

Estimation of facial attractiveness as biomarker of ovulation using facial photogrammetry during phases of female sexual cycle

ABSTRACT

Background: Facial photogrammetry during various phases of female sexual cycle was used to estimate the facial beauty/attractiveness of females at menstruation and ovulation phase of their monthly cycle; in order to form basis of using facial attractiveness as a biomarker of ovulation. **Methods:** Thirty-seven (37) volunteered female scholars in an institution in Southern Nigeria were purposively selected to include menstruating females of 17 – 28 years. Photographs of the selected subjects were taken during menstruation and two weeks after menstruation (ovulation period). Afterwards, photogrammetric analysis was performed; 350 males were asked to pick preferred facial picture of each of the subjects. **Results:** There was significant differences between the facial proportions measured during the sexual cycle and ideal facial proportion of the subjects $p < 0.05$. The estimation of attractiveness was higher in ovulation phase as there was positive significant correlation of facial proportions of the subjects during the various phases of their sexual cycle. **Conclusion:** The findings suggests that facial beauty/attractiveness may be used to estimate the sexual cycle of females as enhanced facial beauty/attractiveness could be a biomarker of ovulation.

Keywords: Photogrammetry, Sexual cycle, Ovulation, Facial beauty, Attractiveness.

Introduction

Photogrammetry is the evaluation of qualitative and quantitative features of objects and environments via measuring, recording and interpreting photographic emulsions as well as patterns of electromagnetic radiant imagery etc. [1, 2]. Photogrammetry evolved from plane table type to digital photogrammetry since its invention by Colonel Aime Laussedat in 1851. Digital photogrammetry involves the use of computers to perform photogrammetric analysis and it is also photogrammetry that is applied to digital photographs stored and processed in a computer [3]. Facial photogrammetry gives photographic analysis of the face and this can be used to determine facial beauty and attractiveness of an individual [4, 5].

Facial beauty determined by symmetry and ideal harmony of facial structures (features) consists of underlying facial bone (skeleton), fats compartment (which forms retaining ligaments) and facial muscles responsible for facial expressions (frowning, smiling, laughing etc.). Facial beauty forms an aspect of attractiveness of an individual [6, 7].

Female sexual cycle plays vital role in human reproductive functionality as it involves menstruation and ovulation phase. Menstruation is the shedding away of unfertilized ovum, thereby giving room for production of more viable eggs, while ovulation is the release of an

ovum that is ready for fertilization during the monthly (averagely 28 days) sexual cycle [8, 9]. Several hormones (Follicle stimulating hormone, luteinizing hormone, estrogen) influence the female sexual cycle and hormones like melanin also influence skin coloration which in turn adds to beauty and attractiveness of a person [10, 11].

Reports suggest that females are more attractive in the fertile phase of their sexual cycle [12, 13]: in animals; redness of waist, colourful plumes, etc. are biomarker of ovulation that makes them attractive as well as makes mating possible [14, 15]. In humans reliable indicators of ovulation is not fully explained. Hence, this study was designed to demonstrate the estimation of facial attractiveness as biomarker of ovulation using facial photogrammetry of females during various phases of their sexual cycle.

Materials and Methods

About thirty seven (37) volunteered **subjects** (17 – 28 years) was purposively selected; subjects with no history of facial surgery, no form of craniofacial anomaly and females with regular 28 days menstrual cycle was included for the study. Exclusion criteria were for subjects with history of facial surgery, dental occlusion, allergies, prior facial fracture and craniofacial anomaly. Subjects with irregular menstruation as well as subjects on contraceptives were also excluded.

Photogrammetry procedures

All standardized facial photographs of selected volunteered subjects were taken using Nikon Coolpix A100 digital camera. The photographic set up is made up of a tripod stand which has support to mount digital camera. The height of the tripod stand was adjusted to fit subject's height as well as control the stability of the camera. The subjects stood in an upright and relaxed position, with both hands by their sides in front, a black wig cap covering their head showing their hairline and a graph sheet was pinned to the wall behind them providing a life size measurement. With the aid of the meter rule, the camera was placed exactly 100cm away from the subjects, the camera lens was zoomed as required to suit each subject's head size. Photographs were taken carefully and as accurately as possible to ensure that facial soft tissues were visibly captured. Captured pictures of subjects on the various phases of their sexual cycle was compiled on a power point presentation and presented to 350 males to pick the preferred one.

Facial parameters; the width of the eye, total height of the face, the chin length, width of the face at eye level, mouth width, width of the face at mouth level, height of the visible eye ball were measured on the print outs of the pictures to find the ideal proportions of beauty and differences in morphology. The differences in the width of the eye, the height of the face, the chin length, width of the face at eye level, mouth width, width of the face at mouth level, height of the visible eye ball were measured with a 30cm ruler. Analysis of the facial photographs was done using a computer based software program (SPSS **version 25**) using the t-test. T-test was used to determine sexual dimorphism using some simplified mathematical relations to show the

measures of dispersion. These included the mean, standard error of mean and standard deviation. The ranges and mean \pm standard deviations were calculated for each angle and unpaired students t-test was calculated to find out the differences of facial parameters between the females in their different phases of menstrual cycle. A p value < 0.05 was set as statistically significant.

Results

Facial parameters during menstrual and ovulatory phases

Results showed the mean value, standard error mean (SEM), standard deviation (STD) of each of the facial parameters during the menstrual and ovulatory phases. The values of measured parameters showed no significance in all measured groups at $P < 0.05$ (Table 1).

Table 1: Descriptive statistics and T test for inference of measured facial parameters of females during the phases of their sexual cycle

Parameters	Phase	Mean	SEM	STD	T	Df	Sig.(2-tailed)	Inference
WE	Menstruation	5.01	0.09	0.53	-.108	35	.914	NS
	Ovulation	5.03	0.11	0.68				
WFEL	Menstruation	20.08	0.25	1.48	-.188	35	.852	NS
	Ovulation	20.15	0.39	2.31				
MW	Menstruation	8.07	0.16	0.95	.397	35	.693	NS
	Ovulation	7.97	0.20	1.22				
WFML	Menstruation	16.36	0.26	1.54	-.051	35	.960	NS
	Ovulation	16.38	0.34	2.02				
THF	Menstruation	28.57	0.44	2.67	.417	35	.680	NS
	Ovulation	28.29	0.69	4.12				
CL	Menstruation	4.22	0.13	0.79	-.706	35	.485	NS
	Ovulation	4.32	0.14	0.81				
HVE	Menstruation	1.44	0.06	0.35	.373	35	.711	NS
	Ovulation	1.42	0.07	0.44				

WE= width of eye, WFEL = width of face at eye level, MW = mouth width, WFML = width of face at mouth level, THF = total height of face, CL = chin length, HVE = height of visible eyeball. NS= not significance.

Comparison of Cunningham's proportion for ideal beautiful face with obtained facial proportions

The comparison of Cunninghams proportion for ideal beautiful face with obtained facial proportions of females during phases of their sexual cycle; Pairs 1,2,3 showed differences in the

comparison of Cunninghams proportion for ideal beautiful face while pair 4 which is the width of face at mouth level and width of mouth which showed perfect alignment with the postulated proportions at both phases of sexual cycle (Table 2). Table 3 shows the standard for drawing inferential comparison for degree of beauty with an ideal beautiful face.

Table 2: Comparison of Cunningham’s proportion for ideal beautiful face with obtained facial proportions of females during phases of their sexual cycle

Variables	Paired Parameters	Measured Parameters	Cunninghams Ideal proportion	Obtained Proportion	Difference in Proportion	Inference
Menstruation	PAIR 1	WFEL	WE	Three-tenth		
	WFEL & WE	20.08	5.01	6.02	One-fourth	1.01 Strong
Ovulation		20.15	5.03	6.05	One-fourth	1.02 Strong
	PAIR 2	THF	CL	One-fifth		
Menstruation	THF & CL	28.57	4.22	5.71	One-seventh	1.49 Strong
		28.29	4.32	5.66	One-seventh	1.34 Strong
Ovulation	PAIR 3	THF	HVE	One-fourteenth		
	THF & HVE	28.57	1.44	2.04	One-twentieth	0.6 Strong
Ovulation		28.29	1.42	2.02	One-twentieth	0.6 Strong
	PAIR 4	WFML	WM	50%		
Menstruation	WFML & WM	16.36	8.07	8.18	50%	0.11 Perfect
		16.38	7.97	8.19	50%	0.11 Perfect

WE =width of eye, WFEL = width of face at eye level, MW= mouth width, WFML = width of face at mouth level, THF = total height of face, CL = chin length, HVE = height of visible eyeball.

Table 3: Standard for comparison for degree of beauty with an ideal beautiful face using Cunninghams Ideal proportion

Difference in Proportionality	Inference
≤ 0	Perfect

1.0 -2.0	Very strong
3.0 - 4.0	Strong
5	Fair
6.0 - 7.0	Weak
8.0 - 9.0	Very Weak
≥ 10	Not Perfect

Correlation of facial proportions of females during the menstrual phase of their sexual cycle

Table 4 shows the correlation of facial proportions of females during the menstrual phase of their sexual cycle. All facial parameters showed a likely hood of correlation but certain parameters showed positive significance. These parameters are the width of eye and width of face at eye level, mouth width and width of face at eye level, width of face at eye level and width of face at mouth level, width of face at mouth level and chin length that are significant at $p < 0.01$ while the width of face at eye level and total height of the face, width of eye and total height of face, mouth width and width of face at mouth level, mouth width and total height of face and total height of face with height of visible eyeball are significant at $p < 0.05$.

Table 4: Correlation of facial proportions of females during the menstrual phase of their sexual cycle

Parameters		WEm	WFELm	MWm	WFMLm	THFm	CLm	HVEm
Wem	Pearson	1	.602**	.411*	.204	.481**	.027	.310

	Correlation							
	Sig.(2-tailed)	.000	.013	.232	.003	.877	.066	
WFELm	Pearson	.602**	1	.595**	.562**	.734**	.076	.418*
	Correlation							
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.662	.011
MWm	Pearson	.411*	.595**	1	.494**	.514**	.246	.118
	Correlation							
	Sig. (2-tailed)	.013	.000	.002	.001	.148	.493	
WFMLm	Pearson	.204	.562**	.494**	1	.377**	.631	.299
	Correlation							
	Sig.(2-tailed)	.232	.000	.002	.023	.000	.076	
THFm	Pearson	.481**	.734**	.514**	.377*	1	.210	.458**
	Correlation							
	Sig.(2-tailed)	.003	.000	.001	.023	.219	.005	
CLm	Pearson	.027	.076	.246	.631**	.210	1	.148
	Correlation							
	Sig.(2-tailed)	.877	.662	.148	.000	.219	.389	
HVEm	Pearson	.310	.418*	.118	.299	.458**	.148	1
	Correlation							
	Sig.(2-tailed)	.066	.011	.493	.076	.005	.389	
	N	36	36	36	36	36	36	36

** Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

WE = width of eye, WFEL = width of face at eye level, MW = mouth width, WFML = width of face at mouth, THF = total height of face, CL = chin length, HVE = height of visible eyeball. Values are expressed as Mean, ** Correlation is significant at the 0.01 level (2-tailed), *Correlation is significant at the 0.05 level (2-tailed)

Correlation of facial proportions of females during the ovulation phase of their sexual cycle

Table 5 shows the correlation of facial proportions of females during the ovulation phase of their sexual cycle. All facial parameters showed a likely hood of correlation but certain parameters showed positive significance. These parameters are the width of eye and width of face at eye level, width of eye and mouth width, width of eye and total height of face, width of face at eye level and width of face at mouth level, width of face at eye level and total height of face, mouth width and width of face at mouth level, width of face at mouth level and total height of face and width of face at mouth level and chin length are significant at $p < 0.01$ while the width of eye and width of face at mouth level, width of eye and height of visible eyeball, mouth width and total height of face are significant at $p < 0.05$.

Table 5: Correlation of facial proportions of females during the ovulation phase of their sexual cycle

Parameters		WEo	WFELo	Mwo	WFMLo	THFo	Clo	HVEo
WEo	Pearson	1	.669**	.652**	.527**	.582**	.231	.465**
	Correlation Sig.(2-tailed)		.000	.000	.001	.000	.176	.004
WFELo	Pearson	.669**	1	.622**	.845**	.732**	.399*	.266
	Correlation Sig.(2-tailed)	.000		.000	.000	.000	.016	.117
Mwo	Pearson	.652**	.622**	1	.665**	.459**	.276	.142
	Correlation Sig.(2-tailed)	.000	.000		.000	.005	.103	.407
WFMLo	Pearson	.527**	.845**	.665**	1	.578**	.575**	.117
	Correlation Sig.(2-tailed)	.001	.000	.000		.000	.000	.497
THFo	Pearson	.582**	.732**	.459**	.578**	1	.321	.392*
	Correlation Sig.(2-tailed)	.000	.000	.005	.000		.056	.018
Clo	Pearson	.231	.399**	.276	.575**	.321	1	.157
	Correlation Sig.(2-tailed)	.176	.016	.103	.000	.056		.361
HVEo	Pearson	.465**	.266	.142	.117	.392*	.157	1
	Correlation Sig.(2-tailed)	.004	.117	.407	.497	.018	.361	
	N	36	36	36	36	36	36	36

** Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

WE =width of eye, WFEL = width of face at eye level, MW = mouth width, W FML = width of face at mouth level, THF = total height of face, CL = chin length, HVE = height of visible eyeball. Values are expressed as Mean. ** Correlation is significant at the 0.01 level (2-tailed), *Correlation is significant at the 0.05 level (2-tailed)

Men's perception of facial beauty of females during their sexual cycle and test for significance

Table 6 shows the descriptive statistics for men's perception of facial beauty of females during their sexual cycle and test for significance using ANOVA which showed that the comparison between the mean frequencies of the perception of females in the phases of their sexual cycle was 95% significant at $p < 0.05$ suggesting that men prefer females in their ovulatory phase.

Table 6: Descriptive statistics of Men's perception of facial beauty of females during their sexual cycle and test for significance using ANOVA

Parameters	N	Frequency	% Frequency	Mean Frequency	SEM	STD	df	F	Sig.	Inference
Menstruation	350	170	48.57	17.99	0.40	3.37	5	3247	.000	**
Ovulation	350	180	51.43	19.00	0.40	3.39	6	.019		

** indicates significant, SEM=standard error of mean STD= standard deviation

Discussion

Photogrammetry has been used over the years in obtaining measurement of objects in a photograph which has evolved from plane table photogrammetry to digital photogrammetry. Its application has been found useful in fields like archaeology, art, medicine where it is used in diagnosis and treatment of human conditions, biomedical research, production of planes of large or complex sites and neuroanatomical sections [1-5, 16].

In this study, photogrammetry was applied in order to evaluate facial attractiveness of females during menstruation and ovulation phases of their sexual cycles. This is to ascertain whether facial beauty/attractiveness maybe deduced as an indicator for ovulation; since unlike other animals that has visible signs of ovulation [14, 15], visible indicators of ovulation is not fully elucidated. Considering the preference of the males which tilts towards the facial picture during the ovulatory phase in this study, it was suggested that enhanced facial beauty/attractiveness could be a biomarker of ovulation as there was positive significant correlation of facial proportions of the subjects during the various phases of their sexual cycle. This corresponds to reports [12, 13] that suggest females are more attractive in the fertile phase of their sexual cycle. The enhanced beauty could be as result of changes in facial texture and shape, since study showed that there are changes in facial texture and shape during the various phases of menstrual cycle which could result to shift in the facial beauty to ovulation [17, 18]. Hormonal system may have also played a role as reports showed increase in melanin secretion which is a hormone of skin coloration which can in turn induce beautification on the skin [19-21].

Conclusion

There was preference of facial photograph of females in their ovulation phase as against menstruation phase which suggests that facial beauty/attractiveness may be used to estimate the sexual cycle of females as enhanced facial beauty/attractiveness could be a biomarker of ovulation.

Ethical Approval and Consent

This study carried out in about 3 months was part of a dissertation in Human Anatomy Department, Gregory University, Uturu, Nigeria and it was performed in accordance to principles of ethics; written consent was obtained from volunteers and subjects' confidentiality was maintained.

References

1. Probst A, Gatzolis D, Strigul N. Intercomparison of photogrammetry software for three-dimensional vegetation modelling. Royal Society open science. 2018;5(7):172192.

2. Düppe K, Becker M, Schönmeyr B. Evaluation of facial anthropometry using three-dimensional photogrammetry and direct measuring techniques. *Journal of Craniofacial Surgery*. 2018;29(5):1245-51.
3. AL-kinani, Y. H. K. (2015). Protect Digital Elevation Model (DTM) from Aerial Photographs by Using (ERDAS IMAGINE). *Engineering and Technology Journal*, 33(8 Part (A) Engineering).
4. Duggal S, Kapoor DN, Verma S, Sagar M, Lee YS, Moon H, Rhee SC. Photogrammetric analysis of attractiveness in Indian faces. *Archives of Plastic Surgery*. 2016;43(02):160-71.
5. D'Alessio R, Laino A, Trunfio TA, Deli R. Measure and comparison of facial attractiveness indices through photogrammetry and statistical analysis. In *Proceedings of the 5th International Conference on Medical and Health Informatics 2021* May 14 (pp. 26-31).
6. Fitzgerald R, Carqueville J, Yang PT. An approach to structural facial rejuvenation with fillers in women. *International Journal of Women's Dermatology*. 2019;5(1):52-67.
7. Elias AS, Gill R. Beauty surveillance: The digital self-monitoring cultures of neoliberalism. *European Journal of Cultural Studies*. 2018;21(1):59-77.
8. Onwuka OM. Prospective loss of human reproductive functionality: an implication of artificial medical intelligence, its invention of sex robot machines and assisted reproductive technology. *Advance Journal of Current Research*. 2023;8(2):1-12.
9. Ajuzie GC, Waxon NO, Onwuka OM. Herbal medicine usage in malaria treatment during pregnancy: practical matters and danger perception among pregnant women in Ahoada town of Nigeria. *Journal of Disease and Global Health*. 2022; 15(2):14-20.
10. SharokhyanRezaee M, Farzinpour A, Farshad A, Hatfaludi T. The regulative effect of *Urtica dioica* on sex hormones imbalance: elevated follicle-stimulating hormone/luteinizing hormone ratio ≥ 4.5 is associated with low performance in aged breeder quails. *Italian Journal of Animal Science*. 2022;21(1):142-52.
11. Samson N, Fink B, Matts PJ. Visible skin condition and perception of human facial appearance. *International Journal of Cosmetic Science*. 2010;32(3):167-84.
12. Roberts SC, Havlicek J, Flegr J, Hruskova M, Little AC, Jones BC, Perrett DI, Petrie M. Female facial attractiveness increases during the fertile phase of the menstrual cycle. *Proceedings of the Royal Society of London. Series B: Biological Sciences*. 2004;271(suppl_5):S270-2.
13. Cobey KD, Buunk AP, Pollet TV, Klipping C, Roberts SC. Men perceive their female partners, and themselves, as more attractive around ovulation. *Biological psychology*. 2013;94(3):513-6.
14. Kreutzer M, Aebischer V. The riddle of attractiveness: looking for an 'aesthetic sense' within the hedonic mind of the beholders. *Current Perspectives on Sexual Selection: What's left after Darwin?*. 2015:263-87.
15. Johnston VS. Mate choice decisions: the role of facial beauty. *Trends in cognitive sciences*. 2006;10(1):9-13.

16. Landi F, O'Higgins P. Applying geometric morphometrics to digital reconstruction and anatomical investigation. *Biomedical Visualisation: Volume 4*. 2019:55-71.
17. Oberzaucher E, Katina S, Schmehl SF, Holzleitner IJ, Mehu-Blantar I, Grammer K. The myth of hidden ovulation: Shape and texture changes in the face during the menstrual cycle. *Journal of Evolutionary Psychology*. 2012; 10(4):163-75.
18. Kiazadeh M, Goncalves G, Shahbazkia HR. Human Ovulation Hidden Hints and It's Effects on Fluctuant Assymetry Studies. In *BIOINFORMATICS 2019* (pp. 281-288).
19. Burriss RP, Troscianko J, Lovell PG, Fulford AJ, Stevens M, Quigley R, Payne J, Saxton TK, Rowland HM. Changes in women's facial skin color over the ovulatory cycle are not detectable by the human visual system. *PLoS One*. 2015; 10(7):e0130093.
20. Samson N, Fink B, Matts PJ. Visible skin condition and perception of human facial appearance. *International Journal of Cosmetic Science*. 2010; 32(3):167-84.
21. Thorstenson CA. The social psychophysics of human face color: Review and recommendations. *Social Cognition*. 2018; 36(2):247-73.