INTRODUCTION
The second-to-fourth digit ratio is measured by dividing the length of the index finger by the length of the ring finger. A ratio <1 means that the ring finger is longer; this is known as the male pattern or “A” pattern. A ratio >1 means that the index finger is longer; this is known as the female pattern or “C” pattern. When both fingers are equal in length (ratio = 1), the pattern is labeled as “B” pattern; this may be seen in both sexes. None of the previously reported studies on this topic were reported in the plastic or hand surgery literature. Our aim is to increase the awareness of plastic and hand surgeons to these types of hand patterns and to correlate such patterns to sex, body mass index (BMI), and physical activity in a group of healthy medical students and interns.

Methods: We conducted a cross-sectional study on 160 healthy medical students/interns. There were 82 females and 78 males between the ages of 20 and 30. A male pattern (pattern A) was defined as pattern A in both hands or pattern A in one hand and pattern B in the other hand. A female pattern (pattern C) was defined as pattern C in both hands or pattern C in one hand and pattern B in the other hand. The correlation between hand pattern and sex, BMI, and physical activity was done using the chi-square test and Fisher’s exact test. A \( P \) value of <0.05 was considered statistically significant.

Results: Five participants (3.1%) had pattern B in both hands. Another 15 participants (9.4%) had a male pattern in one hand and a female pattern in the other hand. Both of these groups were excluded from the statistical analysis. Pattern A was significantly higher in males, and pattern C was significantly higher in females (\( P < 0.001 \)). BMI and physical activity did not significantly affect the hand pattern in males. However, the correlations between hand pattern and both BMI and physical activity were significant in females (\( P = 0.005 \) for BMI) (\( P = 0.042 \) for physical activity).

Conclusions: About 12.5% of the study group did not fit into a male or female pattern. In the remaining 87.5% of the participants, sex correlated with hand pattern. BMI and physical activity significantly affected the hand pattern in females. We believe that our study will encourage plastic surgeons to further investigate the correlation of different hands patterns to other variables of interest in plastic surgery such as masculine facial anthropometric values, hypoplastonic breasts, gynecostia, and lipodystrophy. (Plast Reconsr Surg Glob Open 2019;7:e2144; doi: 10.1097/GOX.0000000000002144; Published online 20 May 2019.)

Disclosure: The authors have no financial interest to declare in relation to the content of this article.
such patterns to sex, body mass index (BMI), and physical activity in a group of healthy medical students and interns.

METHODS

Ethical approval was obtained from King Saud University. This is a cross-sectional study conducted on a total of 160 healthy King Saud University medical students and interns. There were 82 females and 78 males. Medical students/interns were randomly selected using computer-generated random numbers. Exclusion criteria were the following: subjects younger than 20 years or older than 30 years of age, any history of congenital deformity or disorder, any history of hand injuries/surgeries, unclear hand demarcations, any history of chronic diseases (including diabetes mellitus) or endocrine disorders.

The lengths of the index and ring fingers were measured (in millimeter) in both hands for each subject using electronic calipers (Stainless Steel iGaging ABSOLUTE ORIGIN 0–6” Digital LCD Electronic Caliper-IP54; iGaging, Los Angeles, Calif.). The proximal landmark was the base of the proximal volar crease at the base of the finger, and the distal landmark was the most distal point of the fingertip as shown in Figure 2. The 160 subjects were divided into 4 groups. The first group was individuals with pattern B in both hands. The second group was individuals with pattern A in one hand and pattern C in the other hand. These 2 groups did not fit into a male (pattern A) or female (pattern C) pattern. The third group was labeled as the male (A) pattern; those with pattern A in both hands or those with pattern A in one hand and pattern B in the other hand. The fourth group was labeled as the female (C) pattern; those with pattern C in both hands or those with pattern C in one hand and pattern B in the other hand. The percentages of the first 2 groups were calculated, but they were excluded from the statistical analysis. The latter 2 groups (male/female pattern) were then correlated with sex, BMI, and physical activity.

Based on the BMI, individuals were grouped into 2 groups: those with a BMI <25 and those with a BMI ≥25. The physical activity levels were assessed by the "General Practice Physical Activity Questionnaire." The questionnaire divided participants into 4 groups: active, moderately active, moderately inactive, and inactive. For statistical analysis, the former 2 groups were labeled as "active," and the latter 2 groups were labeled as "inactive."

Data were analyzed using SPSS version 22.0. Categorical variables: hand pattern (A or C), sex (male or female), BMI (<25 or ≥25), and physical activity (active or inactive) were expressed as percentages. The chi-square test and Fisher’s exact test were used for these categorical variables to correlate hand pattern to sex, BMI, and physical activity. A $P$ value of <0.05 was considered statistically significant.

RESULTS

Five participants (3.1%) had pattern B in both hands. Another 15 participants (9.4%) had a male pattern in one hand and a female pattern in the other hand. Both these groups were excluded from the statistical analysis. The remaining participants ($n = 140, 87.5\%$) were then analyzed. There were 70 males and 70 females with a mean age of 22.14 (SD = 1.56).

There was a significant correlation between hand pattern and sex (Table 1). Pattern A was significantly higher in males, and pattern C was significantly higher in females ($P < 0.001$).
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BMI (Table 2) and physical activity (Table 3) did not significantly affect the hand pattern in males. However, a tendency toward pattern C was seen in males with a BMI ≥ 25 and in inactive males.

The correlation between hand pattern and both BMI (Table 4) and physical activity (Table 5) was significant in females (P = 0.005 for BMI and P = 0.042 for physical activity). Females with a BMI < 25 and active females had significantly higher percentages of pattern A and vice versa.

**DISCUSSION**

Our study is unique to the surgical literature and shows several interesting findings. First, 9.4% of healthy males and females had a male pattern in one hand and a female pattern in the other hand. No adequate scientific explanation could be given to explain this finding. Second, the significant correlation between the hand pattern and sex supports the findings of several other studies in the literature and also supports the theory that hand pattern is a reflection of prenatal androgen/estrogen exposure.

We reviewed the embryology of hand development regarding the determinants of digital lengths. Embryologically, the levels of expression of bone morphogenetic proteins (BMPs) in the “phalanx-forming region” of the developing hand affect the length of the digits. The thumb is the shortest digit and has the lowest BMP expression. Androgens induce the expression of BMP receptors, enhancing the BMP pathway and BMP expression. Hence, the length of the digits may be affected by prenatal androgen exposure.

The correlation between hand pattern and BMI is a controversial issue in the literature. Ibegbu et al. could not find a significant correlation. Van Dongen found a negative association between hand pattern and BMI in men.
(ie, men with a higher BMI had a more masculine hand pattern). Manning et al.\(^1\) found that males with higher concentrations of testosterone had a significantly higher percentage of male hand pattern (pattern A). Our study showed that a BMI $\geq 25$ is associated with more C patterned hands, although statistical significance was only reached in the female group. Scientifically, testosterone is converted in fat cells into estrogen through the aromatase pathway.\(^9\)

There are numerous studies in the literature that show that a masculine hand pattern (ie, pattern A) is a significant predictor of performance in professional athletes including volleyball players,\(^10\) speed runners,\(^11\) and American football players.\(^12\) Our study was not conducted on professional athletes, yet physically active individuals had a tendency for a masculine hand pattern (ie, pattern A), although statistical significance was only reached in the female group.

**CONCLUSIONS**

Our study introduces digit ratio/hand pattern to the surgical literature and had several interesting findings regarding the correlation between hand pattern and sex/BMI/physical activity. We attempted to give a scientific explanation regarding the effect of androgens on digital length in utero. We believe that our study will encourage plastic surgeons to further investigate the correlation of different hands patterns to other variables of interest in plastic surgery such as masculine facial anthropometric values, hypoplastic breasts, gynecomastia, and lipodystrophy.

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