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Changes in Refractive and Optometric Findings During Pregnancy

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Abstract

Background: Pregnancy-induced changes in the physiological responses during the gestational period can affect the eye. This study aimed to evaluate the effect of pregnancy on visual, refractive, vergence, and accommodative status.

Methods: In this cross-sectional study, twenty-five healthy pregnant women with a mean age of 29±3.1 were examined. All of the subjects underwent comprehensive ophthalmologic examinations, including anterior segment and fundus examinations and tonometry. Refractive error was determined in each trimester using Autokeratometer. Furthermore, near the point of convergence (NPC), best-corrected visual acuity (BCVA), and near the point of accommodation (NPA) were measured. Data analysis was performed using SPSS version 22. To compare the data during pregnancy, repeated measures analysis of variance (ANOVA) was performed.

Results: During pregnancy, in the right and left eye, spherical equivalent (SE) had a myopic shift from -0.13 to -0.35 D and +0.096 to -0.23 D, respectively (p=0.049 and p=0.020, respectively). Also, in the right and left eyes BCVA significantly decreased from -0.13 to 0.00 and -0.14 to 0.00 LogMAR, respectively (p=0.039 and p=0.045, respectively). NPA and NPC did not change statistically significantly during pregnancy (p=0.385, and p=0.801, respectively).

Conclusion: Due to the unstable hormonal status, a myopic shift and decrease in BCVA occur during pregnancy. So, any change in their spectacle prescription, fitting of contact lenses, performing refractive surgeries, etc., during this period should be postponed.

Keywords: Pregnancy, Visual Acuity, Refractive Error, Myopia

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Introduction

During pregnancy, alterations occur in several organ systems, such as metabolic, cardiovascular, hormonal, immunologic, and hematologic systems (1, 2). The changes in hormonal levels seem to be one of the most important systemic changes during pregnancy. Also, pregnancy-induced changes in the physiological responses during the gestational period can affect the eye. Previous studies have shown that cornea, conjunctiva, crystalline lens, eyelids, etc., can be affected during pregnancy (3-5). It is noteworthy that pregnancy changes can develop new situations or can worsen pre-existing ones (1, 6). When the amount of hormonal activity reaches its peak, some of

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↑***What is "already known" in this topic:***
Pregnancy causes changes in several organ systems such as metabolic, cardiovascular, hormonal, immunologic, hematologic, and especially ocular systems. Pregnant women often have a concern about ocular and visual changes. Therefore, Knowledge of pregnancy-induced changes is necessary for pregnant women, optometrists, and ophthalmologists.

→***What this article adds:***
This study indicates that several changes happen in visual, refractive, vergence, and accommodative during pregnancy. Although some of them are not statistically significant, spectacle prescribing, contact lens fitting, etc. should be performed with caution.

the physiological changes like decreased intraocular pressure (IOP) and corneal sensitivity, development of visual field defect, and an increase in central corneal thickness (CCT) and corneal curvature are usually determinable (6-9). However, the mentioned changes are reversible and return to their normal conditions when all hormonal levels become similar to the pre-pregnant situations (6-9). In addition to ocular structural changes, visual functions may be affected during pregnancy. Decreasing visual acuity (VA) as a usual symptom in pregnancy, may occur because of the presence of refractive error, accommodative disorders, preeclampsia, or any underlying diseases such as diabetes (1, 10-12). According to previous studies, temporary accommodative loss due to accommodative insufficiency and paralysis have been documented both during pregnancy and after delivery (12, 13). Despite ocular and visual changes that have been reported, some studies have not found any significant change in mean corneal curvature, VA, and refractive error measurements during pregnancy (9, 14, 15). According to a study conducted in Iran to show the changes in mean VA in pregnant and non-pregnant situations, VA significantly changes during pregnancy (16). These controversies indicate that further studies will need to evaluate changes in visual and ocular parameters during pregnancy.

Pregnant women must know their refractive, accommodative, and vergence changes during this period. Furthermore, optometrists and ophthalmologists should be able to differentiate between physiologic and pathologic changes in ocular and visual systems and also situations that need management and follow during pregnancy. Also, knowledge about changes during pregnancy is essential to prevent unnecessary management. We assumed that there would be some changes in visual, refractive, accommodative, and vergence status during pregnancy.

According to our knowledge, there is no single study has evaluated the changing refraction, VA, near the point of convergence (NPC), and near the point of accommodation (NPA) during pregnancy in Iran. The aim of the current study was the investigation refractive, VA, NPA, and NPC changes during pregnancy.

Methods

This prospective longitudinal study was performed at Obstetrics and Gynecology private clinic, where pregnant women were referred for routine visits and screening between February 2018 and January 2019. The current study followed the tenets of the Declaration of Helsinki. After explaining the purpose and details of the research to pregnant women, informed consent was attained.

A total of thirty pregnant women enrolled in this study, of which 5 subjects who aborted or did not participate in 2 later examinations were excluded. Thus, the data of 25 pregnant women between 20 to 38 years old were analyzed. Examinations were conducted in the three trimesters of pregnancy. The first, second, and third follow-ups were conducted between 8-11, 13-28, and 31-34 weeks of pregnancy, respectively.

Comprehensive ophthalmic examinations including anterior segment and fundus examination and tonometry, were performed by an experienced ophthalmologist. The inclusion criteria of the present study were the absence of bilateral blindness, systemic and ocular pathologies, previous trauma and eye surgery, no history of systemic and ocular medication except for supplements, and age between 20 to 40 years old without any complicated pregnancy such as diabetes, high blood pressure, etc. Refractive error was determined in each trimester using the RT-7000 Autokeratometer (Tomey Corporation, Nagoya, Japan). Subjects were examined for the determination of best-corrected VA (BCVA) by an experienced optometrist with a chart projector (HCP-7000; Huvitz, Gyeonggi-do, Korea) at 6 meters distance. Then, BCVA, based on the decimal scale of the Snellen VA chart, was converted to a logarithm of the minimum angle of resolution (logMAR) for the statistical analysis. Moreover, NPA and NPC were measured in each trimester (17). NPA was measured using the "push-up" test in such a way that the accommodative target would approach the dominant eye until the patient reports a blurred vision. Then, the desired distance from the external canthus was measured with the ruler. To measure NPC using the "push up" test method, the accommodative target binocularly approaches the eyes until the patient reports diplopia or one or both eyes lose their fixation. This distance was measured from the external canthus to the point of interest as the NPC (17). It should be noted that the spherical equivalent of refractive errors (SE was described as the spherical power in addition to one-half of the cylinder power) was calculated and the results were compared between the two eyes in three periods of pregnancy. To avoid diurnal variation in IOP, all tests were done between 4.00 pm and 6.00 am on every visit by a single optometrist.

Data analyses were performed using SPSS version 22 (IBM Inc., New York, NY, USA). To check the normality of the data the Kolmogorov– Smirnov test was done. The data are reported as mean±standard deviation (SD). To compare the ophthalmic data during pregnancy, repeated measures analysis of variance (ANOVA) was performed. A $P < 0.05$ was considered to be statistically significant.

Results

According to Table 1, in either eye, SE changed to myopic shift (*P*-value for OD and OS, 0.049 and 0.020, respectively). Furthermore, BCVA significantly decreased in both eyes during pregnancy (*P*-value for OD and OS, 0.039 and 0.045, respectively). Our results showed no significant change in NPA and NPC (*P*-value 0.385 and 0.801, respectively).

Mean±SD, range, and comparison of parameters during pregnancy are shown in Table 1.

As shown in Figure 1, during pregnancy, in the right and left eyes SE had a myopic shift from -0.13 to -0.35 D and +0.096 to -0.23 D, respectively [p=0.049 and p=0.020, respectively]. This means that the time has a significant effect on the mentioned parameters. Our results showed that NPA and NPC did not change significantly during pregnancy (Fig. 2), [p=0.385, and p=0.801, respectively]. This means that the time has no significant effect on NPA and NPC.

Table 1. Comparison of refractive, visual, accommodative, and vergence parameters during pregnancy

	First trimester (n=25)	Second trimester (n=25)	Third trimester (n=25)	*P** value
	Mean±SD (Range)	Mean±SD (Range)	Mean±SD (Range)	
SE, right eye (D)	-0.13±0.43 (-0.75 to +1.00)	-0.22±0.42 (-0.88 to +0.75)	-0.35±0.42 (-0.96 to +0.75)	0.049
SE, left eye (D)	0.096±0.33 (-0.50 to +1.00)	-0.11±0.41 (-1.35 to +0.38)	-0.23±0.31 (-1.49 to +0.25)	0.020
NPA (cm)	11.53±3.31 (9 to 21)	11.87±2.64 (9 to 18)	12.02±2.43 (9 to 18)	0.385
NPC (cm)	9.20±1.52 (7 to 12)	7.87±2.03 (5 to 13)	8.13±2.07 (5 to 13)	0.801
BCVA, right eye (LogMAR)	-0.13±0.02 (-0.14 to -0.10)	0.00±0.03 (0.00 to 0.40)	0.00±0.05 (0.00 to 0.60)	0.039
BCVA, left eye (LogMAR)	-0.14±0.01 (-0.14 to -0.12)	0.00±0.06 (0.00 to 0.70)	0.00±0.04 (0.00 to 0.50)	0.045

SE, spherical equivalent; D, diopter, Cm, centimeter; LogMAR, the logarithm of the minimum angle of resolution; BCVA, best-corrected visual acuity; SD, standard deviation. * Repeated measures analysis of variance. Bold values are significant.

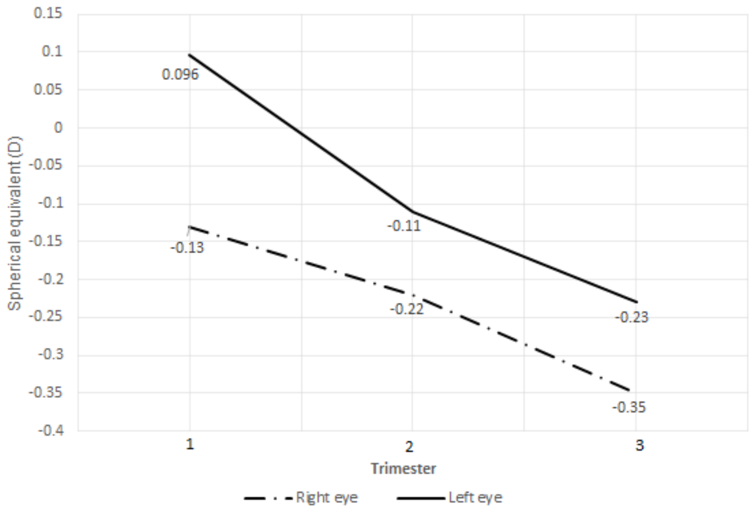

Fig. 1. Changes in spherical equivalent during pregnancy. 1, 2, and 3: first, second, and third trimesters, respectively.

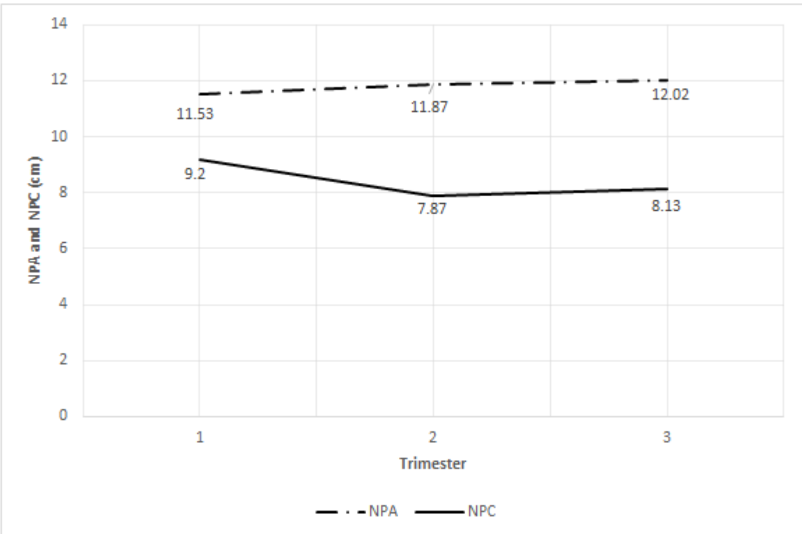

Fig. 2. Changes in near point of accommodation (NPA) and near the point of convergence (NPC) during pregnancy. 1, 2, and 3: first, second, and third trimesters, respectively.

As shown in Figure 3, in the right and left eyes BCVA decreased during pregnancy from -0.13 to 0.00 and -0.14 to 0.00 LogMAR, respectively [p=0.039, and p=0.045, respectively]. This means that the time has a significant effect on the mentioned parameters.

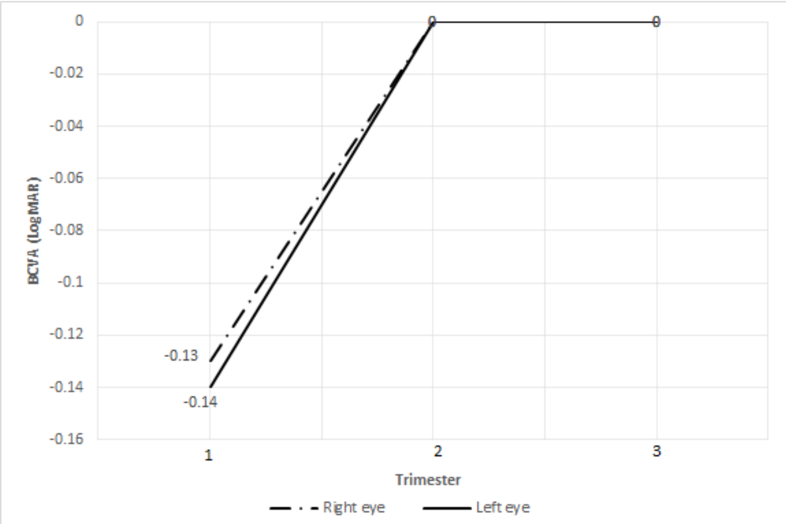

Fig. 3. Changes in best-corrected visual acuity (BCVA) during pregnancy. 1, 2, and 3: first, second, and third trimesters, respectively.

Discussion

Considering visual and ocular changes often occur during pregnancy (5, 18), Our study aimed to evaluate the refractive, visual, NPA, and NPC changes during pregnancy.

As shown in the current study, there was a progressive significant myopic shift from the first to the third trimesters in the right and left eyes. Also, a decrease in the mean distance BCVA was observed in both eyes during pregnancy. Although the distance BCVA decreased from the first to the second trimesters, it did not change from the second to the third trimesters. According to the results, the mean NPA increased during pregnancy but its changes were not significant. Furthermore, the mean NPC decreased from the first to the second trimesters and increased from the second to the third trimesters. However, these changes were not statistically significant. There is numerous published literature with contradictory results on the refractive changes during pregnancy (14, 15, 19-21). Similar to our findings, some authors have found that the mean refractive error tends to myopic shift (19-23). López-Prats et al. (19) evaluated pregnant women who had undergone corneal refractive surgery before pregnancy and pregnant patients with non-surgically corrected the refractive error as a study and control group, respectively. In either group, a myopic shift was reported which was more significant in the study group. They evaluated the refractive changes between the first and second trimesters of the pregnancy period. Meanwhile, the current study was performed across the three trimesters of pregnancy. It is noteworthy that most of the physiologic changes that occur during pregnancy are usually more significant in the third trimester than in other trimesters because hormonal activity reaches its peak at this period (6). Hefetz et al. (24) studied 8 pregnant women who had undergone refractive surgery one year ago. They found out that 2 of the 8 women developed myopic regression, whereas the remaining 6 remained in a stable ocular condition. Sharif et al., (21) conducted a study to evaluate the effect of pregnancy on refractive results after PRK. In this study, three women

became pregnant at least 5 months after the laser refractive surgery, while the others became pregnant just one month after the laser refractive surgery. They found out that pregnancy would not have noticeable effects on refractive results after PRK-type refractive surgery. The changes in refractive error during pregnancy have been attributed to increased levels of estrogen which absorb water (20). Corneal thickness increases due to excessive hydration of the stroma. The excessive hydration occurs because of the activation of estrogen receptors (13). Accordingly, corneal thickening and edematization can lead to myopic progression (9, 22). A previous study has also attributed this refractive change to an increase in the lens curvature following water absorption (25).

Classical belief states that pregnancy causes physiological changes which can temporally increase the refractive error (20, 26, 27) but inconsistent with the current study results, several studies reported no significant changes in refractive error during pregnancy (14, 15, 28-30). Fernández-Montero et al. (28) concluded that pregnancy had an inverse association with the risk of myopia progression. Their rationale for this finding is that the increased time outdoors spent by women during their maternal leave and the fewer times that they spent at work are more probable explanations of the observed inverse association.

A few studies reported a hyperopic shift during pregnancy (31). Comprehensive evaluations showed central serous chorioretinopathy (CSR) due to hormonal changes in pregnancy causing the hyperopic shift (31). So, the change in refractive situation could not have been due to pregnancy-induced corneal thickness because the CCT changes which occur during pregnancy cause a myopic shift (26).

In addition to the refractive changes, variations in BCVA were also evaluated during pregnancy (19, 20, 29).

Similar to the study performed by Mehdizadehkashi et al. (16), the current study showed that distance BCVA significantly reduced during pregnancy. This did not agree with several studies (19, 20, 29).

In the present study, distance BCVA decreased from the first to the second trimesters, but it did not change from the second to the third trimesters. This finding was similar to a study conducted by López-Prats et al. (19) It should be mentioned that they did not evaluate the third trimester. Our finding was not in the same line as several studies which found that the BCVA decreases only in the second and third trimesters (23, 32, 33).

The change in BCVA could be related to the increased level of estrogen and aldosterone which leads to retention of fluid in the cornea, thereby increasing CCT (20, 29).

Accordingly, the myopic shift could be responsible for reduced BCVA found in pregnant women. It seems racial differences, various study protocols, clinical characteristics of the subjects, different sample sizes, and exclusion criteria may cause different findings.

Although evidence demonstrated temporary loss of accommodation capacity (13) during pregnancy, NPA and NPC did not significantly change in the present study. These findings were similar to the studies by Manges et al. (15) and Millodot et al. (34) which report non-significant changes in accommodative and vergence systems of pregnant women.

There are several limitations in the current study. We evaluated changes during pregnancy without evaluating post-pregnancy changes. Because most of the subjects did not participate in the postpartum phase. Also, our study was conducted on a limited sample size. It is recommended that changes should be evaluated after postpartum on large sample size. Furthermore, there is a need for a more comprehensive evaluation of accommodative and vergence functions. It would have been better to topographic and tomographic parameters of these patients as well. Also, it is better to evaluate greater refractive error changes.

Conclusion

because of unstable refraction related to changes in corneal thickness and curvature and crystalline lens, it is recommended to postpone changes in prescription, fitting of contact lenses, and refractive surgeries until several weeks postpartum.

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Conflict of Interests

The authors declare that they have no competing interests.

References

1. Sunness JS. The pregnant woman's eye. Surv Ophthalmol. 1988;32(4):219-38.
2. Thornburg KL, Jacobson S-L, Giraud GD, Morton MJ, editors. Hemodynamic changes in pregnancy. Semin Perinatol; 2000: Elsevier.
3. Gupta P, Johar Sr K, Nagpal K, Vasavada A. Sex hormone receptors in the human eye. Surv Ophthalmol. 2005;50(3):274-84.
4. Suzuki T, Kinoshita Y, Tachibana M, Matsushima Y, Kobayashi Y, Adachi W, et al. Expression of sex steroid hormone receptors in human cornea. Curr Eye Res. 2001;22(1):28-33.
5. Mackensen F, Paulus WE, Max R, Ness T. Ocular changes during pregnancy. Dtsch Arztebl Int. 2014;111(33-34):567.
6. Qureshi IA. Measurements of intraocular pressure throughout the pregnancy in Pakistani women. Chin Med Sci J. 1997;12(1):53-6.
7. Riss B, Riss P. Corneal sensitivity in pregnancy. Ophthalmologica. 1981;183(2):57-62.
8. Weinreb RN, Lu A, Beeson C. Maternal corneal thickness during pregnancy. Am J Ophthalmol. 1988;105(3):258-60.
9. Park SB, Lindahl KJ, Temnycky GO, Aquavella JV. The effect of pregnancy on corneal curvature. CLAO J. 1992;18(4):256-9.
10. Dinn RB, Harris A, Marcus PS. Ocular changes in pregnancy. Obstet Gynecol Surv. 2003;58(2):137-44.
11. Pilas-Pomykalska M, Czajkowskii J, Oszukowski P. Ocular changes during pregnancy. Ginekol Pol. 2005;76(8):655-60.
12. Duke-Elder S. System of ophthalmology V. Ophthalmic optics & refraction. 1970.
13. Sharma S, Rekha W, Sharma T, Downey G. Refractive issues in pregnancy. Aust N Z J Obstet Gynaecol. 2006;46(3):186-8.
14. Akar Y, Yucel I, Akar ME, Zorlu G, Ari ES. Effect of pregnancy on intraobserver and intertechnique agreement in intraocular pressure measurements. Ophthalmologica. 2005;219(1):36-42.
15. Manges TD, Banaitis DA, Roth N, Yolton RL. Changes in optometric findings during pregnancy. Am J Optom Physiol Opt. 1987;64(3):159-66.
16. Mehdizadehkashi K, Chaichian S, Mehdizadehkashi A, Jafarzadepour E, Tamannaie Z, Moazzami B, et al. Visual acuity changes during pregnancy and postpartum: a cross-sectional study in Iran. J Pregnancy. 2014;2014.
17. Goss DA. The Ocular Examination: Measurements and Findings. LWW; 1997.
18. Barbazetto IA, Pizzarello LD. Ocular changes during pregnancy. Compr Ophthalmol Update. 2007;8(3):155-67.
19. López-Prats M, Hidalgo-Mora J, Sanz-Marco E, Pellicer A, Perales A, Díaz-Llopis M. Influence of pregnancy on refractive parameters after laser in situ keratomileusis surgery. Arch Soc Esp Oftalmol (Engl Ed). 2012;87(6):173-8.
20. Pizzarello LD. Refractive changes in pregnancy. Graefes Arch Clin Exp Ophthalmol. 2003;241(6):484-8.
21. Sharif K. Regression of myopia induced by pregnancy after photorefractive keratectomy. J Refract Surg. 1997;13(5):S445-S6.
22. Khalaj M, Mohammadi Zeidi E, Gorbani S, Hashemi F. Assessment of the prevalence of refractive eye error and IOP during pregnancy and after delivery in patients referred to ophthalmology clinic of Boo-Ali Hospital of Qazvin in 1387. J Mazandaran Univ Med Sci. 2010;19(74):25-31.
23. Nkiru ZN, Obiekwe O, Lilian O, Daniel CN, Uchenna IN, Rich U. Visual acuity and refractive changes among pregnant women in Enugu, Southeast Nigeria. J Family Med Prim Care. 2018;7(5):1037.
24. Hefetz L, Gershevich A, Haviv D, Krakowski D, Eshkoly M, Nemet P. Influence of pregnancy and labor on outcome of photorefractive keratectomy. J Refract Surg. 1996;12(4):511-2.
25. Yenerel NM, Küçümen RB. Pregnancy and the eye. Turk J Ophthalmol. 2015;45(5):213.
26. Omoti AE, Waziri-Erameh JM, Okeigbemen VW. A review of the changes in the ophthalmic and visual system in pregnancy. Afr J Reprod Health. 2008;12(3).
27. Schultz KL, Birnbaum AD, Goldstein DA. Ocular disease in pregnancy. Curr Opin Ophthalmol. 2005;16(5):308-14.
28. Fernández-Montero A, Bes-Rastrollo M, Moreno-Montañés J, Moreno-Galarraga L, Martínez-González MÁ. Effect of pregnancy in myopia progression: the SUN cohort. Eye. 2017;31(7):1085-92.
29. Ebeigbe J, Ebeigbe P, Ighoroje A. Ocular changes in pregnant Nigerian women. Niger J Clin Pract. 2012;15(3):298-301.
30. Efe YK, Ugurbas SC, Alpay A, Ugurbas SH. The course of corneal and intraocular pressure changes during pregnancy. Can J Ophthalmol. 2012;47(2):150-4.
31. Ekpenyong BN, Aruotu NA, Uzodike EB, Njoku CG. Clinical investigations and management of refractive changes in pregnancy: a

case report. Afr J Reprod Health. 2015;19(4):107-17.
32. Samra KA. The eye and visual system in pregnancy, what to expect? An in-depth review. Oman J Ophthalmol. 2013;6(2):87.
33. El-Baz HE, Mostafa MM, Abdel Karim AAM. Variations Occurring in Intraocular Pressure and Refraction during Pregnancy. Egypt J Hosp Med. 2018;73(10):7814-20.
34. Millodot M. The influence of pregnancy on the sensitivity of the cornea. Br J Ophthalmol.1977;61(10):646-9.