Eyebrow Height Changes with Aging: A Systematic Review and Meta-analysis

Malke Asaad, MD*
Ahmad Beshr Kelarji†
Cham Shaban Jawhar†
Joseph Banuelos, MD*
Editt Taslakian, MS*
Waseem Wahood, MS*
Krishna S. Vyas, MD, PhD, MHS*
Basel Sharaf, MD, DDS, FACS, FRCDC*

Background: The eyebrows play an important role in emotional facial expressions, nonverbal communication, and facial esthetics. A comprehensive understanding of the mechanisms underlying eyebrow aging is vital in allowing plastic surgeons to appropriately address these age-related changes and to recreate an aesthetically desirable outcome for patients seeking brow rejuvenation. The aim of this study is to summarize the current literature on eyebrow height changes with aging.

Methods: A comprehensive search was conducted across several databases to identify all published studies that reported changes of eyebrow position or height with aging, from 1946 to January 2019. Studies that reported eyebrow position at the level of medial canthus, mid-pupil, and lateral canthus were included in a meta-analysis.

Results: A total of 346 articles were initially identified, of which 19 met our inclusion criteria. Of 3,634 patients who were identified, 2,237 (64%) were females and 1,274 (36%) were males. Eyebrow height showed significant increase with aging at the level of medial canthus (mean difference 1.4 mm; 95% CI: 0.22–2.59; $P = 0.02$), and the level of mid-pupil (mean difference 1.17 mm; 95% CI: 0.54–1.8; $P = 0.0002$). However, no significant difference was found at the level of lateral canthus (mean difference 0.19 mm; 95% CI: –0.87 to 1.25; $P = 0.72$).

Conclusions: Based on the reviewed literature to date, the medial eyebrow height increases with age, whereas it remains stable at the level of the lateral canthus. These results should be considered when considering eyebrow rejuvenation. *(Plast Reconstr Surg Glob Open 2019;7:e2433; doi: 10.1097/GOX.0000000000002433; Published online 30 September 2019)*

INTRODUCTION

The eyebrows play an important role in emotional facial expressions, nonverbal communication, facial esthetics, and facial recognition.[1] Our understanding of eyebrow aesthetics continues to evolve with cultural and societal influences.[2–4] The earliest description of surgically lifting the eyebrows in the literature was in 1919 by Passot.[5] By 1974, Westmore[6] described the aesthetically ideal eyebrow as a lateral arch with the apex peaking above the lateral limbus of the iris and the medial and lateral ends of the eyebrow being at the same height. Although several studies have since described different aesthetic criteria for the ideal eyebrow position and shape, to this day, there is a lack of consensus regarding the ideal position of the eyebrow.[2–4,7–10]

Aging eyebrows give the impression of a tired or sad appearance, and severe brow ptosis can impair normal peripheral vision.[11–13] If done inaccurately, brow rejuvenation procedures can lead to an unnatural "surprised" appearance, especially due to excessive elevation of the medial eyebrow, a medial or flat brow apex, or excessive elevation of the entire eyebrow without taking into consideration the overall brow shape.[7,14,15] A comprehensive understanding of the mechanisms underlying eyebrow aging is vital in allowing the plastic surgeon to appropriately address these age-related changes and to recreate an aesthetically desirable outcome for the patient seeking brow rejuvenation.[16] The current literature is inconclusive regarding brow height changes with age. Although some studies reported an increase,[17] others reported stability[18] or decrease of eyebrow position with aging.[19] This study aims to summarize the current literature and assess eyebrow height changes with aging.

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METHODS

Literature Search Strategy

A comprehensive search was conducted across several databases including Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid Embase, Ovid Cochrane Central Register of Controlled Trials, Ovid Cochrane Database of Systematic Reviews, and Scopus for studies published from 1946 to January 2019. The search strategy was designed and conducted by an experienced librarian and the study team. The following were used as either keywords or Medical Subject Headings in all combinations in the search strategy: "eyebrow," "brow," "periorbital," "position," "height," "measurement," "aging," "elderly," and "older adults." In addition, references of the initially included studies were also searched to identify additional articles.

Inclusion and Exclusion Criteria

Studies published in English were included if they (1) reported changes of eyebrow position or height with aging, (2) compared 2 groups (young and old) for eyebrow position, height, or shape (different age cohorts or the same cohort over time). Studies were excluded if they met one of the following criteria: (1) review articles, letters, or conference abstracts, (2) reported changes of eyebrow height or position after surgery, (3) studies lacking comparative groups (young and old) in the same study.

Selection of Articles and Data Extraction

Two authors (M.A. and C.S.J.) independently screened the articles through review of titles and abstracts. Duplicates were then eliminated and an independent full-text review of the remaining potentially relevant studies was performed independently by 2 authors (M.A. and A.B.K.) according to the set inclusion criteria. Data extraction was performed independently by the same authors. The extracted data included year and country of publication, total number of individuals, gender, race, defined eyebrow measurements, and differences in these measurements over time. A third author (B.S.) reviewed and solved any conflicts in the data extraction. This study complied with the guidelines outlined in the Preferred Reporting Items for Systematic reviews and Meta-analyses.[20]

Quality Assessment

Two independent reviewers (M.A. and J.B.) independently evaluated the quality of each publication using the Newcastle-Ottawa Scale (NOS). Discrepancies between the reviewers were addressed by a third author (K.S.V.).

Statistical Analysis

Outcomes were summarized using mean difference (MD) with the corresponding 95% CIs. Heterogeneity was evaluated using values of Higgins I-squared (I^2), where >50% indicated significant heterogeneity and a random-effects model was used. Otherwise, in cases of < 50% heterogeneity, a fixed-effects model was used.[21] Pooled estimates were graphically represented using forest plots. A *P* value <0.05 was considered significant. Statistical analysis was conducted using Review Manager 5 (Cochrane Collaboration, Oxford, United Kingdom).

RESULTS

Literature Search Strategy

A total of 346 articles were identified through the initial database search and 5 additional articles were further identified from references of included articles. A total of 351 articles were screened resulting in 26 studies for further analysis. A full-text article review was then performed of the identified studies and only 19 met our inclusion criteria and were selected for data extraction. Finally, 8 of these studies reported the mean and SD of the eyebrow height between the 2 age groups (old: ≥50 years old and young: <50 years old) were included for meta-analysis. Figure 1 shows the Preferred Reporting Items for Systematic reviews and Meta-analyses flow diagram of the performed search strategy.

Quality Assessment

The NOS for all publications are listed in Table 1. When assessing quality and risk of bias, 15 publications (78%) had a NOS score of 7, 3 articles (17%) scored 6, and 1 article (6%) scored 5.

Study Characteristics

A total of 19 studies published between 1994 and 2018 were included in the final analysis. A total of 3,634 subjects were included in this review, which encompassed 1,274 (36%) males and 2,237 (64%) females. Sixteen studies (3,484 subjects) provided specific data regarding the ethnicity or race of the participants, which included White (44%), Hispanic (24%), Asian (12%), Indian (11%), African (9%), and others (2%). Most of the studies (16) evaluated differences in eyebrow position by comparing measurements between 2 cohorts at different ages. Only 3 studies compared eyebrow position in the same group of participants at different times in their life. Table 1 summarizes the general characteristics of the included studies. Different reference points were used to measure the changes of the eyebrow position with age. Figure 2 demonstrates reference points used by the studies. Individual results of the included studies are summarized in Tables 2, 3.

Medial Eyebrow Height Changes with Aging

Three reference points were utilized to measure changes in the medial aspect of the eyebrow. The medial canthus was utilized in 5 studies: 2 reported a significant increase in eyebrow height with age,[17,25] 1 study reported a significant decrease,[28] and 2 studies found no difference.[18,19] The medial limbus was utilized only by 1 study which showed no significant difference in brow height with age.[24]

The midpupillary point was used in 12 studies: 5 reported a significant increase in midpupillary brow height with age,[17,25–27,32] 1 reported a significant decrease in height
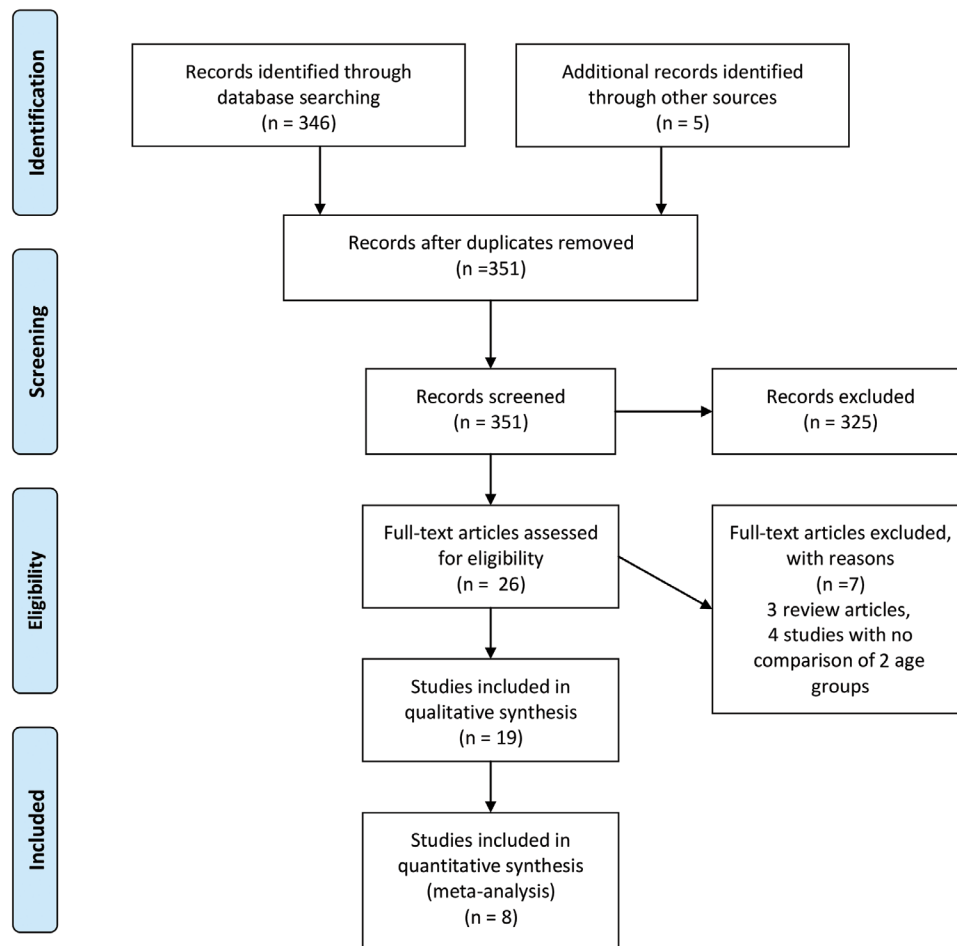
Fig. 1. PRISMA flow diagram.

with age only in African American males,[29] and 6 studies reported no significant changes.[18,23,28,30,31,33] A meta-analysis of 4 studies assessing eyebrow height at the level of medial canthus, with 192 older patients and 198 younger patients, revealed that medial eyebrow height was higher in the older patients compared with their younger cohort (MD: 1.4, 95% CI: 0.22–2.59; $P = 0.02$). This analysis is represented in Figure 3. In addition, a meta-analysis of 7 studies assessing the eyebrow height at the level of mid-pupil, with 339 older patients and 434 younger patients, revealed that eyebrow height was higher in the older patients compared with their younger cohort (MD: 1.17, 95% CI: 0.54–1.8; $P = 0.0002$). This analysis is summarized in Figure 4.

Lateral Eyebrow Height Changes with Aging

Four reference points were utilized to measure changes in lateral brow height. The lateral canthus was the most common reference point for lateral brow height measurement (6 studies). Two studies reported a significant decrease in height with age,[19,28] and 4 studies reported no significant changes in height with age.[17,18,25,30] The lateral limbus point was used as a reference point in 2 studies, 1 reporting a significant decrease in height with age[19] and another reporting no differences.[18] The apex point[24] and

the lateral brow end point[19] were used by 1 study each, both showing a significant decrease in height with age. A meta-analysis of 4 studies, with 192 older patients and 198 younger patients, revealed that lateral eyebrow height was similar between the 2 groups (MD: 0.19, 95% CI: –0.87 to 1.25; $P = 0.72$). This analysis is depicted in a forest plot in Figure 5.

Gender of Subjects and the Effect on Aging

A meta-analysis of 4 studies, with 66 older and 94 younger male patients, indicated a similar change in mid-pupillary brow height in older patients compared with the younger cohort (MD: 1.24, 95% CI: –0.2 to 2.68; $P = 0.09$). A forest plot of this analysis can be seen in Figure 6. As for the female patients, a meta-analysis of 6 studies, with 213 older and 276 younger female patients revealed a significantly higher midpupillary brow height in older females compared with the younger group (MD: 1.58, 95% CI: 0.92–2.24; $P < 0.00001$). This is illustrated in Figure 7.

DISCUSSION

Our understanding of brow aging continues to change as does our approaches to periorbital rejuvenation. Advances in esthetic techniques have changed how plastic

Table 1. General Characteristics of Included Articles

Study	Year	Country	Study Design	NOS	Number	Sex	Race	Age Groups
Studies comparing individual from different age groups								
Kraus et al.[22]	2019	Germany	Cross-sectional	7	244	130 females, 114 males	White	Two groups: group 1 (15–34 y, n = 136) and group 2 (55–82 y, n = 108)
Jung et al.[3]	2018	Korea	Cross-sectional	7	347	347 females	Korean	Six groups: group 1 (<10 y old, n = 27), group 2 (10–19 y old, n = 62), group 3 (20–29 y old, n = 99), group 4 (30–39 y old, n = 68), group 5 (40–49 y old, n = 54), group 6 (50–59 y old, n = 37)
Park et al.[19]	2017	Korea	Cross-sectional	7	36	36 females	Korean	Two groups: group 1 (20–30 y, n = 18) and group 2 (50–70 y, n = 18)
Brunea et al.[18]	2016	France	Cross-sectional	6	95	48 females, 47 males	White	Three groups: group 1 (20–39 y, n = 32); group 2 (40–59 y, n = 33); and group 3 (60–79 y, n = 30)
Glass et al.[23]	2014	United States	Cross-sectional	7	1,024	659 females, 365 males	526 Dominican Hispanic, 269 Non-Dominican Hispanic, 72 White, 105 Black, 52 other	Three groups: group 1 (18–40 y, n = 384), group 2 (41–60 y, n = 405), group 3 (≥61 y, n = 235)
DeLyzer and Yazdani[24]	2013	Canada	Cross-sectional	7	100	100 females	White	Five groups: group 1 (20–29 y; n = 20), group 2 (30–39 y; n = 21), group 3 (40–49 y; n = 21), group 4 (50–59 y; n = 25), group 5 (≥60 y; n = 13)
Patil et al.[25]	2011	India	Cross-sectional	7	160	160 females	Indian	Two groups: group 1 (20–30 y; n = 80), group 2 (50–60 y; n = 80)
Patil et al.[26]	2011	India	Cross-sectional	7	216	106 females, 110 males	Indian	Three groups: group 1, 16–30 y; group 2, 31–45 y; and group 3, 46–60 y
Cole et al.[27]	2010	United States	Cross-sectional	6	213	157 females, 56 males	68 Whites, 106 African Americans, 13 Asian, 16 Hispanic, 1 Middle Eastern, 10 Eastern Indian	Five groups: group 1 (5–10 y, n = 10), group 2 (11–20 y, n = 21), group 3 (21–40 y, n = 91), group 4 (41–60, n = 56), group 5 (61–80 y, n = 35)
Sclafani and Jung[28]	2010	United States	Cross-sectional	5	30	23 females, 7 males	17 whites, 8 Hispanics, and 5 Asians	Two groups: group 1 (20–39 y), group 2 (≥40 y)
Matros et al.[17]	2009	United States	Cross-sectional	7	70	70 females	White	Two groups: group 1 (20–30 y, n = 36), group 2 (50–60 y, n = 34)
Price et al.[29]	2009	United States	Cross-sectional	7	164	92 females, 72 males	89 African Americans, 75 Whites	Three groups: group 1 (20–39 y; n = 56), group 2 (40–59 y; n = 60), and group 3 (60–79 y; n = 48)
Goldstein et al.[30]	2005	United States	Cross-sectional	6	222	222 males	216 of the patients were White, 4 were Black, 1 was Chinese, and 1 was Indian	Eight groups: group 1 (10–19 y, n = 23), group 2 (20–29 y, n = 19), group 3 (30–39 y, n = 22), group 4 (40–49 y, n = 57), group 5 (50–59 y, n = 45), group 6 (60–69, n = 28), group 7 (70–79 y, n = 25), group 8 (80–86 y, n = 3)
Erbagci et al.[31]	2005	Turkey	Cross-sectional	7	100	45 females, 55 males	White	Six groups: group 1 (<10 y, n = 16), group 2 (11–20 y, n = 18), group 3 (21–40 y, n = 21), group 4 (41–50 y, n = 19), group 5 (51–60 y, n = 14), group 6 (>60 y, n = 12)
Van den Bosh et al.[32]	1999	The Netherlands	Cross-sectional	7	320	160 females, 160 males	White	Eight groups: group 1 (10–19 y old, n = 40), group 2 (20–29 y old, n = 40), group 3 (30–39 y old, n = 40), group 4 (40–49 y old, n = 40), group 5 (50–59 y old, n = 40), group 6 (60–69 y old, n = 40), group 7 (70–79 y old, n = 40), group 8 (80–89 y old, n = 40)

(Continued)

Table 1. Continued

| Study	Year	Country	Study Design	NOS	Number	Sex	Race	Age Groups
Cartwright et al.[33]	1994	United States	Cross-sectional	7	143	77 females, 66 males	White	Six groups: group 1 (<1 y old, n = 17), group 2 (1–10 y old, n = 30), group 3 (11–20 y old, n = 25), group 4 (21–40 y old, n = 30), group 5 (41–60 y old, n = 21), group 6 (>60 y old, n = 20)
Studies comparing same individuals over time								
Mally et al.[34]	2014	United States	Case series	7	25	25 females	*	Photographs of participants taken 10–15 y earlier compared with current images
Friedman et al.[35]	2009	Israel	Case series	7	2	2 females	NA	One was photographed from age 25–50, and the other from age 15 to 40
Lambros[36]	2007	United States	Case series	7	123	†	‡	The average time between images was 25 y (range, 10–56 y)

*Most participants were White.
†Most participants were females.
‡Most participants were White.

surgeons address periorbital and brow aging.[37–40] The medial and midpupillary brow position demonstrated a significant increase in eyebrow height with aging. At the lateral canthus, based on the 4 studies included in the meta-analysis, there were no significant changes in brow height with aging. Only 2 studies reported changes to eyebrow height along the lateral eyebrow end, and both showed a significant descent with aging.[19,23] No meta-analysis was conducted along the lateral eyebrow end because SD for eyebrow height of the 2 age groups was not reported in one of the studies.[23] Because the eyebrow height increases along the medial end while the lateral end decreases with advancing age, this would also imply a change in the eyebrow shape. The above-mentioned changes could be explained by several mechanisms. The eyebrow position is affected by the balance of the surrounding muscles.[12] In his anatomic study, Knize[41] demonstrated that the frontalis muscle extends laterally to the temporal fusion line. The lack of frontalis fibers lateral to the temporal fusion line and the unopposed effect of gravity and the activity of the lateral orbicularis oculi and possibly the corrugator muscle make the lateral brow vulnerable to ptosis with aging. On the other hand, the medial eyebrow position is affected by the frontalis muscle pull vertically, and the corrugator muscle pull inferomedially.[12,41] Knize[12,41] postulated that the supraorbital and supratrochlear nerves might add additional support to the medial eyebrow in resisting ptosis. The lateral extent of the frontalis muscle interdigitates with the orbicularis oculi muscle and variability in frontalis muscle anatomy may play a role on lateral brow ptosis.[41,42] Changes to the activity of the muscles surrounding the eyebrow also occur with aging. Yun et al.[43] demonstrated that the motion proportion index of the frontalis, orbicularis oculi, and corrugator muscles are significantly greater in older subjects in several eyebrow movements.

It has been suggested that obstruction of the visual field from pseudoptosis of the lateral eyebrow and weakness of the levator system stimulate the frontalis muscle contraction which elevate the eyebrow.[12,17,44] A finding that support this hypothesis is the descent of eyebrow after blepharoplasty in some patients.[14,45] Moreover, skeletal changes,[46] ligaments attenuation,[47,48] fat redistribution,[16,49] and skin changes[50] play a role in periorbital aging which might affect eyebrow position.

The ideal method to assess eyebrow position is best performed on the same individuals over time. However, such a study design is very challenging to perform, particularly with the long follow-up required with photographs of similar standards. Only 3 studies evaluated the same individuals over time were reported.[34–36] By superimposing patients' photographs taken 10–50 years before recent matched pictures, Lambros[36] found that the eyebrow elevated in 28%, remained stable in 51%, and descended in 29% of the cases. Friedman et al.[35] studied brow ptosis in 2 sisters by studying photographs taken yearly for a period of 25 years. They found the stability of the medial eyebrow after the middle of the fourth decade, whereas the lateral eyebrow showed continuous descent over the years starting from the third decade. Mally et al.[34] compared photographs of 25 females taken
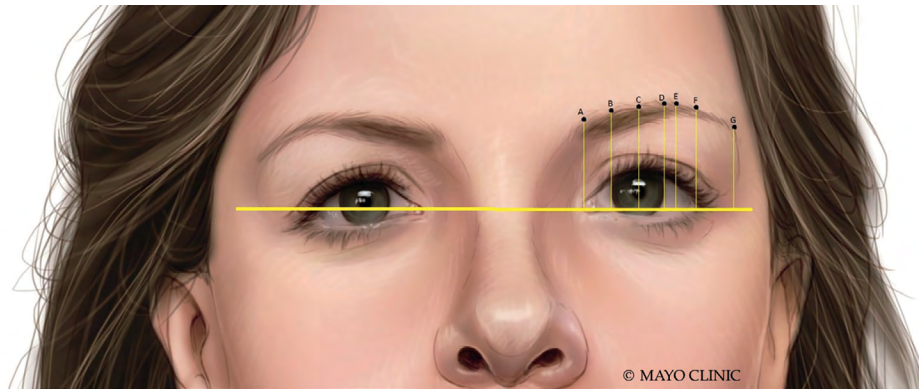
Fig. 2. Different reference points used in the included studies to measure eyebrow height (the medial inter-canthal line was used as the reference line for the lower margin of the measurements). (A) Medial canthus; (B) medial limbus; (C) mid-pupil; (D) lateral limbus; (E) eyebrow apex; (F) lateral canthus; (G) lateral eyebrow end.

Table 2. Changes of Eyebrow Height along the Points of Reference

	Medial Canthus	Medial Limbus	Mid-pupil	Lateral Limbus	Apex	Lateral Canthus	Lateral End
Park et al. (2017)[19]	No sig	—	—	↓	—	↓	↓
Brunea et al. (2016)[18]	No sig	—	No sig	No sig	—	No sig	—
Glass et al. (2014)[23]	—	—	No sig	—	—	—	—
DeLyzer and Yazdani (2013)[24]	—	No sig	—	—	↓	—	—
Patil et al. (2011)[25]	↑	—	↑	—	—	No sig	—
Patil et al. (2011)[26]	—	—	↑	—	—	—	—
Cole et al. (2010)[27]	—	—	↑	—	—	—	—
Sclafani and Jung (2010)[28]	↓	—	No sig	—	—	↓	—
Matros et al. (2009)[17]	↑	—	↑	—	—	No sig	—
Price et al. (2009)[29]	—	—	↑*	—	—	—	—
Goldstein et al. (2005)[30]	—	—	No sig	—	—	No sig	—
Erbagci et al. (2005)[31]	—	—	No sig	—	—	—	—
Van den Bosh et al. (1999)[32]	—	—	—	—	—	—	—
Cartwright et al. (1994)[33]	—	—	No sig	—	—	—	—

*Only for male African American.

No sig, no significant change; ↑, significant increase with aging; ↓, significant decrease with aging.

Table 3. Other Measurements Used to Assess Eyebrow Position Change with Aging

Study	Result
Kruas et al. (2019)[22]	The HBP was situated higher and more lateral in both genders with aging. All measured points (H1–H5)* of the upper brow border were statistically significantly higher in females with aging, whereas in males, only H3 and H4 moved upward*
Jung et al. (2018)[3]	The HWR† was found to decrease dramatically and statistically from age 30 y onward ($P < 0.05$). Takeoff angle‡ was found to increase from age 30 y onward
Glass et al. (2014)[23]	Measurements of NALB,§ LBPL,¶ and angle from the mid-brow to the lateral brow tail‖ all showed statistically significant decline over time. The angle and LBPL varied most by ethnicity, whereas the NALB varied most by age
DeLyzer and Yazdani (2013)[24]	The mean eyebrow slope** significantly decreased as age increased from group 1 (20–29) to group 3 (40–49), then significantly increased from group 3 to group 5 (≥60)

*Distances from the line between the medial canthi to the upper border of the brow were measured at defined positions (H1: 1/4 ICD, H2: 1/3 ICD, H3: 2/3 ICD, H4: ICD, H5: 6/5), where ICD is the distance between the medial and lateral canthus.
†HWR (the ratio between the vertical distance from the brow apex to the palpebral fissure and the horizontal distance from the medial canthus to the lateral canthus).
‡The TOA (the angle between the straight line connecting the 2 lateral canthi and the line from the brow apex through the center of the medial brow segment).
§NALB, defined as the lateralmost mature brow hair.
¶The LBPL, which was measured as a vertical line from the tip of the tail of the brow to a reference horizontal line going through the lateral canthus.
‖The angle formed by the line from mid-pupil to mid-brow and a line from that same point at the mid-brow to the lateral brow.
**The ratio between eyebrow height H and length L (slope = H/L) [B: arch apex, A: medial limbus, length L: a line drawn between B and A, eyebrow height ($H = B - A$)].
HBP, highest brow point; HWR, height-to-width ratio; ICD, xxx; LBPL, lateral brow plumb line; NALB, Nasal ala to lateral brow tip; TOA, takeoff angle.
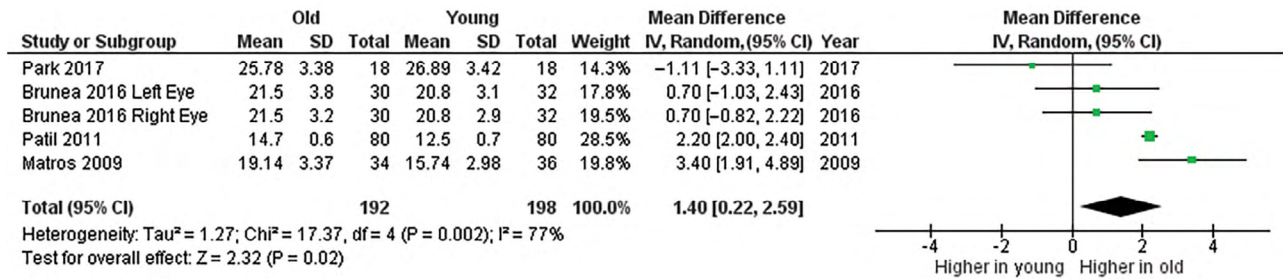
Fig. 3. Forest plot analysis of eyebrow height at the level of the medial canthus.
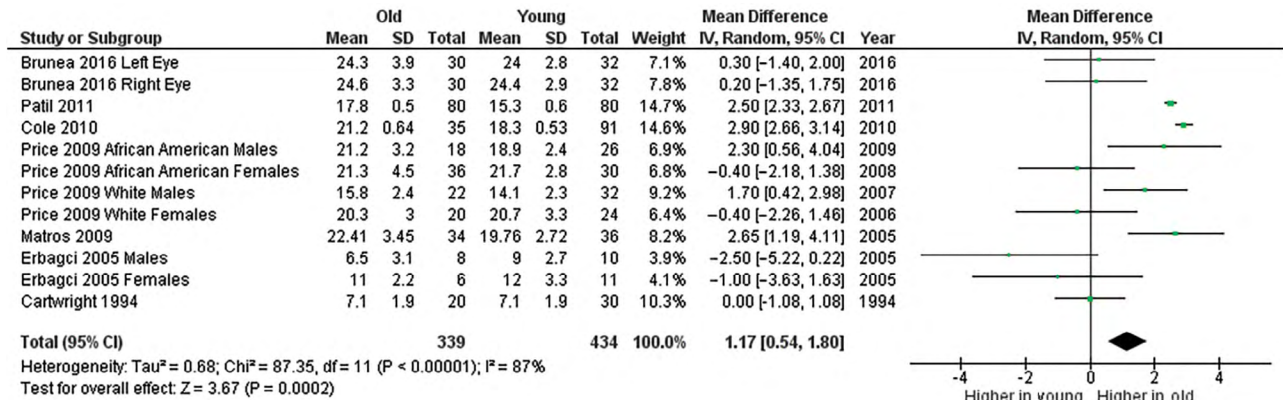

Fig. 4. Forest plot analysis of eyebrow height at the level of mid-pupil.
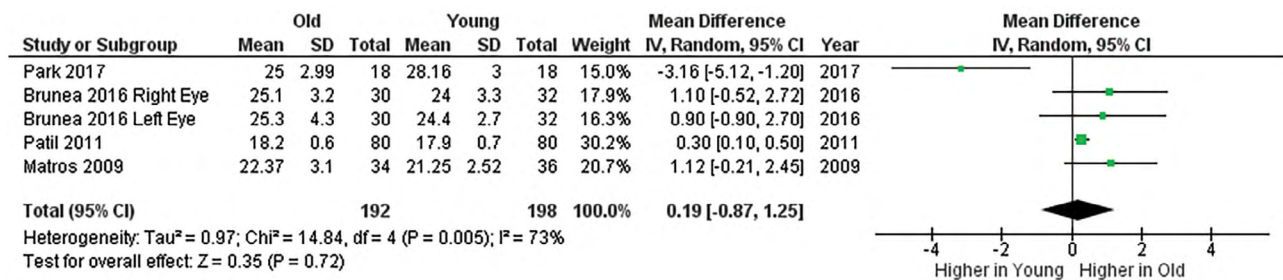
Fig. 5. Forest plot analysis of eyebrow height at the level of the lateral canthus.
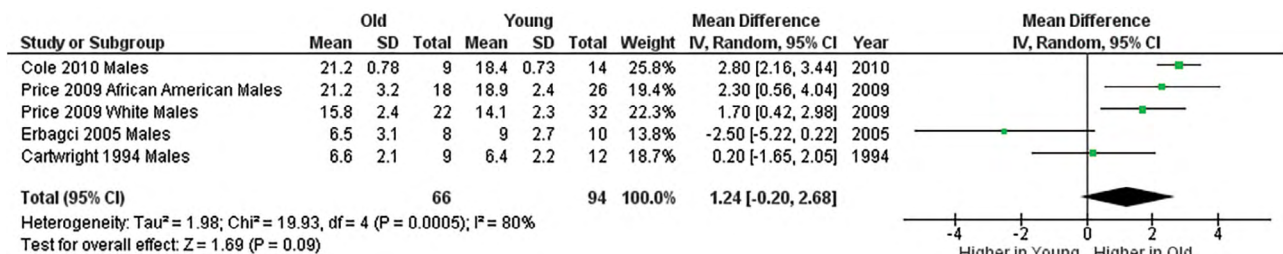
Fig. 6. Forest plot analysis of eyebrow height at the level of mid-pupil in males.

10–15 years earlier with closely matched current photographs. Interestingly, they found that the earlier photographs were similar to the current supine but different from the current upright photographs which had lower eyebrow position.[34]

Sex and race are important factors to consider when discussing brow aging. Price et al.[29] demonstrated significant differences in eyebrow height between different age cohorts in African American men, but not in females or White men. In our gender subgroup-analysis, we found

Study or Subgroup	Old Mean	Old SD	Old Total	Young Mean	Young SD	Young Total	Weight	Mean Difference IV, Random, 95% CI	Year
Patil 2011	17.8	0.5	80	15.3	0.6	80	25.9%	2.50 [2.33, 2.67]	2011
Cole 2010 Females	21.2	0.5	26	18.3	0.33	77	25.7%	2.90 [2.69, 3.11]	2010
Price 2009 African American Females	21.3	4.5	36	21.7	2.8	30	9.0%	-0.40 [-2.18, 1.38]	2009
Price 2009 White Females	20.3	3	20	20.7	3.3	24	8.5%	-0.40 [-2.26, 1.46]	2009
Matros 2009	22.41	3.45	34	19.76	2.72	36	11.5%	2.65 [1.19, 4.11]	2009
Erbagci 2005 Females	11	2.2	6	12	3.3	11	5.1%	-1.00 [-3.63, 1.63]	2005
Cartwright 1994 Females	7.6	1.6	11	7.6	1.5	18	14.4%	0.00 [-1.17, 1.17]	1994
Total (95% CI)			213			276	100.0%	1.58 [0.92, 2.24]	

Heterogeneity: Tau² = 0.43; Chi² = 56.45, df = 6 (P < 0.00001); I² = 89%
Test for overall effect: Z = 4.70 (P < 0.00001)

Fig. 7. Forest plot analysis of eyebrow height at the level of mid-pupil in females.

a significant increase in eyebrow height with age along the level of the mid-brow in females but not in males. Although this may reflect gender-related differences in eyebrow aging, it could be due to the small sample size and limited number of studies assessing eyebrow height in males. A focused analysis on the effect of race on eyebrow height was not performed due to limited number of study subjects from each racial subgroups.

Another point that warrants discussion is the different measurements used for quantifying the eyebrow aging changes. Some studies used the intermedial canthi line as the horizontal reference line,[17–19,22,26] whereas others used the midpupillary axis,[24] the upper lid margin,[25,27,29,32] the upper lid lash line,[31,33] or the inferior limbus.[27] To measure the upper limit of the eyebrow height, the superior margin of the eyebrow[17–19,22,26,28,30] was used interchangeably with the inferior margin.[23,25,27,29–33] It is vitally important to standardize brow position measurements to draw evidence-based conclusions from future research in brow aging and brow rejuvenation procedures. We echo Graham et al.[40] recommendations for a standardization of brow height measurements across studies. One way to standardize brow photographs is using consistent lighting and photographic techniques. The intercanthal line is set as the lower reference line (due to the stability of the medial canthus with aging)[18] and the upper eyebrow margin as the upper margin for the measurement (as often brow plucking is done along the lower hair margin).[18] The head should be positioned appropriately using the Frankfort horizontal plane. Using a Vernier caliper to measure the intercanthal or interpupillary distance in forward gaze can then be used to calibrate measurements between photographs.[51] Standard brow views including anteriorposterior view, bilateral 3-quarter views, and bilateral lateral views. Additional reference points that can be used along the eyebrow include the height at the level of the medial canthus, mid-pupil, and lateral canthus.[52] The eyebrow contour is a 3-dimensional (3D) structure. To assess the eyebrow height at the level of the lateral end and contour changes more advanced imaging methods, such as 3D imaging, should be used to take into account the 3D anatomy of the brow.[18] Excluding patients with a history of procedures that affect eyebrow shape (as done by Matros et al.,[17] Patil et al.,[25] and Park et al.[19]) would allow more accurate findings.

In periorbital rejuvenation, addressing eyebrow aging has evolved over time.[38,40,53–55] The focus of these procedures has been to elevate the eyebrow due to the common perception of soft tissue descent with aging. Over-lifting the eyebrows can lead to a surprised look and an aesthetically unpleasing brow contour.[7,14,15] Our study showed that the medial aspect of the eyebrow increases in height with age and the lateral aspect remains stable or decreases in height with age. The age-related brow changes are likely more complex and simply do not follow a 2D depiction. A 3D analysis will offer a more accurate assessment of the eyebrow as we age. This is reflected in the shifting paradigms of eyebrow rejuvenation procedures from a pure lifting to include volume enhancement of the periorbital area with microfat grafting.[56–58]

Limitations

The findings of our systematic review are limited by the design and methodology of the studies included and the results may not be generalizable across different races because the majority of subjects in the included studies were White females. Males and other races were represented to a lesser extent. Moreover, the lateral eyebrow end, which is hypothesized to be the most susceptible area to ptosis with aging, was not included in the meta-analysis due to the limited availability of studies. Lack of a standardized method for measuring the eyebrow height and using different age cutoffs for identifying younger versus older groups adds another limitation to our study. Moreover, Lambros[36] reported that some patients unconsciously elevate their eyebrows when in front of a camera or a mirror to look younger. Accordingly, some inconsistencies in eyebrow height measurements may be inherent in the articles included.

CONCLUSIONS

Based on the available literature reviewed, the medial aspect of the eyebrow increases in height with age. The brow height remains stable at the level of the lateral canthus but decreases at the lateral eyebrow end. These results should be considered when performing eyebrow rejuvenation to achieve a natural result.

Basel Sharaf, MD, DDS, FACS, FRCDC
Department of Surgery
Mayo Clinic
200 First Street SW
Rochester, MN 55905
E-mail: sharaf.basel@mayo.edu

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