Journal of Pharmaceutical Research International

33(48A): 97-104, 2021; Article no.JPRI.74454
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Evaluation of Blood Pressure and Heart Rate Variability during Different Phases of Menstrual Cycle

T. Srigopika[1], G. Sridevi[2*] and S. Preetha[2]

[1]Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai-600077, Tamilnadu, India.
[2]Department of Physiology, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Chennai-77, TamilNadu, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i48A33224
Editor(s):
(1) Prof. Rafik Karaman, Al-Quds University, Palestine.
Reviewers:
(1) Sudheer Kumar Dokuparthi, Jawaharlal Nehru Technological University Hyderabad, India.
(2) Kiril Stefanov Slaveykov, Trakia University, Bulgaria.
Complete Peer review History: https://www.sdiarticle4.com/review-history/74454

Original Research Article

Received 02 August 2021
Accepted 08 October 2021
Published 06 November 2021

ABSTRACT

Introduction: Every month, between puberty and menopause, a woman's body goes through a number of changes to get it ready for a possible pregnancy. This series of hormone-driven events is called the menstrual cycle. A woman's menstrual cycle is divided into three phases- proliferative phase, secretory phase and menstrual phase. The hormonal surge during each phase causes profound effects on the cardiovascular system as well. However, previous research reported conflicting results in this concept. Thus the controversial statements associating blood pressure and heart rate variability with menstrual cycle promoted this research.
Objective: The aim of this study is to evaluate the blood pressure and heart rate variability during different phases of the menstrual cycle.
Materials and Methods: 20 healthy women belonging to the proliferative, secretory and menstrual phase of the menstrual cycle were analyzed for autonomic functions tests using systolic blood pressure, diastolic blood pressure, pulse rate and heart rate variability.
Results: It showed that there was a statistically significant increase in systolic blood pressure, diastolic blood pressure, and pulse rate during the secretory phase. There was an increase in heart rate variability during the menstrual phase but this was statistically insignificant.

**Corresponding author: E-mail: sridevig.sdc@saveetha.com;*

Conclusion: The study concluded that there were significant changes in blood pressure during the secretory phase and pulse rate and insignificant increase in heart rate variability during the menstrual phase. Thus, the study also concluded that sympathetic nervous activity in the secretory phase is significantly greater than in the proliferative phase, whereas parasympathetic nervous activity is predominant in the proliferative phase.

Keywords: Hormones; autonomic nervous system; proliferative; secretory; menstrual phase.

1. INTRODUCTION

The reproductive system of women shows regular cyclic changes. It lasts for an average of 28 days and contains 2 types of cycles - ovarian and endometrial [1]. Ovarian cycles have follicular phase and luteal phase whereas endometrial cycle has proliferative, secretory and menstruation. Analysis of heart rate variability is a useful tool to assess cardiac autonomic control and the rhythm is controlled by the sino-atrial node [2][3]. Endogenous sex hormones change constantly during menstrual cycle. Estrogen increases halfway through the follicular phase whereas both estrogen and progesterone are elevated during the mid-luteal phase [4]. In women, heart rate variability is related to many factors including endogenous sex hormones, menstrual cycle, menopause, hormone replacement therapy, body mass index and physical conditioning [5]. However it is not confirmed whether in the general population, low heart rate variability is a consequence of disease or an indicator of an underlying mechanism for future disease[6][7]. Our team has extensive knowledge and research experience that has translate into high quality publications[8– 12].

Several of the researches done before had conflicting results. Vishrutha et al noticed a higher sympathetic control during the proliferative phase of menstrual cycle [13] Brar et al concluded a higher parasympathetic control during the proliferative phase of the menstrual cycle [2],[14]. From a physiological point of view, the overall heart rate variability expresses the general capacity of the cardiovascular system to respond to physiological regulations as well as external demands that modulate the heart rate[15-17].

One of the most important reasons for carrying out this research is, although a lot of people have looked into this, their results have always been conflicting [18]. Thus, to have a clearer picture, this study is being carried out. Moreover, it can explain the symptoms of premenstrual syndrome, improves quality of life. It can make women aware of their cardiovascular problems and helps to take precautionary measures during the menstrual phase [19]. Thus, the aim of the study is to evaluate the autonomic functions or cardiovascular status during different phases of the menstrual cycle [20]. The null hypothesis is that there is not much of a heart rate variation during the menstrual cycle and the assumed hypothesis is that there is heart rate variation during menstrual cycle [21].

2. MATERIALS AND METHODS

Normal young and healthy female students, 20 in number, with anthropometrically matched variables were chosen for this study, from Saveetha Dental College and Hospitals, Poonamallee, Chennai. The Institutional human ethical committee has given ethical clearance for the present study as it does not involve invasive procedures. After explaining the experimental procedure and making the subjects fully aware of their role in the project, informed consent was obtained from them. Those with a history of irregular menstrual cycles, hypertension, diabetes mellitus, cardio-respiratory disorders, practicing yoga or any respiratory exercises were excluded from the study.

The students were assessed under three different conditions- proliferative, secretory, menstrual phase. The students were assessed for systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial pressure, pulse rate, heart rate variability.

Systolic blood pressure (SBP), Diastolic blood pressure (DBP) was recorded using a sphygmomanometer. Pulse pressure (PP) was noted as the difference between SBP and DBP. Mean arterial pressure was noted using the formula DBP+⅓xPP. The pulse rate was noted for 1 minute. The Heart rate variability was recorded continuously in Lead II by using an ECG machine (VESTA 301i electrocardiograph) in lying posture (10 waves), while getting up and after standing (60 waves). HRV was calculated as a 30:15 ratio, i.e. the longest RR interval in the 30th heartbeat divided by the shortest RR

interval in the 15th heartbeat after standing. And then, differences and variations were analyzed.

2.1 Statistical Analysis

Data were entered in an Excel spreadsheet and were analyzed using descriptive analysis and one way ANOVA. SPSS version 23 was used to carry out the test. Independent variables include age, gender, profession, educational and socioeconomic status and dependent variables include dietary habits and types of communities.

3. RESULTS

Table 1. The table below represents the different parameters and the respective mean ± standard deviation values of the different phases in the menstrual cycle

Parameters	Proliferative phase	Secretory Phase	Menstrual Phase
Systolic Blood pressure	103 ± 5	117 ± 6.6 *	100 ± 7
Diastolic Blood pressure	77 ± 6.2	83 ± 4.7 *	67.7 ± 8.3
Pulse rate	68 ± 4.3	75 ± 8.4*	70 ± 0.8
Pulse pressure	32 ± 6.2	32 ± 4.4	33 ± 5
Mean arterial pressure	106 ± 5	108 ± 6 *	105 ± 5.2
Heart rate variability	1.08 ± 0.0	1.07 ± 0.0	1.09 ± 0.0

The values are expressed as mean ± standard deviation. The asterisk represents statistical significance p < 0.05 in the secretory phase when compared to the proliferative and menstrual phase.

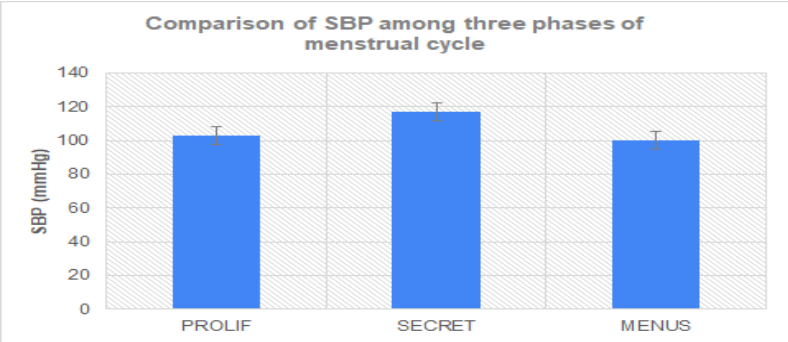

Fig. 1. The above bar graph represents the comparison of systolic blood pressure during the three phases of the menstrual cycle. The X axis denotes systolic blood pressure and the Y axis depicts its value.It is observed that there is increased change in systolic blood pressure in the secretory phase when compared to the proliferative phase and menstrual phase with p-value significant at p= 0.000 (p<0.05)

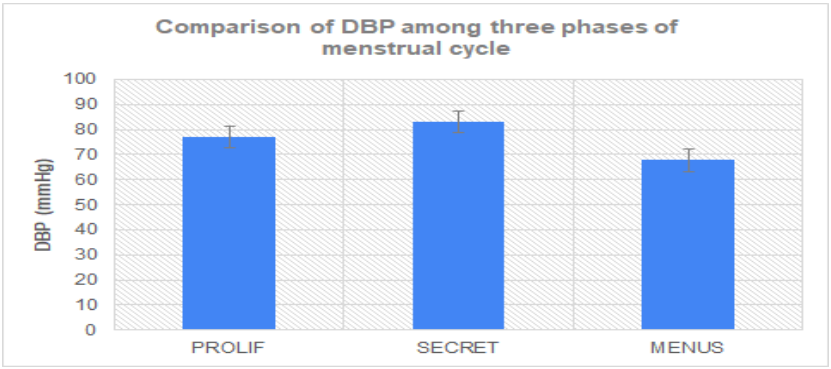

Fig. 2. The above bar graph represents the comparison of diastolic blood pressure during the three phases of the menstrual cycle. The X axis denotes diastolic blood pressure and the Y axis depicts its value. It is observed that there is increased change in diastolic blood pressure in the secretory phase when compared to the proliferative phase and menstrual phase with p-value significant at p= 0.04 (p<0.05)

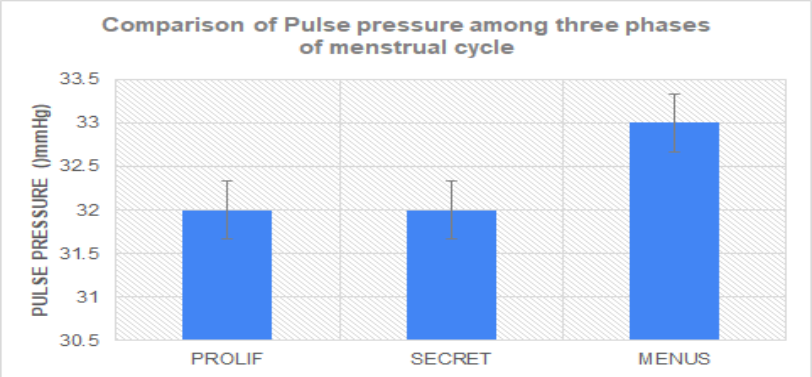

Fig. 3. The above bar graph represents the comparison of pulse pressure during the three phases of the menstrual cycle. The X axis denotes pulse pressure and the Y axis depicts its value. It is observed that there is increased change in pulse pressure in the menstrual phase when compared to the proliferative phase and secretory phase with p-value insignificant at p= 0.925 (p<0.05)

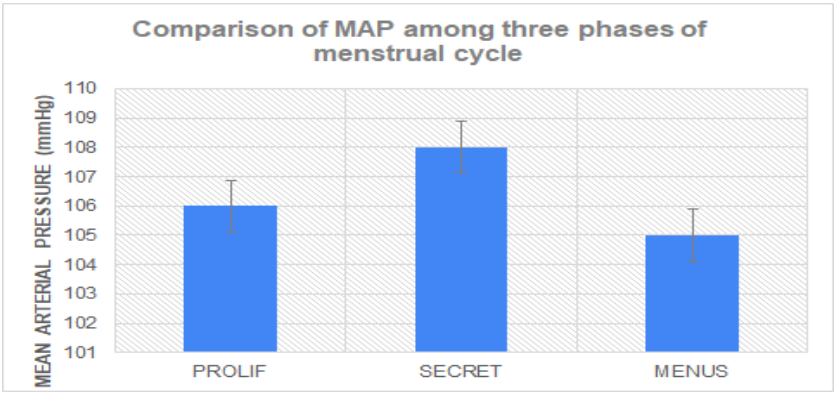

Fig. 4. The above bar graph represents the comparison of mean arterial pressure during the three phases of menstrual cycle. The X axis denotes mean arterial pressure and the Y axis depicts its value. It is observed that there is increased change in diastolic blood pressure in the secretory phase when compared to the proliferative phase and menstrual phase with p-value significant at p= 0.13 (p<0.05)

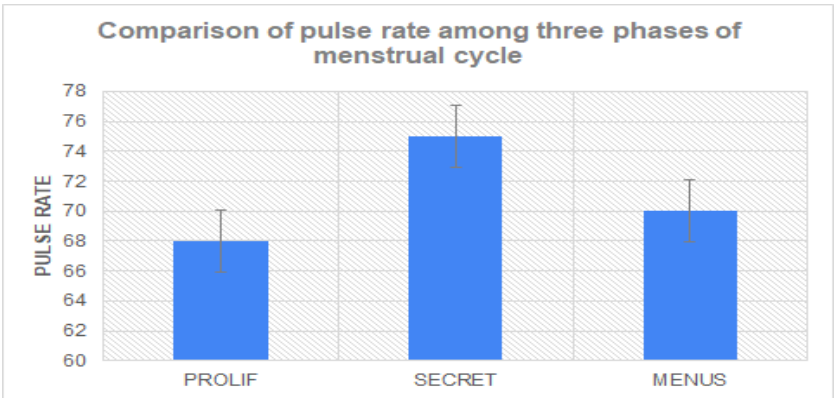

Fig. 5. The bar graph represents the comparison of pulse rate during the three phases of menstrual cycle. The X axis denotes pulse rate and the Y axis depicts its value. It is observed that there is increased change in pulse rate in the secretory phase when compared to the proliferative phase and menstrual phase with p-value significant at p= 0.03 (p<0.05)

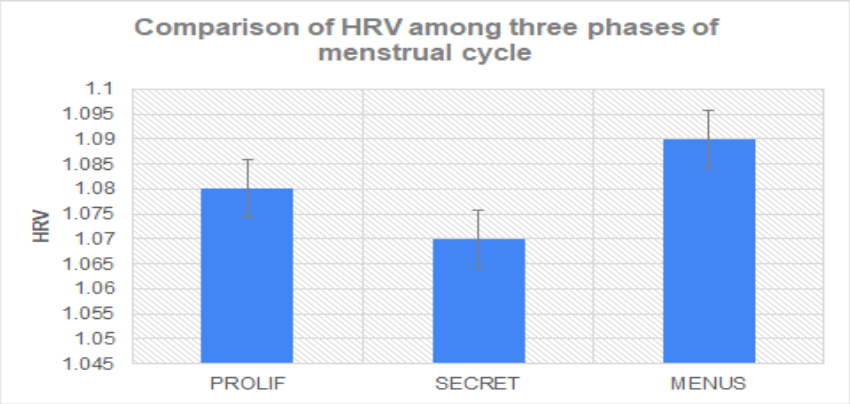

Fig. 6. The above bar graph represents the comparison of heart rate variability during the three phases of menstrual cycle. The X axis denotes heart rate variability and the Y axis depicts its value. It is observed that there is increased change in heart rate variability in the menstrual phase when compared to the proliferative phase and menstrual phase with p-value insignificant at p= 0.895 (p<0.05)

4. DISCUSSION

Researchers have made significant proof showing the association between the influence of female sex hormones and autonomic functional status of heart[22][23]. Autonomic functional status is an important evaluation in the pathogenesis of many cardiovascular conditions like hypertension , myocardial ischemia and cardiac arrhythmias[1,24]. Neurons containing nuclear estrogen receptor (ER) and Membrane binding sites for estrogen, progesterone and testosterone have been identified in brain centers involved in the regulation of cardiovascular functions [25]. Previous reports also suggested that Estrogen receptor β gene expression predominates in human vascular smooth muscle cells (VSMCs) [26].

Also reports suggested that in women, endogenous female sex hormones, like estrogens, are cardioprotective in nature [27]. They act via multiple mechanisms like increased high-density lipoprotein, decreased low-density lipoprotein , and increased release of vasodilators such as nitric oxide (NO) and prostacyclin (PGI_2) from vessel walls and inhibition of vascular constriction and lowering of blood pressure and decreased platelet aggregation. This might be the cause of changes in blood pressure, heart rate during different phases of menstrual cycle[28][29].

Differences in the autonomic system among genders may be attributed to the differences in afferent receptor stimulation, central reflex transmission and the efferent pathways in post synaptic signalling [30] Also there were many differences in the size or number of neurons, variations in receptors, neurotransmitter content and metabolism as well [31]. It has also been postulated that alterations in sex hormones can cause cardiovascular abnormalities and ultimately lead to atherosclerotic Cardiovascular disease [32].

Heart rate variability in systolic blood pressure is high in the secretory phase according to the results of this study and this falls in line with another research finding that states that significant increase in systolic blood pressure during onset of maturation [33]. However, there is a decrease in morning systolic blood pressure in the luteal phase. Overall, the morning diastolic blood pressure is less and there is a decrease in systolic blood pressure in the luteal phase [34]. There is an increase in the morning systolic and diastolic blood pressure at the onset of menstruation. The fact that systolic blood pressure increases during the luteal phase is not confirmed [35].

Similarly there is increased sympathetic modulation and decreased parasympathetic modulation in the luteal phase. No significant changes were found on vagal modulation for follicular and luteal phases [36]. Studies carried out by [37],[2] and[38], showed an increased sympathetic activity in the secretory phase, similar to the findings of this study.

However, there is significant increase in the sympathetic activity in the luteal phase in studies conducted by [39] and[40]. Also, there was

increased parasympathetic modulation in the luteal phase in a study done by [41].

4.1 Future Scope of the Study

The future scope involves more research in the area of study using further tests on autonomic functions and this research would help in improving the quality of life of women and would help them in taking few precautions around the time of menstruation in case they have any health issues. More research would also allow us to establish relations among the different aspects of health, leading to increased improvement in healthcare.

5. CONCLUSION

Thus, the present study concluded that sympathetic nervous activity in the secretory phase is greater than in the proliferative phase, whereas parasympathetic nervous activity is predominant in the proliferative phase.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

ACKNOWLEDGEMENT

The authors would like to thank the study participants for their participation for their kind cooperation throughout the study and S and S Impex for funding this research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Green synthesis, characterization, antibacterial and biofilm inhibitory activity of silver nanoparticles compared to commercial silver nanoparticles. Inorg Chem Commun. 2021;129:108647.
2. Brar TK. Effect of different phases of menstrual cycle on heart rate variability (HRV). Journal of Clinical And Diagnostic Research;2015. Available:https://doi.org/10.7860/jcdr/2015/13795.6592.
3. Santhakumar P, Roy A, Mohanraj KG, Jayaraman S, Durairaj R. Ethanolic Extract of Capparis decidua Fruit Ameliorates Methotrexate-Induced Hepatotoxicity by Activating Nrf2/HO-1 and PPARγ Mediated Pathways. Indian Journal of Pharmaceutical Education and Research 2021;55:s265–74. Available:https://doi.org/10.5530/ijper.55.1s.59.
4. Yazar Ş, Yazıcı M. Impact of menstrual cycle on cardiac autonomic function assessed by heart rate variability and heart rate recovery. Med Princ Pract. 2016; 25:374–7.
5. Chung M-H, Yang CCH. Heart rate variability across the menstrual cycle in shift work nurses. Journal of Experimental & Clinical Medicine. 2011;3:121–5. Available:https://doi.org/10.1016/j.jecm.2011.04.001.
6. Vallejo M, Márquez MF, Borja-Aburto VH, Cárdenas M, Hermosillo AG. Age, body mass index, and menstrual cycle influence young women's heart rate variability. Clinical Autonomic Research. 2005;15:292–8. Available:https://doi.org/10.1007/s10286-005-0272-9.
7. Evaluation of the anticancer potential of Hexadecanoic acid from brown algae Turbinariaornata on HT–29 colon cancer cells. J Mol Struct. 2021;1235:130229.
8. Sathish T, Karthick S. Wear behaviour analysis on aluminium alloy 7050 with reinforced SiC through taguchi approach. Journal of Materials Research and Technology. 2020;9:3481–7.
9. Campeau PM, Kasperaviciute D, Lu JT, Burrage LC, Kim C, Hori M, et al. The genetic basis of DOORS syndrome: an exome-sequencing study. Lancet Neurol. 2014;13:44–58.
10. Dhinesh B, Niruban Bharathi R, Isaac Joshua Ramesh Lalvani J, Parthasarathy M, Annamalai K. An experimental analysis on the influence of fuel borne additives on the single cylinder diesel engine powered by Cymbopogon flexuosus biofuel. J Energy Inst. 2017;90:634–45.
11. Parthasarathy M, Isaac Joshua Ramesh Lalvani J, Dhinesh B, Annamalai K. Effect of hydrogen on ethanol-biodiesel blend on

performance and emission characteristics of a direct injection diesel engine. Ecotoxicol Environ Saf. 2016;134:433–9.
12. Gopalakannan S, Senthilvelan T, Ranganathan S. Modeling and optimization of edm process parameters on machining of Al 7075-B4C MMC using RSM. Procedia Engineering. 2012;38:685–90.
13. Rajakumari R, Volova T, Oluwafemi OS, Rajesh Kumar S, Thomas S, Kalarikkal N. Grape seed extract-soluplus dispersion and its antioxidant activity. Drug Dev Ind Pharm. 2020;46:1219–29.
14. James T, Sunil N. Heart rate variability in different phases of menstrual cycle among healthy medical students of a teaching institution, South India. National Journal of Physiology. Pharmacy and Pharmacology. 2020;1.
Available:https://doi.org/10.5455/njppp.2020.10.03064202022032020.
15. Clarizia G, Bernardo P. Diverse Applications of Organic-Inorganic Nanocomposites: Emerging Research and Opportunities: Emerging Research and Opportunities. IGI Global; 2019.
16. Saraswathi I, Saikarthik J, Senthil Kumar K, Srinivasan KM, Ardhanaari M, Gunapriya R. Impact of COVID-19 outbreak on the mental health status of undergraduate medical students in a COVID-19 treating medical college: a prospective longitudinal study. Peer J. 2020;8:e10164.
Available:https://doi.org/10.7717/peerj.10164.
17. R H, Hannah R, Ramani P, Ramanathan A, Jancy MR, Gheena S, et al. CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo[a]pyrene. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2020;130:306–12.
Available:https://doi.org/10.1016/j.oooo.2020.06.021.
18. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. Journal of Oral Pathology & Medicine. 2019;48:299–306.
Available:https://doi.org/10.1111/jop.12835
19. Tahmasebi S, Qasim MT, Krivenkova MV, Zekiy AO, Thangavelu L, Aravindhan S, et al. The effects of oxygen–ozone therapy on regulatory T-cell responses in multiple sclerosis patients. Cell Biology International 2021;45:1498–509.
Available:https://doi.org/10.1002/cbin.11589.
20. Wadhwa R, Paudel KR, Chin LH, Hon CM, Madheswaran T, Gupta G, et al. Anti-inflammatory and anticancer activities of Naringenin-loaded liquid crystalline nanoparticles *In vitro*. Journal of Food Biochemistry 2021;45.
Available:https://doi.org/10.1111/jfbc.13572
21. Vivekanandhan K, Shanmugam P, Barabadi H, Arumugam V, Daniel Raj Daniel Paul Raj D, Sivasubramanian M, et al. Emerging therapeutic approaches to combat COVID-19: Present status and future perspectives. Front Mol Biosci. 2021;8:604447.
22. Prakash AKS, Devaraj E. Cytotoxic potentials of S. cumini methanolic seed kernel extract in human hepatoma HepG2 cells. Environmental Toxicology. 2019;34:1313–9.
Available:https://doi.org/10.1002/tox.22832
23. Wahab PUA, Abdul Wahab PU, Madhulaxmi M, Senthilnathan P, Muthusekhar MR, Vohra Y, et al. Scalpel Versus Diathermy in Wound Healing After Mucosal Incisions: A Split-Mouth Study. Journal of Oral and Maxillofacial Surgery. 2018;76:1160–4.
Available:https://doi.org/10.1016/j.joms.2017.12.020.
24. Egbuna C, Mishra AP, Goyal MR. Preparation of Phytopharmaceuticals for the management of disorders: The development of nutraceuticals and traditional medicine. Academic Press; 2020.
25. Ramirez AJ, Graham J, Richards MA, Cull A, Gregory WM. Mental health of hospital consultants: the effects of stress and satisfaction at work. Lancet. 1996;347:724–8.
26. Lopez-Garcia J, Periyasamy M, Thomas RS, Christian M, Leao M, Jat P, et al. ZNF366 is an estrogen receptor corepressor that acts through CtBP and histone deacetylases. Nucleic Acids Res. 2006;34:6126–36.
27. Ezhilarasan D. Critical role of estrogen in the progression of chronic liver diseases. Hepatobiliary Pancreat Dis Int. 2020;19:429–34.
28. Shabgah AG, Ezzatifar F, Aravindhan S, Zekiy AO, Ahmadi M, Gheibihayat SM, et al. Shedding more light on the role of

Midkine in hepatocellular carcinoma: New perspectives on diagnosis and therapy. IUBMB Life. 2021;73:659–69.
Available:https://doi.org/10.1002/iub.2458.

29. J PC, Pradeep CJ, Marimuthu T, Krithika C, Devadoss P, Kumar SM. Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study. Clinical Implant Dentistry and Related Research 2018;20:531–4.
Available:https://doi.org/10.1111/cid.12609
30. Kamath SM, Manjunath Kamath S, Jaison D, Rao SK, Sridhar K, Kasthuri N, et al. In vitro augmentation of chondrogenesis by Epigallocatechin gallate in primary Human chondrocytes - Sustained release model for cartilage regeneration. Journal of Drug Delivery Science and Technology. 2020; 60:101992.
Available:https://doi.org/10.1016/j.jddst.2020.101992.
31. Diebold AE, Boudreaux JP, Wang Y-Z, Anthony LB, Uhlhorn AP, Ryan P, et al. Neurokinin A levels predict survival in patients with stage IV well differentiated small bowel neuroendocrine neoplasms. Surgery. 2012;152:1172–6.
32. Vitale C, Fini M, Speziale G, Chierchia S. Gender differences in the cardiovascular effects of sex hormones. Fundamental & Clinical Pharmacology. 2010;24:675–85.
Available:https://doi.org/10.1111/j.1472-8206.2010.00817.x.
33. Dunne FP, Barry DG, Ferriss JB, Grealy G, Murphy D. 41. Changes in blood pressure during the normal menstrual cycle. Journal of Hypertension. 1991;9:S439.
Available:https://doi.org/10.1097/00004872-199112006-00232.
34. Mudigonda SK, Murugan S, Velavan K, Thulasiraman S, Krishna Kumar Raja V. Non-suturing microvascular anastomosis in maxillofacial reconstruction- a comparative study. Journal of Cranio-Maxillofacial Surgery. 2020;48:599–606.
Available:https://doi.org/10.1016/j.jcms.2020.04.005.
35. Nambi G, Kamal W, Es S, Joshi S, Trivedi P. Spinal manipulation plus laser therapy versus laser therapy alone in the treatment of chronic non-specific low back pain: a randomized controlled study. Eur J Phys Rehabil Med. 2018;54:880–9.
36. Pestana ER, Mostarda CT, Silva-Filho AC, Salvador EP, de Carvalho WRG. Effect of different phases of menstrual cycle in heart rate variability of physically active women. Sport Sciences for Health. 2018;14:297–303.
Available:https://doi.org/10.1007/s11332-018-0426-5.
37. Matsumoto T, Ushiroyama T, Kimura T, Hayashi T, Moritani T. Altered autonomic nervous system activity as a potential etiological factor of premenstrual syndrome and premenstrual dysphoric disorder. Biopsychosoc Med. 2007;1:24.
38. Bai X, Li J, Zhou L, Li X. Influence of the menstrual cycle on nonlinear properties of heart rate variability in young women. American Journal of Physiology-Heart and Circulatory Physiology. 2009;297:H765–74.
Available:https://doi.org/10.1152/ajpheart.01283.2008.
39. Yildirir A, Kabakci G, Akgul E, Tokgozoglu L, Oto A. The effects of menstrual cycle on cardiac autonomic innervation as assessed by heart rate variability. Journal of the American College of Cardiology. 2002; 39:208.
Available:https://doi.org/10.1016/s0735-1097(02)80922-6.
40. Guasti L, Grimoldi P, Mainardi LT, Petrozzino MR, Piantanida E, Garganico D, et al. Autonomic function and baroreflex sensitivity during a normal ovulatory cycle in humans. Acta Cardiol. 1999;54:209–13.
41. Shaikh S. Evaluation of changes in cardiorespiratory functions during different phases of the menstrual cycle in young women. International Journal of Medical and Biomedical Studies 2020;4.
Available:https://doi.org/10.32553/ijmbs.v4i2.1032.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/74454