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Is Increased Facial Asymmetry Associated With the Use of Hormonal Contraceptive Among Polish Young Women in Wroclaw?

Slawomir Koziel[1], Raja Chakraborty[2], Dariusz Danel[3], Krzysztof Borysławski[4]

[1] Department of Anthropology, Hirszfeld Institute of Immunology and Experimental Therapy, Polish Academy of Sciences, Wroclaw
[2] Department of Anthropology, Dinabandhu Mahavidyalaya, Bongaon, West Bengal Country, India
[3] Department of Anthropology, Hirszfeld Institute of Immunology and Experimental Therapy, Polish Academy of Sciences, Wroclaw, Poland
[4] Department of Anthropology, Wroclaw University of Environment and Life Sciences, Poland

A B S T R A C T

Fluctuating asymmetry (FA) is the small random deviations from a perfect bilateral symmetry in a morphological trait. It is considered as an indicator of biological quality and developmental stability of individual. Adverse environmental conditions and high levels of sex steroids may increase FA. Symmetry in women was found to be related with phases of the menstrual cycles (MC). This cross sectional study aimed to compare facial symmetry between women using and not using hormonal contraceptives with reference to the phases of their fertile and non-fertile phases of MC. Participants were 150 young adult Polish female students in Wrocław, Poland. Facial photograph of each woman was taken and information on the use of hormonal contraception, date of menarche, number of days past since the last menstruation (beginning of bleeding) were collected. Measurements of facial asymmetry were taken digitally in pixels on facial photographs by using ImageJ software. The results revealed that the women who used HC had a significantly higher total and central facial FA than those who did not use HC. However, the women in relatively non fertile phase did not demonstrate a difference in FA among the non-users of HC.

Key words: *fluctuating asymmetry, facial asymmetry, hormonal contraceptive, menstruation, fertile phase*

Introduction

Morphological symmetry, in general, refers to the extent to which one lateral half of the body of an individual is identical as the other half. Asymmetry in an individual is measured as the right minus the left value of the bilaterally paired traits. Fluctuating asymmetry (FA) is defined as the small random deviations from a perfect bilateral symmetry in a morphological trait, for which differences between the right and left sides have a mean value of zero and are normally distributed[1,2] and thus show symmetry at the population level[3]. Asymmetries stabilize early in ontogeny in response to environmental and hormonal stress[4,5]. FA was thought as an indicator of individual quality and developmental stability in studies of natural and sexual selection[6]. It was argued that poor and adverse environmental conditions and high levels of sex steroids might also increase FA[5,7,8]. In humans, facial asymmetry was shown to be associated with homozygosity and inbreeding[9], poor maternal health[10], genetic diseases[11,12], and various neurological disorders[13-15]. Hormonal conditions might also have relationship with FA. For instance, it is commonly accepted that the ratio of second digit (2D) to the fourth (4D) is associated with prenatal exposures to androgens and lower 2D:4D values are associated with greater concentrations of prenatal androgen[16,17]. Interestingly, both low 2D:4D and high 2D:4D were associated with elevated levels of asymmetry, especially in the fingers[18]. Also postnatal, and temporal fluctuations in the hormone concentrations may be related to the symmetry levels. In particular, it has been shown that symmetry of women's ears and digits was the lowest in the infertile phases of the menstrual cycles (MC)[19,20]. The authors suggested that changes of the asymmetry across MC may serve as a marker of a women's temporal fertility status[19]. This corresponds with more recent evidence that

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attractiveness of women's face as perceived by men varied across the MC and is the highest in the fertile window, around ovulation[21,22]. Since facial attractiveness is linked to the FA[23] it can be assumed that hormonal condition in adult females might also be related to the facial FA.

Hormonal contraceptives (HC) are meant to modify the relative levels of sex hormones to prevent conception. However, a hitherto unaddressed question is whether the use of HC has some association with facial FA relative to phases of MC in women. The aim of this study was therefore to assess the difference in facial symmetry between women using and not using HC with reference to the phases of their MCs, viz. fertile and non-fertile. Although being a cross sectional study with a small sample size, this was probably the first of its kind to date to examine this kind of association in any population.

Materials and Methods

Participants

Participants of this cross sectional study were 150 young adult female students of the final year in three high schools in the city of Wrocław (Southwest Poland) aged 18 years or older. All women gave informed consent to voluntary participation in the study. During the course of experiment, facial photograph of each woman was taken. They were also asked to complete a survey including questions regarding socio-demographic variables, use of hormonal contraception, date of menarche, number of days past since the last menstruation (beginning of bleeding). All women however reported to have undergone menarche. Finally, seven women were excluded from the analysis due to missing information.

Facial photograph

Each participant was photographed under standard condition of indoor lighting and using SONY DSLR-alpha 390 digital camera and external flash. Subjects were asked to remain neutral facial expression (with no smile) and look straight into camera lens. In the second step, using graphics editor GIMP 2.6.12 (GNU Image Manipulation Program, www.gimp.org) each picture was rotated in order to align pupils to horizontal line and cropped to the same size of 1592x2056 pixels.

Menstrual phases

An estimation of the day of ovulation within a cycle was made using the information about the last menstruation, viz., duration of the cycle and the number of bleeding days. We defined the relatively high fertile phase (F) of the cycle, including the day (estimated) of ovulation and 5 days preceding that day – days 9 to14 in the conventional medical 28-day MC. We defined the low fertile (luteal) phase (L) of the cycle 4 days after ovulation and the following 5 days (days 18–23 in a 28-day MC), because there is a very low probability of conception after day 17[24,25].

Measurements of asymmetry

All measurements in the study were done digitally in pixels using ImageJ software (National Institutes of Health, www.rsbweb.nih.goc/ij). The software allows determining on digital photographs coordinates of user-defined measurement points (landmarks, equivalents of the anthropometric points). The coordinates enable calculation of pixel distances between analyzed landmarks. Facial asymmetry was measured on each facial portrait according to the method proposed by Grammer and Thornhill[26]. This procedure allows obtaining two measures of facial horizontal asymmetry: overall and central. In brief, the overall facial asymmetry is measured as the sum of all non-redundant differences between the midpoints of six horizontal lines. The lines were digital analogues of classic anthropometric measurements between following pairs of facial-metric points: ectocanthion-ectocanthion (L1), endocanthion-endocanthion (L2), zygion-zygion (L3), alare-alare (L4), cheilion-cheilion (L5)and gonion-gonion (L6). Using the pixel coordinates of particular point pairs, the midpoint of each line was determined by the formula: [(Left Point – Right Point)/2] + Right point. The sum on all differences between the midpoints on perfectly symmetrical face equals zero since all the midpoints are located on the same vertical midline. Similarly, the central facial asymmetry bases on the sum of differences between the midpoints of adjacent lines (i.e. L1-L2, L2-L3, L3-L4, L4-L5, L5-L6). Analogously, results deviating from zero indicate facial central asymmetry[26].

Statistics

Analysis included 143 women with complete information. T-Student test was applied in order to assess differences in continuous features (e.g. indexes of facial asymmetry, MC characteristics) between women using and not-using contraceptives, and between women in and out of the fertile window. Two-way analysis of variance (ANOVA) was employed separately for the two indices of FA, the total and central. The HC using status (yes/no) and fertile window period status (F/L) were used as two factors in each ANOVA test. A probability value < 0.05 was considered to be statistically significant. All analyses were conducted through STATISTICA 12.0 software.

Results

Mean (SD) age of the participants was 18.34 (0.54) years. Mean age (SD) at menarche was 12.6 (1.22) years with a range of 10-17 years. The duration of MC varied from 19-45 days with a mean (SD) of 28.13 (3.87) days. The mean (SD) number of the bleeding days was 5.5 (1.1) days with a range of 3-8 days (results not shown).

Table 1 summarizes the differences between women using and not-using contraceptives as well as between women in the fertile versus non-fertile window periods in respect of the two indexes of facial asymmetry, age, age at menarche and menstrual characteristics. The contraceptive users showed significantly higher total- and cen-

TABLE 1

MEAN (SD) OF VARIABLES ACCORDING TO USE OF HORMONAL CONTRACEPTIVE AND MENSTRUAL PHASE

Variables	Used HC	Not-used HC	t	Fertile window	Non-fertile window	t	All
Age	18.5 (0.50) (N=30)	18.3 (0.68) (N=113)	1.70	18.32 (0.47) (N=41)	18.36 (0.59) (N=85)	0.45	18.34 (0.54) (N=150)
Age at menarche	12.03 (1.16) (30)	12.82 (1.20) (N=113)	3.22**	12.41 (1.24) (N=41)	12.73 (1.22) (N=85)	1.35	12.65 (1.22) (N=150)
Duration of cycle (days)	25.84 (3.50) (N=29)	28.58 (3.47) (N=99)	3.72***	28.76 (4.28) (N=41)	27.75 (3.82) (N=85)	1.33	28.13 (3.87) (N=135)
Number of bleeding days	5.56 (1.04) (N=27)	5.07 (1.09) (N=104)	2.09*	5.14 (1.25) (N=39)	5.60 (1.02) (N=77)	2.14*	5.46 (1.10) (N=138)
Total facial FA	88.60 (56.54)	59.86 (48.69)	–2.776*	71.62 (49.86)	67.51 (52.41)	– 0.419	65.52 (50.87) (N=150)
Central facial FA	13.13 (8.39)	9.04 (7.32)	–2.637*	10.76 (7.49)	10.17 (7.92)	– 0.395	9.79 (7.61) (N=150)

*p<0.05; **p<0.01; **p<0.001

tral facial asymmetry (t = 2.78 and 2.64, respectively, both $p < 0.05$) compared to the non-users. However, these measures of asymmetry were not significantly different between women who were approximately in their fertile and non-fertile window periods of their MCs (among the non-users of contraceptive). Age at menarche was significantly, although slightly, higher among the non-users than in users of contraceptives (t = 3.222; $p < 0.01$), which is not the case between the women in fertile and non-fertile window periods. Mean duration of cycle was about 3 days less among the contraceptive users (t = 3.72; $p < 0.001$), but not significantly different between women in fertile and non-fertile windows. Number of bleeding days was slightly higher among the contraceptive users as well as in the women in their non-fertile window, compared to their respective counterparts. Figure 1 also demonstrates the clear differences between contraceptive users and non-users in respect of both central and total facial asymmetry.

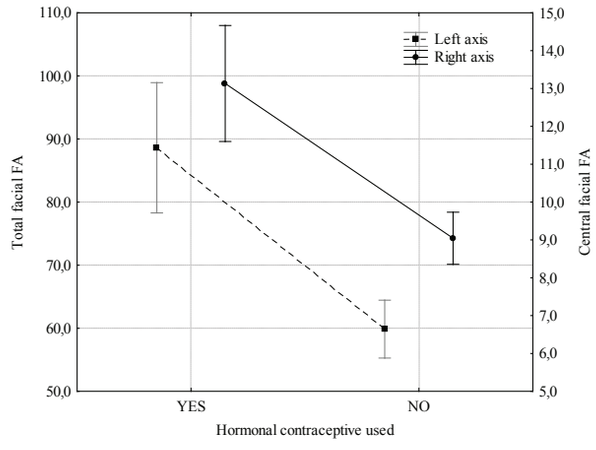

Fig. 1. Means (95% CI) of total and central facial by hormonal contraceptive use status (Yes / No).

Discussion

The MC is a phenomenon associated with systematic changes in sex hormone levels in women and the major role of HC is to manipulate these changes in favour of temporary non-fertility. The present study demonstrated that the women who used HC had a significantly higher total and central facial FA than those who did not report using HC. However, when their MC phases were taken into consideration in further analysis, the women in relatively non fertile phase did not demonstrate a difference in FA among the non-users of HC. In other words, the faces of the non-users of HC were quantitatively more symmetrical than the users.

Higher FA was associated with decreased fecundity and other factors negatively linked to natural and sexual selection[2,27]. It was long argued that facial symmetry had a positive role in partner choice and reproductive success in humans[23,28,29,30]. Measures of symmetry in the human

body and face were often found to be correlated with attractiveness[31,32]. Such correlations, however, might be due to other factors that also co-vary with symmetry. For example, it was suggested that sex hormones might influence the symmetry of growth[35] and chin shape, which independently was shown to affect attractiveness[33]. Although we did not observe any obvious association of FA with the menstrual phases, facial asymmetry was higher among the HC users, who artificially prevented conception, and thus, in other words, maintained a hormonal condition favouring to non-fertility.

Menstrual phase and FA were already found linked in some earlier studies. FA was the highest at the beginning and the end of a MC, when women were generally relatively infertile, and the lowest in mid-cycle, when the expectance of fertility was the highest[19]. In addition, soft tissue traits, such as ears, fingers and breasts, become more symmetrical in the days leading up to ovulation[19,20]. Therefore higher symmetry is expected during the fertile phase of the cycle. It was already reported that the relative changes of female sex hormone levels during the fertile window period might have a link with higher symmetry[34]. However, the present study could not distinguish between the extents of facial asymmetry in these two phases.

In the present study the examination of the association between facial symmetry and hormonal contraception showed that women with pharmacologically ceased fertility had more asymmetrical faces. Such a result corresponded with the conclusions by Manning[19] that higher symmetry observed in fertile windows of MC might be a sign of women's temporal fertility status and higher chances for conception. Moreover, as more symmetrical faces were found to be perceived as more attractive[30] our results were in line with results by Roberts et al.[22] indicating that women appeared more attractive in the fertile phase of their MC.

While discussing the link between HC and higher facial asymmetry observed in our study it should be noted that the observed association did not indicate causality. By analogy to the MC studies[19,20] it was plausible that increased asymmetry was associated with the hormonal state related to the hormonal birth control. However, in general, higher asymmetry could also be a predisposing factor for using HC. Nonetheless, without further, longitudinal trials the question regarding the possible reasons of this statistical link between HC and FA shall remain open.

This study, nevertheless, had a number of potential limitations. Firstly, the information regarding the nature of HC drugs used were lacking. Besides, the classification of women into relatively fertile (follicular) and non-fertile (luteal) phase on the basis of reported cycle days is also not physiologically ideal[35]. Moreover, follow up information on the same set of participants in the follicular and luteal phases would have been more conclusive about the probable change in the symmetry status of same faces across MC. Besides, in young girls the MC is not stable and thus the ovulation also could occur at different time within a cycle. After menarche until 4 years most of the girls need to regularise the duration of MC. In the first year after menarche 60% of MC are without ovulation, and MC are with different duration[36]. In spite of all these shortcomings, the study, nevertheless, cited a clear indication of an interactive association of hormonal contraception – facial fluctuating asymmetry among young girls, warranting more detailed studies with larger sample size and in other populations.

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S. Koziel

Department of Anthropology Hirszfeld Institute of Immunology and Experimental Therapy, Polish Academy of Sciences in Wroclaw
e-mail: slawomir.koziel@iitd.pan.wroc.pl

JE POVEĆANA ASIMETRIJA LICA VEZANA UZ UPOTREBU HORMONALNE KONTRACEPCIJE MEĐU POLJSKIM MLADIM ŽENAMA U WROCLAWU?

S A Ž E T A K

Fluktuirajuća asimetrija (FA) su mala slučajna odstupanja od savršene bilateralne simetrije u morfološkoj osobini. Smatra se kao pokazatelj biološke kvalitete i razvojne stabilnost pojedinca. Nepovoljni uvjeti u okolišu i visoke razine spolnih steroida mogu povećati FA. Utvrđena je simetrija u žena da je u vezi s fazama menstrualnog ciklusa (MC). Ovo iz presjeka istraživanje čiji je cilj usporediti lica simetriju između žena koje koriste i ne koriste hormonsku kontracepciju s obzirom na faze svojih plodnih i ne-plodne faze MC. Sudionici su 150 mlada osoba Engleski studentice u Wroclawu, Poljska. Lica fotografija svake žene je snimljena i informacije o uporabi hormonske kontracepcije, datum menarhe, broj dana proteklih od zadnje menstruacije (početak krvarenja) su prikupljeni. Mjerenje asimetrije lica su uzeti digitalno u pikselima na fotografijama lica pomoću ImageJ softvera. Rezultati su pokazali da su žene koje koriste HC imali su značajno višu ukupno i centralno FA lica od onih koji nisu koristili HC. Međutim, žene su u relativno ne plodnoj fazi nije pokazao razliku u FA među ne-korisnika HC.