

Title: Factors Contributing to the Facial Aging of
Identical Twins

Running Header: Facial aging in identical twins

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Background: The purpose of this study was to identify the environmental factors that contribute to the facial aging on identical twins. **Methods:** During the Twins Festival in Twinsburg, OH, 186 pairs of identical twins completed a comprehensive questionnaire and digital images were obtained. A panel reviewed the images independently and recorded the differences in the perceived twins' ages and their facial features. The perceived age differences were then correlated with multiple factors. **Results:** Four points higher BMI was associated with an older appearance on twins younger than age 40, but resulted in a younger appearance after age 40 ($p = 0.0001$). Eight points higher BMI was associated with an older appearance on twins younger than age 55 but was associated with a younger appearance after age 55 ($p = 0.0001$). The longer the twins smoked the older she appeared ($p < 0.0001$). Increased sun exposure was associated with an older appearance and accelerated with age ($p = 0.015$), as was a history of outdoor activities and lack of sunscreen usage. The twin who used hormone replacement had a younger appearance ($p = 0.002$). Facial rhytids were more evident on twins with a history of skin cancer ($p = 0.05$) and with those who smoked ($p = 0.005$). Dark and patchy skin discoloration was less prevalent on twins with a higher BMI ($p = 0.01$) and more common on twins with a history of smoking ($p = 0.005$) and those with sun exposure ($p = 0.005$). Hair quantity was better with a higher BMI ($p = 0.01$) and while it was worse with a history of skin cancer ($p = 0.005$), and better with the use of hormones ($p = 0.05$). **Conclusions:** This study offers strong statistical evidence to support the role of some of the known factors that govern facial aging.

INTRODUCTION

Factors that contribute to the facial senescence have been the subject of curiosity for centuries. Detecting these factors and educating the public can enormously reduce the amount of skin damage and the need for rejuvenation and improve the outcome of the aesthetic goals during surgery. The Twins Day Festival attracts nearly 2,000-3,000 pairs of twins to Twinsburg, an area outside of Cleveland, Ohio. This large congregation of twins provides an unparalleled opportunity to conduct meaningful studies on a variety of medical conditions, including aging. Our research team used this opportunity and conducted a study to identify the environmental factors that influence the facial aging on identical twins.

METHODS

After obtaining IRB approval, the research team of the Department of Plastic Surgery at Case Western Reserve University set up a booth during the Twins Day Festival in 2006 and in 2007. In 2006, the team interviewed 98 pairs of identical twins which included 18 pairs of males and 80 pairs of females between the ages of 18 to 76. In 2007, the team interviewed 88 pairs of identical twins. Each twin completed a separate comprehensive questionnaire. Digital images were obtained by the plastic surgery department photographer with every effort being devoted to create consistency in lighting and sizing of the photographs. Additionally, the images were standardized and color and size matched at a later date as needed. Four judges reviewed the images independently and recorded the differences in the overall perceived twin ages and the facial features. The perceived age differences were then correlated with the multiple factors that could have

been influential in aging (Tables 1-2). After data collection in 2006, additional features were added both to the questionnaire and the judge's reviewer sheet. Of the additional features that were added to the questionnaire, only the activities of the individuals and use of sunscreen were analyzed independently of the 2006 data. Otherwise, these new data were not independently analyzed during this study but may be used in future studies. Some of the questions used in 2006 however, were reworded for the 2007 questionnaire. The results were statistically analyzed using multiple regression. The *p* value was set at 0.05 or less. The multiple regression model was developed using a forward-selection, stepwise procedure with review. The inter-rater reliability was documented by the biostatistician. Furthermore, several twins analyzed in 2006 were also analyzed in 2007 to allow the biostatistician to also evaluate the inter-year and inter-rater reliability.

Results:

Inter-rater reliability in 2006 was found to be 1.0 years; while in 2007 was 2.0 years. When data from 2006 and 2007 were merged and re-analyzed, no bias between years was detected and a new inter-rater reliability was found to be 1.7 years for all patient data. There were 13 pairs of twins available to establish the yearly repeatability of the respondents and raters. These inter-year reliability data were used as an adjunct to create the total inter-rater reliability for this study. We found one inconsistency on one set of twins in which one twin changed the number of total years she was on oral contraceptives. Due to the discrepancy, the data for this twin pair was omitted for analysis of the effect of oral contraceptives on perceived age. In addition, the variance

inflation factors for all independent variables in the model were less than 1.12, which indicates that co-linearity among these variables was very small.

The Role of Body Mass Index

The body mass index (BMI) was calculated and the twins were divided into groups based on a 4 point difference. A 4 point higher BMI was associated with an older appearance in the age group younger than 40 while it caused younger appearance after age 40. An 8 point higher BMI produced an older appearance on twins younger than age 55 but resulted in a younger appearance after age 55 (Figure 1,2).

Effects of Cigarette Smoking

The longer the twin smoked the older she appeared ($p < 0.0001$). The minimum duration of smoking to result in perceived age change was 5 years. Each 10 years of smoking culminated to a 2 ½ years older appearance (Figures 3-5).

Sun Exposure

Increased sun exposure was associated with an older appearance and accelerated with aging (Figure 6,7). ($p=0.015$) When evaluating the new 2007 questionnaire, those with outdoor hobbies such as golf and tennis had a perceived older appearance ($P<0.05$).

Also, skin protection using sunscreen led to a younger appearance ($P<0.020$).

Hormone Replacement

Estrogen and progesterone replacements was associated with a younger perceived appearance ($p = 0.002$) (Figure 8,9). As the age of the twin set increases, the effect of the HRT on age increases slightly. Also, larger differences of years of hormone therapy between the twins resulted in younger perceived age of the twin on HRT.

Alcohol Avoidance

The 2007 questionnaire also contained questions regarding to alcohol avoidance. When compared to their twin, those who avoided alcohol were perceived to be significantly younger ($P < 0.0002$) (Figure 10).

Marital Status

Women who have been divorced looked older than their married or single counterpart ($P < 0.004$). There were no differences found with increasing number of divorces. The twin who is divorced appears about 1.7 years older than the twin who is not divorced. The twin who is a widow or widower appears about 2 years younger than the twin who is not.

Use of Antidepressants

The current or past usage of antidepressants was associated with a significantly older appearance when compared to a twin with no history of antidepressant use ($P < 0.05$).

Analysis of the Features

All of the facial features analyzed by the raters were assessed independently as to their contribution to perceived aging. The presence of coarse rhytids, degree of malar descent, presence of glabellar “frown lines”, orbital fissure orientation, presence of marionette lines, degree of nasolabial fold, and presence of excess submental fat were all statistically significant determinants in perceived age.

Rhytids were more visible on twins who had a history of skin cancer which likely relates to sun exposure ($p = 0.005$). Additionally, twins who smoked showed generalized and more specifically perioral rhytids ($p = 0.0005$). Skin discoloration was less on the twins with a high BMI ($p = 0.01$) and more on those who smoked ($p = 0.0005$) and those who had excessive sun exposure ($p = 0.0005$).

When hair quantity was taken into consideration, a higher BMI and the use of hormones ($p = 0.005$) was associated with better hair quantity ($p = 0.01$) while those who had a positive history of skin cancer had worse hair quantity ($p = 0.005$). The older appearing twins had a higher eyebrow ($p = 0.05$), however, on further analysis it was noted that invariably these patients who had a higher eyebrow had either eyelid ptosis or a significant blepharochalasis to require frontalis compensation.

Discussion

Perceived age of an individual is attributed to both genetics and environment, in varying degrees. Many deleterious environmental agents have been associated with facial aging,

however conclusive data have been elusive. Many investigations have shown that smoking and sun exposure are two main environmental determinants of perceived aging[1-3]. However, in these studies, despite their size, one cannot control for one of the most important contributors of aging: genetics.

Monozygotic twins, having identical genetic dispositions in terms of aging, offer an unmatched opportunity to assess the effects of the environmental factors on senescent changes. The current study has utilized a large cohort of twins that congregate yearly to celebrate their relatively unique human genetic characteristics. This study provides strong statistical evidence to support the role of some of the previously recognized as well as several unrecognized factors that may accelerate an aged appearance.

Reversal of the role of BMI in different age groups is fascinating. Ironically, excessive weight on twins who were younger than 40 years old, caused their faces to appear older, perhaps due to the fact that it obscured certain facial structures better visible on the younger individuals. A 4 point increase in BMI beyond age 40 resulted in the twin appearing younger. Around age 55, an eight point increase in BMI produces a statistically significant rejuvenated appearance. Obviously, at this age the volume depletion is more substantial, requiring a higher BMI to provide adequate change. This finding is mirrored in a large Danish study of elderly twins[4]. In this investigation, Rexbye, et al found that a lower BMI in this set of female and male twins over the age of 70 resulted in a significantly increased perceived age. These data, in effect, support the role of volume replacement in facial rejuvenation.

This is a cardinal finding and supports the rationale for the selective volume augmentation in facial rejuvenation.

The two most investigated environmental causes of perceived aging are smoking and sun exposure. Smoking's effect on aging has been recognized for decades[5]. Smoking contributes to aging in a variety of ways. These individuals exhibit dense facial hyperpigmentation. Furthermore, dynamic lines develop around the perioral region.

Additionally, the elasticity of the facial skin is diminished and perhaps more significantly, transient malar bags appear[3]. As with smoking, sun exposure leads to decreased elasticity of the skin. Further signs of photoaging include elastin clumping in the upper dermis, irregular epidermal cell maturation, collagen degeneration, and a thinning dermis. In the present study, both smoking and sun exposure were significant determinants in increasing one's perceived age. Furthermore, the participation in outdoor hobbies (presumably due to sun exposure) led to an increase in perceived age. These perceived age differences are present even at an early age, however become increasingly evident as the twin pair ages.

The role of hormones in aging is not as clearly defined. Obviously estrogen contributes to the elasticity of the skin and sudden changes that occur during menopause provides in favor of hormone replacement in maintaining a youthful appearance. Additionally, hormonal imbalance results in male pattern alopecia and a receding hairline.

The increased perceived age of female twins that used antidepressants was also seen. This is also corroborated by Rexbye, et al, who found that depression was borderline statistically significant with facial aging[4].

In the current study, twins who “avoided” alcohol were perceived to be younger than their twin who did not avoid alcohol. Alcohol consumption affects the human body in a myriad of ways far too diverse for the context of this paper. The deleterious effects with respect to aging in the casual alcohol consumer is unknown. Chronic alcohol consumption may effect the hypothalamic-pituitary-adrenal axis and thus cortisol secretion[6]. The rates of type 2 diabetes mellitus, coronary heart disease, stroke, peripheral arterial disease, and overall cardiovascular disease may be increased in heavy drinkers, but actually decreased in moderate consumers[7]. Data also suggests that red wine is a viable source of antioxidants that may augment oxidative protection mechanisms[8]. Our data collection was limited to the avoidance of alcohol mandated by our Institutional Review Board. With this new correlation, it would be prudent to gain approval to add questions pertaining to the amount of alcohol consumption and years of consumption to our questionnaire.

The rise in the eyebrow as a consequence of aging is interesting since many of the plastic surgery authorities have claimed that this is an integral part of aging. However, with careful analysis of the photographs it has become clear that this change is in reality a compensation for the eyelid ptosis and the redundant skin above the eyelashes rather than the real elevation of the eyebrow which is inconceivable.

There are several limitations to this study. Despite the large number of twins that appear yearly, the difficulty in studying monozygotic twins is that many sets of twins develop nearly identical lifestyles. In fact, monozygotic twins are statistically significantly more similar in educational achievement, smoking, occupation, alcohol consumption, and exercise habits than their dizygotic counterparts[9]. Thus, a large number of twins are needed to discern environmental differences that may have a determinant on perceived facial aging. Another limitation encountered is that the questionnaire is limited by the ability of the subject to recall particular life events, such as hours in the sun many years ago and the use of sunscreen and its SPF value. This is acutely evident in the aforementioned comparison of one group of twins analyzed in 2006 and 2007, where one of the twins changed the years of oral contraceptive use. In deference to these facts, multiple analyses were performed to ensure the relative accuracy of the data. Inter-rater reliability and year-to-year reliability factors were applied to the information in order to ensure that the differences seen were truly statistically significant and were not merely the result of one spurious rater or an anomaly caused by an unusual twin pair.

Conclusion:

Multiple environmental factors may contribute to facial aging. This analysis of monozygotic twins inherently allows for control of the genetic influences of aging. Our study provides further confirmation that aging and sun exposure have deleterious effects on the skin. Also, marital status, alcohol consumption, and use of antidepressants increase the perceived age of individuals. Increased BMI in younger twins led to an older

appearance, whereas as the twins increased in age, a higher BMI led to a decrease in perceived age.

ACKNOWLEDGMENT

Adam Bryce Weinfeld's current affiliation is the University Medical Center at Brackenridge and Dell Children's Medical Center of Central Texas, Austin, Texas

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Table Legends:

Table 1: Analysis of Facial Features

Table 2: Possible Environmental Aging Factors

Figure Legend:

Figure 1: BMI

A four-point higher BMI was associated with an older appearance on twins younger than age 40, but caused younger appearance after age 40 ($p < 0.0001$). Conversely, an eight point higher BMI was associated with an older appearance on twins younger than age 55, but a younger appearance after 55 ($p < 0.0001$).

Figure 2: Twins (natural age 58) with differences in BMI. Twin A had a 14.7 point higher BMI than twin B. No other differences were discerned from the questionnaire. Perceived age difference was 5.25 years.

Figure 3: Smoking

The longer the twin smoked, (beyond 5 years) the older she appeared ($p = 0.005$). Each ten years of smoking difference led to a 2 ½ year increase in perceived age.

Figure 4: Twins (natural age 52) with difference in smoking history. Twin A (Figures A&C) had a 20 year greater smoking history than Twin B (Figures B&D). Perceived age difference of the twins was 6.25 years.

Figure 5: Twins (natural age 57) with difference in smoking history. Twin B (Figures B&D) had a 40 year greater smoking history than Twin A(Figures A&C). Twin A had two years of hormone replacement therapy. The perceived age difference was 8.25 years.

Figure 6: Twins (natural age 61) with significant difference in sun exposure. Twin B (Figures B&D) had approximately 10 hours/week greater sun exposure than twin A(Figures A&C). Twin A had a BMI 2.7 points higher than twin B. The perceived age difference was 11.25 years.

Figure 7: Twins (natural age 69) with difference in sun exposure. Twin A had 19 hours/week greater sun exposure than Twin B. Twin A had received four more years of hormone replacement therapy. Perceived age difference was 3.375 years.

Figure 8: Hormone Replacement Therapy

Use of hormone replacement therapy was associated with a younger appearance ($p < 0.002$). The effect of hormone replacement was greater as the differences between years treated increased between twins.

Figure 9: Twins (natural age 71) with difference in HRT. Twin B (Figures B&D) had 22 more years of HRT than twin A(Figures A&C). Twin B had a 1.2 lower BMI. Perceived age difference was 7.25.

Figure 10: Alcohol Avoidance

Avoidance of alcohol was associated with a younger appearance ($P < 0.0002$).