes of collagen fibers, resulting in dehydration and loss of elasticity, accompany the ageing process of the skin.⁶ HA concentrations among women aged 19–47, or 60, or 70 years have been estimated at approximately 0.03%, 0.015% and 0.007%, respectively.²⁴ The most noticeable changes include loss of skin elasticity and volume, and the appearance of facial fossa and wrinkles. Moreover, up to 80% of the visible signs of skin ageing (dryness with scaling and wrinkling,²⁵ impaired pigmentation and photoaging) are the results of exposure to ultra-violet radiation (UV) and correlate with cancer risk.²⁶

HA injections are one of the most commonly used treatments to correct the age-related skin changes. In photo-aged skin, they stimulate fibroblasts, collagen and elastin production, HA synthesis, extracellular matrix production and epithelial regeneration in the areas undergoing treatment.²⁷ Intradermal injections of stabilized HA also decrease skin porosity and have a beneficial effect on skin elasticity.²⁸

In our study, we found that HA treatment positively influenced the perceived attractiveness of the facial skin, which is consistent with the findings of other authors.^{29,30} In a study by Baumann et al, the majority of the patients undergoing injectable HA gel therapy for facial fossa reported “a younger look” after treatment.³⁰ According to Wilson et al,³¹ over 80% of the participants with age-related volume loss of the facial skin reported significant improvement, even up to 12 months after treatment. A high level of satisfaction with the appearance of the facial skin after tear trough and temporal fossa augmentation was noted by Tung et al, and Berguiga et al^{32,33} Jegasothy et al,³⁴ also reported beneficial effects (wrinkle depth reduction, improved skin hydration, firmness and

elasticity) of low molecular nano-hyaluronic acid injections. Positive changes in the appearance of the facial skin after HA treatment (improved firmness and pigmentation) were observed by Landi et al³⁵ Trong et al³⁶ also documented improved skin elasticity and wrinkle depth reduction, while Baspeyras et al,³⁷ observed significant improvement in skin hydration, firmness and viscoelasticity after HA microinjection treatment. A statistically significantly improved radiance, pigmentation and hydration were observed by Sparavigna et al,³⁸ in the process of treating skin with symptoms of ageing and photoaging.

In our study, we found significantly improved skin appearance after HA injections, not only in the areas where the preparation was administered, but also on the torso and the limbs. At the same time, improved appearance of the facial skin after the treatment negatively affected the perceived appearance of the neck and cleavage skin, possibly due to the disproportion between smoothed facial skin and untreated skin of the neck and the cleavage, with visible ageing signs. It remains a challenge to explain the reasons behind improved self-perceived appearance of the untreated torso and limb skin. To the best of our knowledge, no literature sources have reported similar findings. The results of our study proved that subjective satisfaction after HA injections with skin tone and scent, as well as with the appearance of the toenails, was higher. Baspeyras et al,³⁷ and Qian et al,³⁹ also reported improved satisfaction with facial skin tone after HA injections. However, we were not able to find any reports on changes in the level of satisfaction with skin scent and the appearance of the toenails after such treatment. The scent of the body changes in the course of a person's life.⁴⁰ Mitro et al,⁴⁰ proved that their study participants were able to differentiate between scent samples of younger (20–30 and 45–55 years) and older (75–95 years) people. The 2-Nonenal – an unsaturated aldehyde with greasy and grassy odor which is absent in scent samples from younger people but identified in scent samples from people >40 years of age are considered to be a potential biomarker of the ageing process.^{41,42} Furthermore, the scent of a woman's body changes depending on the phase of the menstrual cycle and its attractiveness, as perceived by men, is connected with high levels of estradiol and low levels of progesterone.⁴³

A properly hydrated skin is perceived as healthier, and its ageing is definitely slower.⁴⁴ The positive effect after stabilized HA injections, i.e. healthier looking facial skin, can be sustained for over half a year.⁴⁵ Marrakchi and Maibach⁴⁶ found that skin hydration in people over 66 years of age is lower than in younger individuals. In our

study, we found the self-reported level of skin hydration after HA injections to be correlated with the age variable – significantly higher differentiation (improvement, no change, deterioration) was observed in the answers of the older women (post-menopausal) as compared to their younger (pre-menopausal) peers, who more frequently reported no change or even deteriorated parameters.

Since the dawn of time, human beings have been altering their appearance. In doing so, they took into consideration – to a lesser or greater degree – the cultural requirements of their times.⁴⁶ Modern surgical dermatology and plastic surgery have offered various possibilities to alter and modify one's own appearance. In the past, changes in the body were mainly connected with the passage of time and, consequently, loss of physical and sexual attractiveness. Currently, there is a visible tendency to treat the body as a stage of sorts, a space where individuals display themselves.⁴⁷

Conclusions

HA injections are connected with significant positive changes in the subjective perception and overall evaluation of the appearance and scent of the facial skin. Numerous authors have confirmed a positive influence of the treatment on patient self-esteem. Self-evaluation of the skin appearance after HA treatment is age-related. HA injections are connected with a change in the subjective evaluation of such skin functions as maintaining proper hydration, ability to regenerate, as well as one's autonomy and well-being.

Disclosure

The authors report no conflicts of interest in this work.

References

- Egert M, Simmering R, Riedel CU. The association of the skin microbiota with health, immunity, and disease. *Clin Pharmacol Ther.* 2017;102(1):62–69. doi:10.1002/cpt.698
- Abdallah F, Mijouin L, Pichon C. Skin immune landscape: inside and outside the organism. *Mediators Inflamm.* 2017;2017:5095293. doi:10.1155/2017/5095293
- Shenefelt PD, Shenefelt DA. Spiritual and religious aspects of skin and skin disorders. *Psychol Res Behav Manag.* 2014;7:201–212. doi:10.2147/PRBM.S65578
- Tomas-Aragones L, Marron SE. Body image and body dysmorphic concerns. *Acta Derm Venereol.* 2016;96(217):47–50. doi:10.2340/00015555-2368
- Santos AL, Lindner AB. Protein posttranslational modifications: roles in aging and age-related disease. *Oxid Med Cell Longev.* 2017;2017. doi:10.1155/2017/5716409
- Kim J. Clinical effects on skin texture and hydration of the face using microbotox and microhyaluronic acid. *Plast Reconstr Surg Glob Open.* 2018;6(11):e1935. doi:10.1097/GOX.0000000000001935

- Kossakowska M. Prezentacja kwestionariusza “Moja skóra” do mierzenia subiektywnej reprezentacji poznawczo-emocjonalnej skóry. [Presentation of the “My skin” questionnaire used for subjective measurement of cognitive and emotional representation of the skin]. *Dermatol Estet.* 2011;2(73):106–112.
- Lemperle G, Holmes RE, Cohen SR, Lemperle SM. A classification of facial wrinkles. *Plast Reconstr Surg.* 2001;108(6):1735–50; discussion 1751–2. doi:10.1097/00006534-200111000-00048
- Jamovi project. Jamovi version 0.8 computer software. Available from: <https://www.jamovi.org/>. Accessed October 3, 2019.
- Turner TS. The social skin. *HAU.* 2012;2(2):486–504. doi:10.14318/hau2.2.026
- Wang C-H, Liu H-J, Tsai Y-T, Lin H-I, Wu P-Y, Lin J-W. An innovative thread-looping method for facial rejuvenation: minimal access multiple plane suspension. *Plast Reconstr Surg Glob Open.* 2019;7(1):e2045. doi:10.1097/GOX.0000000000002045
- Farage MA, Miller KW, Elsner P, Maibach HI. Characteristics of the aging skin. *Adv Wound Care.* 2013;2(1):5–10. doi:10.1089/wound.2011.0356
- Rhodes G, Yoshikawa S, Clark A, Lee K, McKay R, Akamatsu S. Attractiveness of facial averageness and symmetry in non-western cultures: in search of biologically based standards of beauty. *Perception.* 2001;30(5):611–625. doi:10.1068/p3123
- Foo YZ, Simmons LW, Rhodes G. Predictors of facial attractiveness and health in humans. *Sci Rep.* 2017;7:39731. doi:10.1038/srep39731
- Rhodes G. The evolutionary psychology of facial beauty. *Annu Rev Psychol.* 2006;57:199–226. doi:10.1146/annurev.psych.57.102904.190208
- Komori M, Kawamura S, Ishihara S. Averageness or symmetry: which is more important for facial attractiveness? *Acta Psychol (Amst).* 2009;131(2):136–142. doi:10.1016/j.actpsy.2009.03.008
- Hatch CD, Wehby GL, Nidey NL, Uribe LMM. The effects of objective 3D measures of facial shape and symmetry on perceptions of facial attractiveness. *J Oral Maxillofac Surg.* 2017;75(9):1958–1970. doi:10.1016/j.joms.2017.04.042
- Little AC, Jones BC, DeBruine LM. Facial attractiveness: evolutionary based research. *Philos Trans R Soc Lond B Biol Sci.* 2011;366(1571):1638–1659. doi:10.1098/rstb.2010.0404
- Appleton KM, McGrath AJ, McKinley MC, et al. The value of facial attractiveness for encouraging fruit and vegetable consumption: analyses from a randomized controlled trial. *BMC Public Health.* 2018;18. doi:10.1186/s12889-018-5202-6
- Kowner R. Facial asymmetry and attractiveness judgment in developmental perspective. *J Exp Psychol Hum Percept Perform.* 1996;22(3):662–675. doi:10.1037//0096-1523.22.3.662
- Matts PJ, Fink B, Grammer K, Burquest M. Color homogeneity and visual perception of age, health, and attractiveness of female facial skin. *J Am Acad Dermatol.* 2007;57(6):977–984. doi:10.1016/j.jaad.2007.07.040
- Fink B, Grammer K, Thornhill R. Human (*Homo sapiens*) facial attractiveness in relation to skin texture and color. *J Comp Psychol.* 2001;115(1):92–99. doi:10.1037/0735-7036.115.1.92
- Fink B, Matts PJ, Klingenberg H, Kuntze S, Weege B, Grammer K. Visual attention to variation in female facial skin color distribution. *J Cosmet Dermatol.* 2008;7(2):155–161. doi:10.1111/j.1473-2165.2008.00382.x
- Jones BC, Little AC, Burt DM, Perrett DI. When facial attractiveness is only skin deep. *Perception.* 2004;33(5):569–576. doi:10.1068/p3463
- Wang F, Garza LA, Kang S, et al. In vivo stimulation of de novo collagen production caused by cross-linked hyaluronic acid dermal filler injections in photodamaged human skin. *Arch Dermatol.* 2007;143(2):155–163. doi:10.1001/archderm.143.2.155
- Grant WB. The effect of solar UVB doses and vitamin D production, skin cancer action spectra, and smoking in explaining links between skin cancers and solid tumours. *Eur J Cancer.* 2008;44(1):12–15. doi:10.1016/j.ejca.2007.09.009

27. Amaro-Ortiz A, Yan B, D'Orazio JA. Ultraviolet radiation, aging and the skin: prevention of damage by topical cAMP manipulation. *Molecules*. 2014;19(5):6202–6219. doi:10.3390/molecules19056202
28. Price RD, Berry MG, Navsaria HA. Hyaluronic acid: the scientific and clinical evidence. *J Plast Reconstr Aesthet Surg*. 2007;60(10):1110–1119. doi:10.1016/j.bjps.2007.03.005
29. Reuther T, Bayrhammer J, Kerscher M. Einsatz biophysikalischer Messverfahren zur Untersuchung der hautphysiologischen Wirkung injizierbarer Hyaluronsäure. *Hautarzt*. 2007;58(12):1046–1050. doi:10.1007/s00105-007-1411-0
30. Baumann LS, Weisberg EM, Mayans M, Arcuri E. Open label study evaluating efficacy, safety, and effects on perception of age after injectable 20 mg/mL hyaluronic acid gel for volumization of facial temples. *J Drugs Dermatol*. 2019;18(1):67–74.
31. Wilson MV, Fabi SG, Greene R. Correction of age-related midface volume loss with low-volume hyaluronic acid filler. *JAMA Facial Plast Surg*. 2017;19(2):88–93. doi:10.1001/jamafacial.2016.1274
32. Tung R, Ruiz de Luzuriaga AM, Park K, Sato M, Dubina M, Alam M. Brighter eyes: combined upper cheek and tear trough augmentation: a systematic approach utilizing two complementary hyaluronic acid fillers. *J Drugs Dermatol*. 2012;11(9):1094–1097.
33. Berguiga M, Galatoire O. Tear trough rejuvenation: A safety evaluation of the treatment by a semi-cross-linked hyaluronic acid filler. *Orbit*. 2017;36(1):22–26. doi:10.1080/01676830.2017.1279641
34. Jegasothy SM, Zabolotniaia V, Bielfeldt S. Efficacy of a new topical nano-hyaluronic acid in humans. *J Clin Aesthet Dermatol*. 2014;7(3):27–29.
35. Landi A, Garagnani L, Leti Acciaro A, Lando M, Ozben H, Gagliano MC. Hyaluronic acid scaffold for skin defects in congenital syndactyly release surgery: a novel technique based on the regenerative model. *J Hand Surg Eur Vol*. 2014;39(9):994–1000. doi:10.1177/1753193414529046
36. Trong HN, Phuong TVT, Van TN, et al. The efficacy and safety of hyaluronic acid microinjection for skin rejuvenation in Vietnam. *Open Access Maced J Med Sci*. 2019;7(2):234–236. doi:10.3889/oamjms.2019.059
37. Baspeyras M, Rouvrais C, Liégard L, et al. Clinical and biometrological efficacy of a hyaluronic acid-based mesotherapy product: a randomised controlled study. *Arch Dermatol Res*. 2013;305(8):673–682. doi:10.1007/s00403-013-1360-7
38. Sparavigna A, Tenconi B, Ponti ID. Antiaging, photoprotective, and brightening activity in biorevitalization: a new solution for aging skin. *Clin Cosmet Investig Dermatol*. 2015;8:57–65. doi:10.2147/CCID.S77742
39. Qian W, Zhang Y-K, Hou Y, et al. Effect analysis of intradermal hyaluronic acid injection to treat enlarged facial pores. *J Cosmet Dermatol*. 2018;17(4):596–599. doi:10.1111/jocd.12385
40. Mitro S, Gordon AR, Olsson MJ, Lundström JN. The smell of age: perception and discrimination of body odors of different ages. *PLoS One*. 2012;7(5):e38110. doi:10.1371/journal.pone.0038110
41. Yamazaki S, Hoshino K, Kusuhara M. Odor associated with aging. *Anti-Aging Med*. 2010;7(6):60–65. doi:10.3793/jaam.7.60
42. Haze S, Gozu Y, Nakamura S, et al. 2-Nonenal newly found in human body odor tends to increase with aging. *J Invest Dermatol*. 2001;116(4):520–524. doi:10.1046/j.0022-202x.2001.01287.x
43. Lobmaier JS, Fischbacher U, Wirthmüller U, Knoch D. The scent of attractiveness: levels of reproductive hormones explain individual differences in women's body odour. *Proc Biol Sci*. 2018;285(1886). doi:10.1098/rspb.2018.1520
44. Dixon KM, Deo SS, Wong G, et al. Skin cancer prevention: a possible role of 1,25dihydroxyvitamin D3 and its analogs. *J Steroid Biochem Mol Biol*. 2005;97(1–2):137–143. doi:10.1016/j.jsmb.2005.06.006
45. Kim J. Effects of injection depth and volume of stabilized hyaluronic acid in human dermis on skin texture, hydration, and thickness. *Arch Aesthetic Plast Surg*. 2014;20(2):97. doi:10.14730/aaps.2014.20.2.97
46. Marrakchi S, Maibach HI. Biophysical parameters of skin: map of human face, regional, and age-related differences. *Contact Derm*. 2007;57(1):28–34. doi:10.1111/j.1600-0536.2007.01138.x
47. Bauman Z. *Born Liquid: Transformations in the Third Millennium*. Cambridge, UK, Medford, MA, USA: Polity; 2019.

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