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# Observations on female scalp hair population, distribution, and diameter

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Synopsis

SCALP FIBER POPULATION DENSITY, GROUPING, and DIAMETER were studied on a panel of 20 women ranging in age from 24 to 59. The average number of fibers per square cm was above 200, which can be translated to about 170,000 fibers for a full head of hair. The fibers grow in a variety of groupings with wide individual variations. The average fiber diameter for the group was about 70 $\mu$m, with individuals ranging from under 60 to about 90 $\mu$m. The influence of the fiber number and diameter on the bulky appearance of the hair is often masked by other characteristics such as waviness and hair care practices.

## INTRODUCTION

The hair fiber characteristics which determine most cosmetically important hair mass mechanical behavior are: population density, diameter, moduli, shape, and fiber–fiber interactions (1). Fiber length, not being an intrinsic characteristic, is excluded from this list, even though it influences certain properties such as combing (2). Most cosmetic products and processes perform their functions with regard to hair mass mechanical behavior in the dry state by modifying the last 2 groups of parameters. The first 3 groups of parameters, even if partly or completely outside the influence of cosmetic products, are of interest to the cosmetic industry because of their influence on hair behavior. This paper is aimed at collecting and interpreting data on scalp fiber population and diameter of adult women.

The traditionally accepted value for the fiber population of a full head of adult hair is about 100,000 (3, 4, 5). The mean fiber diameters for groups of individuals range from 60 to 100 $\mu$m (6, 7, 8, 9) with individual fiber values from 25 to above 100 $\mu$m having been reported (10, 11, 12, 13, 14, 15, 16). We wanted to check the validity of the accepted mean values, investigate variations between individuals, establish ranges of values for single heads, and determine correlations, if any existed, among different characteristics.

## EXPERIMENTAL

Twenty women employees of the Gillette Research Laboratory were used for this study. They ranged in age from 24 to 59 years, with 17 of them between 24 and 42. The three oldest panelists were Chinese; all others were Caucasians. Within the Caucasian group, the hair color ranged from light blond for 2 panelists to a nearly black, dark brown for 2 panelists. One panelist had reddish hair, but most had hair color in the brown range. The ancestry of the Caucasians—when known—varied from Scandinavian to Mediterranian. All 3 Orientals were born in China. A minimum of 12 cm hair length and the absence of Negroid-type curliness were the only criteria for the selection of the panelists. These restrictions were necessary because of the counting technique used.

### FIBER COUNTING TERMINOLOGY

Simple hair: one hair fiber emerges from a follicle orifice. Compound fibers: 2 or more fibers emerge from a follicular opening without a contiguous epidermal or stratum corneum bridge between them, as seen at 45-fold magnification. Single hair: a simple fiber whose nearest neighbor is set at more than about 10 fiber diameters distance. Grouped hairs: all compound hairs and those simple hairs which had neighbors not more than 3 fiber diameters away. Site: the area occupied by a single hair or by grouped hairs.

### SCALP AREA

Counting was carried out on the left temporal area of each panelist just under the vertex anterior and in front of the vertex posterior, according to the area designation of Moretti (17). On 8 of the panelists, the counting was repeated on the symmetrical right temporal area.

### COUNTING METHOD

Both counting and fiber collection were carried out in November and December, 1975. A template with a 1.00 $cm^2$ opening was placed on the head of the panelists within 24 h of the last shampoo. With the help of a hooked needle, all fibers emerging from the skin within the 1.00 $cm^2$ opening were pulled through the frame while they were being viewed through a stereo microscope at 45-fold linear magnification. All the fibers were bent in one direction and counting started at the opposite end of the square, scanning along the skin line row by row. Each fiber counted was pulled over the opposite side of the opening with the hooked needle and held there by hand and tape. All data and observations were called out by the observer and tape recorded for later transcription, because both hands of the observer were occupied during the process and the subject had to remain still. Only "terminal" fibers were counted. In our method, a fiber was classified as terminal if it was at least about 2 cm long (18) and was similar in diameter to the long fibers. The following characteristics were noted: total number of fibers, total number of sites, number of fibers within each single site, grouping versus compounding for each fiber, relative geometric arrangement of the sites within the area, and the relative geometric arrangement of the fibers within sites.

### FIBER COLLECTION FOR DIAMETER DETERMINATION

Small areas, in the general location where fiber counting had been carried out, were randomly preselected. All fibers within this area were cut off at the skin line. About 30 fibers were collected from each individual. Compound and group fibers were marked and kept separately from others to allow evaluation of intragroup and intracompound variations. The collected fibers were cleaned with an ether rinse, and dried at room temperature. All further treatment and measurements were carried out at 70°F and 65 per cent RH. The fibers were individually cut to an exact length of 5.00 cm in a straightened configuration with the aid of a special instrument (19). The 5.00 cm length was cut starting about 1 cm from the original skin line of the fiber and, therefore, encompassed the last 4 to 6 months of growth. The 5 cm long fiber segments were individually weighed on an electrobalance to the nearest 0.1 $\mu$g. The idealized average cylindrical diameter was calculated from the weight of each fiber according to the following:

$$D = 20\sqrt{W/(3.14 \times l \times d)}$$

where D equals diameter in micrometers; W equals weight in micrograms; l equals length in centimeters = 5; and d equals density of fiber in g/cm$^3$ = 1.3. Correlations among different measured values were calculated according to a standard statistical program package supplied to our computer.

## RESULTS AND DISCUSSION

### HAIR COUNT

A large proportion of the scalp fibers grow in groups. The fibers within a group are closely spaced, but the distance between neighboring groups is considerable, about 1 mm. In order to minimize errors originating from the significant intergroup distance, the fibers were counted over a relatively large area—1 cm$^2$. This was in contrast to some earlier work (10, 11, 12, 13, 14, 15, 16), where the fiber number was determined in 2 mm squares. The results are shown in Table I.

The age of the subjects ranged from 24 to 59, but only 3 participants were over 42. Since both age and racial origin have been reported to influence some of the measured characteristics (10, 11, 13, 16, 20, 21, 22), the average values are given both with and without the inclusion of the Chinese panelists. On the basis of the present work, it cannot be determined whether the differences seen between the 2 averages were due to racial or age factors. The number of fibers/cm$^2$ ranges from 95 to 295 with a mean of 211. Subject number 1—with the extremely low fiber count—shows signs of diffuse allopecia, associated with age, which was confirmed by photographs of her going back a few decades. The next 4 individuals with fiber counts under 160 fibers/cm$^2$ include 2 over 45 years of age (Chinese) and one of Spanish origin (number 4) with very dark hair. Number 3 has light brown hair and, according to her account, never had had more hair. The remainder of the panel had more than 190 fibers/cm$^2$. The correlation between decreasing hair count with increasing age is rather weak; 0.601. This does not negate earlier findings that both hair and follicle numbers decrease with age (13, 16, 22). Our study did not include extreme ages, and even within the range, 85 per cent of

Table I
Fiber and Site Count on Left Side of Head

| Subject | Age | Number of Fibers/ $cm^2$ | Number of Sites/ $cm^2$ | Average Number of Fibers/ Site |
|---|---|---|---|---|
| 1 | 59[a] | 95 | 48 | 2.0 |
| 2 | 48[a] | 131 | 58 | 2.3 |
| 3 | 29 | 145 | 67 | 2.2 |
| 4 | 37 | 153 | 86 | 1.8 |
| 5 | 47[a] | 159 | 64 | 2.5 |
| 6 | 30 | 195 | 72 | 2.7 |
| 7 | 36 | 196 | 84 | 2.3 |
| 8 | 36 | 205 | 76 | 2.7 |
| 9 | 27 | 206 | 88 | 2.3 |
| 10 | 42 | 208 | 105 | 2.0 |
| 11 | 24 | 227 | 87 | 2.6 |
| 12 | 26 | 231 | 88 | 2.6 |
| 13 | 33 | 233 | 82 | 2.8 |
| 14 | 42 | 243 | 110 | 2.2 |
| 15 | 31 | 245 | 98 | 2.5 |
| 16 | 31 | 250 | 110 | 2.3 |
| 17 | 31 | 251 | 108 | 2.3 |
| 18 | 36 | 275 | 101 | 2.7 |
| 19 | 37 | 279 | 98 | 2.8 |
| 20 | 28 | 295 | 90 | 3.3 |
| Average[b] | 35.5 | 211 | 86 | 2.4 |
| Average[c] | 32.7 | 226 | 91 | 2.5 |

[a]These subjects were Chinese, all others apparently Caucasians.
[b]Average for the 20 subjects.
[c]Average for the 17 Caucasian subjects.

the participants were between 24 and 42. If the 3 oldest individuals are left out, the correlation between age and hair count approaches zero, indicating that this age group is rather homogeneous, or at least the individual variability—probably due to inherited factors—is a stronger parameter than age for this sample size. The values of the average fiber count/$cm^2$—211 and 226—are noteworthy in the respect that they are practically identical with those given by Barman (10, 11, 13, 15, 16), although, different from some others cited by Giacometti (22).

A full head of adult hair is commonly stated to contain about 100,000 (3, 5) to about 120,000 (4) fibers. According to Behrman (23), the average scalp area for an adult is in the range of 775 $cm^2$. Using this figure, the fiber density would only be 129 fibers/$cm^2$ for a 100,000 fiber adult head of hair. Only 1 individual in our panel was below this number. With the presently obtained fiber densities of 211 and 226 fibers/$cm^2$, the full head of hair should comprise 164,000 and 175,000 fibers, respectively. Although the densities were determined only at a specific site on all heads, this site is neither an outstandingly dense hair growth area nor are the differences among different scalp areas very large on adult heads (13, 14, 15). Therefore, we believe the estimate for the average fiber content of a full head of hair should be raised to the 160,000 to 180,000 range for women in the age group of 25 to 50. The commonly used low figures probably originate from the works of Stelwagon and Pinkus (24) quoted and even misquoted later (25, 26).

Table II
Fiber and Site Count on Right Side of Head

| Subject | Number of Fibers/ $cm^2$ | Number of Sites/ $cm^2$ | Average Number of Fibers/ Site |
|---|---|---|---|
| 2 | 175 | 68 | 2.6 |
| 3 | 169 | 83 | 2.0 |
| 4 | 142 | 81 | 1.7 |
| 10 | 270 | 105 | 2.6 |
| 12 | 208 | 73 | 2.8 |
| 14 | 182 | 83 | 2.2 |
| 15 | 239 | 100 | 2.4 |
| 18 | 203 | 70 | 2.9 |
| Average | 199 | 85 | 2.4 |
| Average[a] | 204 | 89 | 2.3 |

[a]Left side of head for same group of subjects, derived from values in Table I.

Hair is known to grow in groups on the skin of lower mammals (27), primates (28), and on certain body areas of man (20, 21, 22, 29, 30) including the scalp. Within the site of such groups, each fiber is at most a few diameters away from its neighbors, while the sites are well separated from each other. The site count, obtained together with the fiber count, is shown in Table I. It is seen that the site count ranges from about 50 to just over 100 per $cm^2$. Based on the average values, the centerpoints of such sites are more than 1 mm distant from their neighbors. The average number of fibers per site ranges from 1.8 to 3.3, but 90 per cent of the participants were between 2 and 3. The number of sites showed a reasonably good positive correlation (0.800) with the total number of fibers. However, the correlation with age was even weaker (−0.518) than that of the total number of fibers. The results of a second measurement on the right side of the head of 8 individuals are given in Table II.

It is seen that sizeable differences can exist in both fiber and site count on the 2 sides of the head, even though they were symmetrically positioned. The variation is random—neither side is preferred—as is shown by the close correspondence of the averages for the two sides. These facts indicate that, while single counting for a panel is probably satisfactory, it may be misleading for any one individual.

### FIBER DISTRIBUTION BY GROUP SIZE

The term "group" is used here to describe 2 or more fibers within a single site, whether they are separated by stratum corneum (simple fibers) or issue from a common follicle orifice (compound fiber) or contain a mixture of the 2 forms. The average number of fibers in a group varied between 1.8 and 3.3 for our panelists, as shown in Table I. The actual distribution of the fibers according to group size varied widely among the individuals. The results are given in Table III. The proportion of single fibers ranged from 1 to 23 per cent within the panel of 20. On some subjects, the largest groups contained only 4 fibers while on others 8. Even an identical maximum group size—as seen on subjects 1, 4, 5 and 17—does not ensure a similar distribution curve within the range. On the average, two-thirds of all fibers were in groups of 2 and 3, slightly more in the latter category. When the group frequency is expressed as a function of size, the results

Table III
Fiber Distribution According to Group Size

| Subject | Per Cent of Fibers in Groups of: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | 14.7 | 46.3 | 34.7 | 4.2 | — | — | — | — |
| 2 | 6.4 | 31.4 | 42.3 | 12.8 | 3.2 | 3.8 | — | — |
| 3 | 6.1 | 62.6 | 25.8 | 2.5 | 3.1 | — | — | — |
| 4 | 23.4 | 47.5 | 26.4 | 2.7 | — | — | — | — |
| 5 | 1.3 | 44.0 | 39.6 | 15.1 | — | — | — | — |
| 6 | 2.6 | 30.8 | 35.4 | 22.6 | 5.1 | — | 3.6 | — |
| 7 | 7.1 | 41.8 | 32.1 | 10.2 | 5.1 | — | 3.6 | — |
| 8 | 4.9 | 19.5 | 46.8 | 21.5 | 7.3 | — | — | — |
| 9 | 5.8 | 44.7 | 33.5 | 5.8 | 7.3 | 2.9 | — | — |
| 10 | 11.9 | 28.5 | 37.7 | 16.7 | 5.2 | — | — | — |
| 11 | 5.7 | 30.0 | 30.4 | 17.6 | 13.2 | 2.6 | — | — |
| 12 | 2.1 | 34.6 | 39.0 | 22.5 | 2.2 | — | — | — |
| 13 | 4.7 | 15.4 | 43.8 | 24.0 | 4.3 | 7.7 | — | — |
| 14 | 11.8 | 31.1 | 46.6 | 9.4 | 1.2 | — | — | — |
| 15 | 8.7 | 26.4 | 41.5 | 14.0 | 4.1 | 3.7 | 1.4 | — |
| 16 | 8.4 | 41.6 | 28.8 | 19.2 | 2.0 | — | — | — |
| 17 | 8.4 | 34.3 | 38.2 | 19.1 | — | — | — | — |
| 18 | 4.2 | 25.5 | 31.4 | 18.4 | 13.6 | 3.8 | 1.5 | 1.7 |
| 19 | 5.0 | 19.3 | 32.3 | 4.4 | 12.5 | 6.4 | — | — |
| 20 | 6.1 | 6.8 | 26.4 | 23.0 | 15.2 | 10.2 | 9.5 | 2.7 |
| Average[a] | 7.5 | 33.1 | 35.6 | 15.3 | 5.2 | 2.1 | 1.0 | 0.2 |
| Average[b] | 7.5 | 31.8 | 35.1 | 16.1 | 6.0 | 2.2 | 1.2 | 0.3 |

[a] Average for the 20 subjects.
[b] Average for the 17 Caucasian subjects.

are somewhat different. Sites with 1, 2, 3, and 4 fibers occur at 18.2, 40.7, 28.7, and 9.2 per cent frequency, respectively, while groups with 5 or more fibers at 3.3 per cent. This is in slight disagreement with some published results (31), where the group of 3 fibers was found to dominate. The proportion of single fibers is much lower than found earlier (30). Within our panel, no correlation of any significance was found between group size distribution on one hand and age, fiber population density, or site population density on the other. This is in contradiction to the conclusions of Oberste-Lehn (20, 21), who claimed strong correlations between group distribution and age, although on the basis of smaller sample size. In our view, all available studies—including the present one—used too narrow a data base to allow generalized conclusions in this area. Even if strong correlations were obtained from a much larger study, the averages could not be applied to individuals because of the very large variability of the distribution pattern.

The relative positions of fibers in groups showed no specific geometric patterns in agreement with earlier findings (28).

### SIMPLE AND COMPOUND FIBERS

It has long been known that 2 or more fibers can emerge from a single follicular opening at the epidermal level on some parts of the body, including the scalp. In the litera-

Table IV
Fiber Distribution According to Compound Size

| Subject | Per Cent of Fibers | | | |
|---|---|---|---|---|
| | Simple | 2 | 3 | 4 |
| 1 | 36.9 | 50.5 | 12.6 | — |
| 2 | 90.2 | 9.8 | — | — |
| 3 | 48.0 | 48.3 | 3.7 | — |
| 4 | 63.7 | 31.2 | 5.1 | — |
| 5 | 54.7 | 34.0 | 11.3 | — |
| 6 | 94.9 | 5.1 | — | — |
| 7 | 80.6 | 19.4 | — | — |
| 8 | 96.1 | 3.9 | — | — |
| 9 | 73.8 | 26.2 | — | — |
| 10 | 80.5 | 18.8 | 0.6 | — |
| 11 | 74.5 | 25.5 | — | — |
| 12 | 51.3 | 46.0 | 2.7 | — |
| 13 | 40.8 | 42.1 | 15.4 | 1.7 |
| 14 | 73.9 | 24.0 | 2.1 | — |
| 15 | 59.1 | 32.6 | 7.4 | 0.8 |
| 16 | 67.6 | 28.8 | 3.6 | — |
| 17 | 56.6 | 37.4 | 6.0 | — |
| 18 | 63.0 | 31.4 | 5.6 | — |
| 19 | 65.6 | 28.0 | 6.4 | — |
| 20 | 57.3 | 27.1 | 14.2 | 1.4 |
| Average[a] | 66.5 | 28.5 | 4.8 | 0.2 |
| Average[b] | 67.5 | 28.0 | 4.3 | 0.2 |

[a]Average for the 20 subjects.
[b]Average for the 17 Caucasian subjects.

ture, these fibers have alternately been called "bunched" (20, 21) or "compound" (30). We follow the latter designation. The common opening for multiple fibers does not necessarily indicate a single papillary body. The literature refers to the convergence of follicular tubes in the epidermis (32). Our results, based on the total fiber number and not on the number of follicular openings, are given in Table IV. On the average, two-thirds of the fibers emerge in the simple form. Compound fibers with more than 2 members account for only 5 per cent. When the accounting is made on the basis of the number of follicular openings, the distribution is shifted even more toward the simple fibers; 80.7 per cent. Follicles with 2, 3, and 4 compound fibers were present at 17.3, 1.9, and less than 0.1 per cent, respectively. The present results significantly differ from earlier ones (20, 21, 30). This is probably due to the poor definition of what can be counted as a compound fiber. If the magnification during viewing is low, a thin but contiguous epidermal wall may not be seen between closely spaced but separately exiting fibers. On the other hand, loose skin debris may be positioned between real compound fibers unless the scalp is freshly cleaned and these then may be counted as simple fibers. In spite of these uncertainties, the categorical statement of Oberste-Lehn (20, 21) that compound fibers with 4 members appear only after age 50 cannot be accepted. The only 3 individuals with compounds of 4 fibers were 28, 31, and 33 years of age. No significant correlations were found between the number and size of compound hairs on one hand and age, number of fibers and sites, or group distribution on the

Table V
Fiber Diameter

| Subject | Average Diameter | Standard Deviation | Range of Fiber Diameter | | Diameter Ratio Maximum/Minimum |
|---|---|---|---|---|---|
| | μm | | | | |
| 1 | 82.9 | 4.8 | 88.9 | 72.4 | 1.23 |
| 2 | 79.6 | 8.6 | 92.4 | 58.9 | 1.57 |
| 3 | 59.6 | 5.9 | 68.8 | 45.3 | 1.52 |
| 4 | 70.1 | 4.4 | 79.4 | 63.2 | 1.26 |
| 5 | 96.5 | 7.4 | 111.3 | 86.6 | 1.29 |
| 6 | 58.9 | 7.8 | 75.1 | 44.0 | 1.71 |
| 7 | 68.8 | 8.9 | 85.5 | 52.4 | 1.63 |
| 8 | 61.4 | 10.4 | 77.0 | 45.6 | 1.69 |
| 9 | 80.6 | 6.9 | 96.5 | 66.7 | 1.45 |
| 10 | 75.2 | 5.2 | 86.0 | 61.7 | 1.39 |
| 11 | 67.4 | 10.0 | 82.3 | 42.4 | 1.94 |
| 12 | 84.9 | 6.9 | 96.9 | 73.8 | 1.31 |
| 13 | 71.4 | 7.2 | 90.8 | 58.7 | 1.55 |
| 14 | 69.4 | 7.8 | 86.9 | 53.0 | 1.64 |
| 15 | 75.2 | 8.8 | 89.8 | 51.1 | 1.76 |
| 16 | 70.8 | 10.0 | 99.8 | 53.3 | 1.87 |
| 17 | 68.4 | 5.4 | 80.5 | 57.2 | 1.41 |
| 18 | 71.6 | 5.5 | 81.2 | 54.0 | 1.50 |
| 19 | 68.6 | 8.1 | 78.2 | 37.6 | 2.08 |
| 20 | 67.0 | 9.3 | 83.0 | 52.4 | 1.58 |
| Average[a] | 73.4 | | | | |
| Average[b] | 71.1 | | | | |
| Average[c] | 86.3 | | | | |

[a]Average for the 20 subjects.
[b]Average for the 17 Caucasian subjects.
[c]Average for the 3 Oriental subjects.

other in any combination of these factors. Again, the extreme individual variability needs to be pointed out. Subject 8 had nearly exclusively simple hairs, while for others more than half the fibers were compounded.

## FIBER DIAMETER

Most literature references provide only mean diameters for a given population. According to these, Caucasian hair diameters average less than 60 μm (8), more than 60 μm (9), about 77 μm (6), and 79 μm (7). For Oriental hair, the averages range from about 85 to 100 μm (6, 7, 9). Barman and coworkers (10, 11, 12, 13, 14, 15, 16) segmented the hair population by size, but only by crude categories: about 100, about 50, and 25 μm. Our interest centered more on the variations among individuals and among fibers on the same head. The results, concerning the calculated "idealized" diameters, are given in Table V.

The mean diameter for the Caucasian group was 71 μm, which is within the range of earlier data. This is well differentiated from the 86 μm average value of the Orientals.

The average diameters within the Caucasian group range from just under 60 to 85 $\mu$m in a natural distribution pattern. The correlation between mean diameter and age is only 0.45 for the whole group; that is, of no significance. With the exclusion of the Orientals, the correlation approaches zero. Therefore, the age, at least between the midtwenties and early forties, is not a governing factor for hair diameter within a somewhat varied population. Nor was the diameter found to correlate with the number of fibers, sites, or any specific group and compound size. The variation in fiber size on individual heads is shown in Table V. The standard deviation ranges from 5 to 17 per cent, but independently from any other characteristics. The range of absolute diameter of individual fibers is rather wide; from 37 to 111 $\mu$m, and it would certainly increase with larger data bases. Nonetheless, the findings of Barman and coworkers (10, 11, 12, 13, 14, 15, 16) of 10 to 15 per cent fiber content in the 25 $\mu$m range cannot be substantiated with the present results, as we found only one fiber below 40 $\mu$m. The occurrence of fibers below 40 $\mu$m diameter is very low in commercially available human hair as well when determined both by weight and microscopic methods. Even in wool, a 25 $\mu$m fiber is classified as medium fine. The range of diameters on individual panelists, as expressed by the thick–thin ratio, is more restricted. On some subjects the fibers are closely homogeneous with a ratio of less than 1.3. Only in one case did the value exceed 2.0. This thick–thin ratio shows a weak positive correlation (0.49) with fiber population density and similarly weak, but negative correlation with mean fiber diameter and age of the subjects. However, the exclusion of the Orientals from the data base eliminates all significance from these already weak correlations.

### VISUAL APPEARANCE OF THE HAIR

The hair of the panelists differed in a number of characteristics—length, curl, style, cosmetic modifications, and product use—in addition to the measured fiber population density and diameter values. Due to this large number of variables, strict conclusions cannot be drawn concerning the visual bulkiness of hair as a function of the measured parameters on the basis of 20 panelists. Nonetheless, the indications were clear that the fiber diameter had a stronger influence on the visible bulk and elevation of the hair over the head than the population density. Even the curl level and hair setting seemed to be more important factors than the fiber number. Only when a number of these characteristics—low density and diameter with straight configuration—happened to combine, was the total hair mass judged to be very small and weak by visual methods, as in the case of subject 3. When the hair was long—waist length—and very straight, as for Subject 19, a somewhat similar judgment was arrived at, in spite of the very high fiber number and average diameter. On the other hand, wavy hair—not necessarily natural wave—with average to high diameter can show up with high bulk even at low to very low fiber densities, as were seen on panelists 1, 2, 4, and 5. Subject 12 showed the highest bulkiness with naturally strongly waved thick hair, even though the density was only average and the hair reached below shoulder level.

## CONCLUSIONS

Based on the population density, the number of fibers on a full adult head of hair may have to be revised upward by a considerable amount to 150,000 to 200,000. The indi-

vidual variability in fiber number, grouping and diameter is very great and no correlations of statistical significance were found for any of these characteristics. Nor were these characteristics related to age, at least within the age range studied. Deficiency in fiber number or even in diameter can be overcome by other characteristics to provide a hair mass with the visual impression of bulk and fullness.

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