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The Correlation Between Serum Levels of 25-OH Vitamin D and Ovarian Reserve Parameters in Infertile Women

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ABSTRACT

Background & Objective: There is disagreement about the correlation between serum 25-OH vitamin D (25OH-D) concentrations and ovarian reserve. The aim of this study was to evaluate the correlation between serum levels of 25OH-D and ovarian reserve parameters, including Anti-mullerian hormone (AMH), Follicle stimulating hormone (FSH), and Antral follicular count (AFC) in the tropical zone.

Materials & Methods: In this cross-sectional study, 148 infertile women were enrolled. On the third day of their cycles, vitamin D3, FSH, and AMH were measured. An ultrasound scan was done for the measurement of the ovaries AFC. Participants were divided into women with normal ovarian reserve (NOR) and women with diminished ovarian reserve (DOR). Then two groups were compared based on the levels of vitamin D.

Results: Our findings showed that there were significant differences in vitamin D levels between the DOR and NOR groups (11.52±12.24 and 22.74±12.7, respectively), (P value <0.001). The partial Spearman correlation test depicted an inverse relationship between vitamin D and FSH (rho=-0.21, P =0.009). Also, there was a positive relationship between vitamin D and AMH and AFC, (rho=0.27, P=0.001) and (rho=0.39, P< 0.001) respectively.

Conclusion: This study demonstrated that there was an inverse relationship between levels of vitamin D and FSH and a positive relationship with AMH and AFC. It appears that the level of vitamin D is important in DOR.

Keywords: Vitamin D, Ovarian Reserve, Infertility, Follicle Stimulating Hormone

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Introduction

Vitamin D is a fat-soluble vitamin and belongs to the steroid hormone family **(1)**. 1, 25 Dihydroxy vitamin D is the active form of vitamin D. It acts its biologic effect by receptor vitamin D **(2)**. Vitamin D levels can be classified into severe vitamin D deficiency (<10 ng/mL), vitamin D sufficient (≥30 ng/mL), insufficient (20-29.9 ng/mL), and deficient (<20 ng/mL) **(3-6)**. It is known that vitamin D deficiency increases the risk of diabetes mellitus, obesity, some cancers, cardiovascular diseases, autoimmune diseases, infectious diseases, and depression **(7, 8)**. The evidence shows vitamin D regulates reproduction in males and females **(9)**. Also, we know there is a relationship between reproduction and seasons as the level of vitamin D exposure increases, at least in the winter and at its maximum in the summer **(10)**. The other study found that low exposure to sunlight is associated with earlier onset of menopause **(11)**. Lower levels of vitamin D Infertile women with conditions such as polycystic ovary syndrome (PCOS), endometriosis, leiomyomas, primary dysmenorrhea, and diminished ovarian reserve have been found to have lower levels of vitamin D, which is associated with in vitro fertilization (IVF) outcomes **(12-14)**. Infertility is a complex disorder with effects that are psychiatric, economical and clinical in couples that comprise 15% of the population **(9, 15, 16)**. Evidence shows vitamin D deficiency can lead to dysfunction of insulin secretion, insulin resistance and metabolic disorders like polycystic ovarian syndrome **(17)**. In this manner, a decreased level of vitamin D causes primary ovarian insufficiency **(18)**. So this theory suggests vitamin D may be necessary for primordial follicles and to limit recruitment of follicles (via downregulation of the FSH receptor) **(19)**. The different studies show equivocal results regarding the association between vitamin D and FSH (Follicle stimulating hormone) and AMH (anti-mullerian hormone) **(11)**. The aim of this study was to find the association between the level of vitamin D and ovarian reserve status in reproductively infertile women in the hottest areas.

Methods

Study setting and population

A cross-sectional study was conducted on infertile women. One 148 infertile women were entered in this study from September 2016 to September 2017. Infertility is defined as the lack of pregnancy after one year of regular intercourse without any contraception **(20)**. The study was done in a referral university hospital, south-west of Iran, with an arid climate. The mean temperatures in the hot and cold seasons were 38.6 °C and 12.4 °C respectively.

Informed consent was obtained from all of the patients. This study was approved by the ethics committee of Ahvaz Jundishapur University of Medical Sciences (IRAJUMS.REC .122). All patients had a history of infertility (Table 1) with normal serum prolactin and thyroid function tests. Patients with a history of use of vitamin D, calcium, or other drugs that could interfere with vitamin D metabolism in the prior 3 months, diseases that interfere with vitamin D metabolism, malabsorption, PCOS, hypothalamic amenorrhea, smoking, alcohol use, and a history of ovarian surgery were excluded.

Measurement of FSH, AMH and vitamin D levels

For all the patients, FSH (Monbind Inc.Lake Forest,CA 92630, USA) on the third day were checked by ELISA assay, vitamin D3 (Alegria, Alegria Kit Germany/Orgentec), and AMH (Elecsys Cobas e411, Roche kiet, Germany) were also measured. The within- and between-assay precisions of the FSH in a normal sample were 3.8 % and 8.6%, respectively.

Ultrasound for antral follicle count measurement

For all patients, transvaginal ultrasound was done (Toshiba, Xario 200) for counting antral follicles in both of their ovaries on the third day.

Bologna criteria

All sonographies were performed by the same specialist (with an infertility fellowship). Participants were stratified into two groups: normal ovarian reserve (NOR) and diminished ovarian reserve (DOR). DOR patients were selected based on regular menstrual cycles and the Bologna criteria. Therefore, patients with DOR were included if FSH was more than 10 IU/ml and (AFC <5–7 follicles or AMH <0.5–1.1 ng/ml) listed in Table 1 **(21)**.

Outcome measure

Vitamin D levels were measured in both groups, and the patients were divided into two subgroups based on the level of vitamin D **(5)**, which were divided according to the following levels: normal≥ 20 ng/mL and deficient < 20 ng/ml (Table 1). Then two groups were compared based on the levels of vitamin D and FSH, AMH and AFC.

Statistically analysis

To determine the sample size, the formula for comparing the means was used, in which α=0.05 and β=0.1 and based on the results of a pilot study, x1=18.86, x2=12.99 , s1=12.38, s2=9.11 were considered. The minimum estimated sample size was 74 persons for each group. Statistical analysis was performed using SPSS version 23 (IBM, USA). The data were presented as mean ± standard deviation (SD) or number (percentage). The T-test and chi-square test were utilized to compare quantitative and qualitative variables between groups, respectively. A partial Spearman correlation test was used. For controlling the potential confounding effects, we used logistic regression analysis, where the odds ratio was determined, and the ROC curve was depicted. The conventional p-value of ≤ 0.05 was considered significant.

Table 1. Characteristic data of patients in two groups

Characteristic		[1] DOR	[2]NOR	P value
Number of patients		74	74	
	Primary	36 (48.6)	31 (41.9)	
Infertility type				[6]NS
	Secondary	38 (51.4)	43 (58.1)	
Age (year) (mean ±SD)		34.35±5.85	30.5±5.5	<0.001
BMI (kg/m^2) (mean ±SD)		27.68±3.3	26.72±4.1	NS
Infertility Duration (month)		39.16±40.33	36.26±29.3	NS
[3]FSH (IU/l)		16.9±12.2	5.4±1.6	<0.001
[4]AFC (number)		2.2±0.9	12.3±4	<0.001
[5]AMH (ng/ml)		0.5±0.4	4.2±2.9	<0.001
Serum vitamin D Level (ng/m) (Mean ±SD)		11.52±12.24	22.74±12.7	<0.001

Characteristic	[1] DOR	[2]NOR	P value
Normal vitamin D ≥ 30ng/ml Number (%)	8 (10.81)	38 (51.35)	<0.001
Vitamin D Deficiency <30ng/ml Number (%)	66 (89.18)	36 (48.64)	<0.001

[1] Diminished ovarian reserve, [2] Normal ovarian reserve, [3] Follicle stimulating hormone, [4] Antral follicle count, [5]Anti-Mullerian Hormone, [6] No Significant.

Results

In this study, we assessed two groups of normal ovarian reserve and decreased ovarian reserve based on the ovarian reserve parameters and the level of serum vitamin D. The data for these two groups is shown in Table 1. Independent t tests revealed a significant difference between vitamin D levels in the DOR (11.52±12.24) and NOR (22.74±12.77) groups (P value <0.001). Age was a confounding variable, and we used the partial Spearman correlation test. This test depicted an inverse relationship between vitamin D and FSH (rho =-0.21, P =0.009), positive relationship between vitamin D and AMH and AFC, (rho=0.27, P=0.001) and (rho=0.39), P< 0.001) respectively (Figure 1).

Independent t tests showed that the mean age of the DOR group was higher than the NOR group (34.35 ±5.85 vs. 30.5 ±5.5, P value< 0.001). To control the effect of age and determinants of the pure effect of the level of vitamin D on ovarian reserve, we used logistic regression analysis (Table 2). This analysis defined a protective role of vitamin D for ovarian reserve (adjusted OR: 0.87, 95%CI, 0.82-0.91, P value< 0.0001), which means each one-unit increase of vitamin D decreases diminished ovarian reserve with odds 15%. For the prediction of the level of vitamin D in the decreased ovarian reserve, a ROC curve was drawn. It depicted a serum vitamin D level of 12.75 ng/ml could predict decreased ovarian reserve status (sensitivity 77% and specificity 74.5%) (Figure 2).

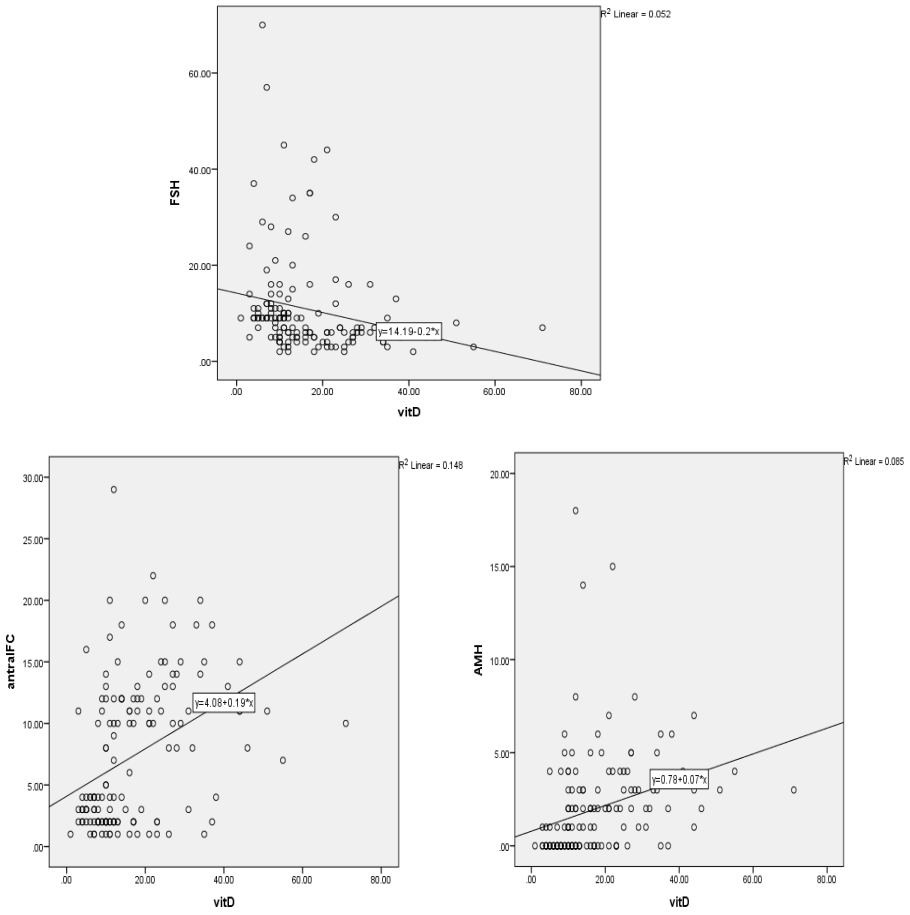


Figure 1. Scatter Diagram of Level of FSH, AMH and AFC with Level of Vitamin D

Table 2. Unadjusted and adjusted Odds Ratio for assess relationship between vitamin D and diminished ovarian reserve.

Variable	Crude Odds Ratio (95%CI)[1]	P value	Adjusted Odds Ratio (95%CI)	P value
Age	1.13 (1.05-1.19)	<0.0001	1.14 (1.06-1.22)	<0.0001
Vitamin D	0.88 (0.83-0.92)	<0.0001	0.87 (0.82-0.91)	<0.0001

[1] Confidence interval

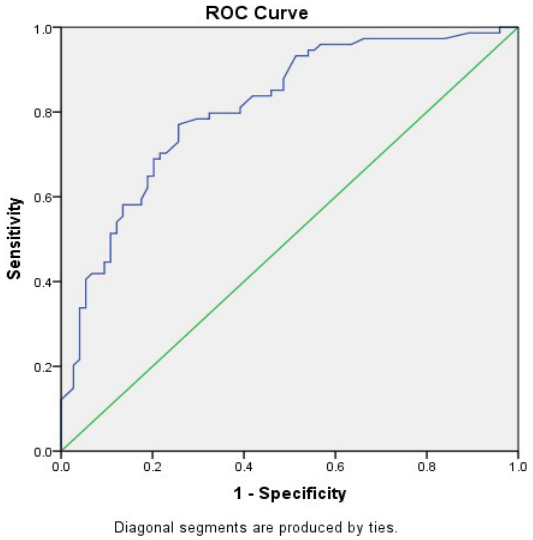


Figure 2. ROC curve level of vitamin D with ovarian reserve status

Discussion

This study showed that the levels of vitamin D had a correlation with parameters of DOR, with an inverse correlation with serum FSH and a positive correlation with AMH and AFC. In accordance with other studies, the lower level of vitamin D was related to the higher level of serum FSH and the lower levels of AMH and AFC, in spite of the hot weather in this region **(22, 23)**. A study involving 1,430 women with uterine fibroids found that among the 527 women over the age of 42, there was an inverse relationship between FSH levels and vitamin D **(22)**. In a multicenter cohort study with 388 non-menopausal women with HIV, there was a relationship between 25 OH-D and AMH in patient ≥40 years of age **(23)**. Consumption of a single oral dose of vitamin D3 led to an increase in the expression of AMH. It was expected that an acute change in the serum levels of 25 (OH) D in young women would be followed by an ongoing rise in their serum AMH levels **(24)**. Another study reported the effect of vitamin D on AMH levels in infertile women. This study was performed on 30 patients with low levels of vitamin D and AMH. Patients were prescribed 50000 IU per week for three months. The level of both of them was increased, and the mean level of vitamin D was higher in the AMH subgroup (level of> 0.7 vs. <0.7) **(25)**. A research analysis found that 25OH-D levels in the follicular fluid of infertile women were related to IVF cycle parameters and outcomes and reflective of vitamin repletion status. They suggested a vitamin D supplement for infertile patients undergoing IVF **(26)**. These studies and our study showed that extending the duration of exposure to lower levels of vitamin D is effective on the reserve of the ovaries. In contrast, in a prospective cross-sectional study on 73 women with a mean age of 33.8 years and no obesity, infertility, or menstrual dysfunction, there was no relationship between FSH, AMH, or vitamin D **(27)**. This difference may be due to the smaller number of participants and the range of ages that were younger than our study. Another study observed no correlation between 25-OH vitamin D and AMH (Spearman's r = 0.02, P value = 0.7) or AFC (Spearman's r = -0.02, P value = 0.7 **(28)**. Another study on 80 infertile women under an IVF/ICSI cycle showed that there was no relation between 25 OD vitamin D follicular fluid and AFC **(29)**.

A recent study found that there is no relationship between vitamin D levels with ovarian reserve in a cohort of infertile women. The authors evaluated whether 25OH-D levels were predictive of AMH levels at three different threshold levels -0.5 ng/mL, 1.0 ng/mL, and 5 ng/ml. They pointed out 25OH-D levels was a poor predictor of AMH in both age subgroups lower and equal or more than 38 years old and three of AMH cut-offs. The difference between our results and

the study may be due to the inclusion criteria of infertile women. In that study, they evaluated FSH and AMH levels with vitamin D in their patients but selection of patients in our study were based on three abnormal ovarian tests (AMH or AFC) and FSH based on Bologna criteria with vitamin D **(30, 31)**. The variation between the results might be also due to the kind of dressing **(32)**. It also may be following the difference ethnicity, kind of region, weather and season, and the time of exposure to ultraviolet. Our study was performed in a region with warm weather and mean heat intensity in summer is 38.6 ˚C that people prefer to stay in a closed space so we could not extend the results to other regions with different context of the weather. In a cross-sectional study in 166 women aged 30–65 years in Saudi Arabia, mean of vitamin D was 20.7 ng/mL (insufficient (20-29.9 ng/mL)) **(6)**. Another study was performed in Brazil on 200 women aged 20 to 40 and 60 to 80 years. They evaluated the effects of duration of sun exposure, amount of exposed skin, and total sun exposure score (TSES) on serum 25OHD concentration. They observed that the mean level of serum 25OHD was 17.60 ± 7.3 ng/mL. Therefore, the sunlight exposure had a weak correlation with serum 25OHD levels and vitamin D intake **(33)**.

Conclusion

This study identified that there was an inverse relationship between levels of vitamin D and FSH and positive relationship with AMH and AFC. It appears the level of vitamin D is important in infertile women especially in patients with decreased ovarian reserve.

We suggest to supplement vitamin D to infertile women especially with ovarian insufficiency. The advantage of this study was to evaluate vitamin D level and ovarian reserve in infertile women in a hot region that it appears we don't have any deficiency of ultraviolet and vitamin D. However, limitation of this study was small sample size and the retrospective design. So, prospective trials are suggested to evaluate the usefulness of vitamin D treatment for infertile women with low vitamin D levels. We also emphasize conducting these studies in different areas with variation of sun expose and heat intensity.

Abbreviation

25(OH) D: 25-hydroxyvitamin D

FSH: Follicular stimulating factor

AMH: Anti-mullerian hormone

AFC: Antral follicular count

DOR: Decreased ovarian reserve

NOR: Normal ovarian reserve

ROC: Receiver operating characteristic

SD: standard Deviation

OD: odd ratio

CI: confidence interval

ELIZA: Enzyme-Linked immunosorbent assay

IVF: In vitro fertilization

ICSI: Intracytoplasmic sperm injection

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Authors' Contribution

RN had substantial contribution to the idea of work. RN, RM, SS and BC had contributions to the design of the research. RN, RM and SS acquired the data. RN, SS and B.C. analyzed and interpreted data. R.N. and SS RM and BC write the manuscript. All authors read and approved the submission.

Conflict of Interest

The authors declare that they have no competing interests.

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Ethics Considerations

This study was approved by ethical committee of Ahvaz Jundishapur University of Medical Sciences (IRAJUMS.REC.122). All patients consent to participate.

References

1. Shahrokhi SZ, Ghaffari F, Kazerouni F. Role of vitamin D in female reproduction. Clin Chim Acta. 2016;455:33-8. [DOI:10.1016/j.cca.2015.12.040] [PMID]
2. Monastra G, De Grazia S, De Luca L, Vittorio S, Unfer V. Vitamin D: a steroid hormone with progesterone-like activity. Eur Rev Med Pharmacol Sci. 2018;22(8):2502-12.

3. Hossein-nezhad A, Holick MF. Vitamin D for Health: A Global Perspective. Mayo Clin Proc. 2013;88(7):720-55. [PMID] [PMCID] [DOI:10.1016/j.mayocp.2013.05.011]
4. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab. 2011;96(7):1911-30. [PMID] [DOI:10.1210/jc.2011-0385]
5. Pagana K, Pagana T, Pagana T. Mosby's Diagnostic & Laboratory Test Reference. 14th edn St. Louis, Mo: Elsevier. 2019.
6. AlFaris NA, AlKehayez NM, AlMushawah FI, AlNaeem AN, AlAmri ND, AlMudawah ES. Vitamin D Deficiency and Associated Risk Factors in Women from Riyadh, Saudi Arabia. Sci Rep. 2019;9(1):20371. [PMID] [PMCID] [DOI:10.1038/s41598-019-56830-z]
7. Aljack HA, Abdalla MK, Idris OF, Ismail AM. Vitamin D deficiency increases risk of nephropathy and cardiovascular diseases in Type 2 diabetes mellitus patients. J Res Med Sci. 2019; 24(1):47. [DOI:10.4103/jrms.JRMS_303_18] [PMID] [PMCID]
8. Migliaccio S, Di Nisio A, Magno S, Romano F, Barrea L, Colao AM, et al. Vitamin D deficiency: a potential risk factor for cancer in obesity?. Int J Obes. 2022;46(4):707-17. [PMID] [DOI:10.1038/s41366-021-01045-4]
9. Luk J, Torrealday S, Neal Perry G, Pal L. Relevance of vitamin D in reproduction. Human reproduction. 2012;27(10):3015-27. [PMCID] [DOI:10.1093/humrep/des248] [PMID]
10. Lerchbaum E, Obermayer-Pietsch B. Vitamin D and fertility: a systematic review. Eur J Endocrinol. 2012;166(5):765-78. [DOI:10.1530/EJE-11-0984] [PMID]
11. Irani M, Merhi Z. Role of vitamin D in ovarian physiology and its implication in reproduction: a systematic review. Fertility and sterility. 2014; 102(2):460-8.e3. [DOI:10.1016/j.fertnstert.2014.04.046] [PMID]
12. Pagliardini L, Vigano P, Molgora M, Persico P, Salonia A, Vailati SH, et al. High prevalence of vitamin D deficiency in infertile women referring for assisted reproduction. Nutrients. 2015;7(12): 9972-84. [DOI:10.3390/nu7125516] [PMID] [PMCID]
13. Panahi Z, Ghalandarpoor-Attar SN, Shabani A, Shariat M, Ghotbizadeh F, Hantoushzadeh S, et al. Maternal Vitamin D Concentration in Mid-pregnancy and Its Effect on Fetal Thymus Size: A Report from a Tertiary Center in Iran. J Obstet Gynecol Cancer Res. 2022;7(6):536-42. [DOI:10.30699/jogcr.7.6.536]
14. Gholami H, Fayazi S, Shirshekan M, Motamed N, Tofighi S. Comparison of Serum level of Vitamin D in Pregnant Women with Preeclampsia and a Control Group in Ayatollah Mousavi Hospital in Zanjan. J Obstet Gynecol Cancer Res. 2022;7(4): 335-40. [DOI:10.30699/jogcr.7.4.335]
15. Thonneau P, Marchand S, Tallec A, Ferial M-L, Ducot B, Lansac J, et al. Incidence and main causes of infertility in a resident population (1 850 000) of three French regions (1988-1989). Hum Reprod. 1991;6(6):811-6. [PMID] [DOI:10.1093/oxfordjournals.humrep.a137433]
16. Wang G, Farzaneh M. Mini review; differentiation of human pluripotent stem cells into oocytes. Curr Stem Cell Res Ther. 2020; 15(4):301-7. [PMID] [DOI:10.2174/1574888X15666200116100121]
17. Thomson RL, Spedding S, Buckley JD. Vitamin D in the aetiology and management of polycystic ovary syndrome. Clin Endocrinol. 2012;77(3): 343-50. [PMID] [DOI:10.1111/j.1365-2265.2012.04434.x]
18. Baird DD, Dunson DB, Hill MC, Cousins D, Schectman JM. Association of physical activity with development of uterine leiomyoma. Am J Epidemiol. 2007;165(2):157-63. [DOI:10.1093/aje/kwj363] [PMID]
19. Steiner AZ, Herring AH, Kesner JS, Meadows JW, Stanczyk FZ, Hoberman S, et al. Antimüllerian Hormone as a Predictor of Natural Fecundability in Women Aged 30–42 Years. Obstet Gynecol. 2011;117(4):798-804. [PMCID] [DOI:10.1097/AOG.0b013e3182116bc8][PMID]
20. Zhao N, Sheng M, Wang X, Li Y, Farzaneh M. Differentiation of human induced pluripotent stem cells into male germ cells. Curr Stem Cell Res Ther. 2021;16(5):622-9. [PMID] [DOI:10.2174/1574888X15666200705214223]
21. Cohen J, Chabbert-Buffet N, Darai E. Diminished ovarian reserve, premature ovarian failure, poor ovarian responder-a plea for universal definitions. J Assist Reprod Genet. 2015;32(12):1709-12. [DOI:10.1007/s10815-015-0595-y] [PMID] [PMCID]
22. Jukic AMZ, Steiner AZ, Baird DD. Association between serum 25-hydroxyvitamin D and ovarian reserve in pre-menopausal women. Menopause. 2015;22(3):312-6. [PMID] [PMCID] [DOI:10.1097/GME.0000000000000312]
23. Merhi ZO, Seifer DB, Weedon J, Adeyemi O, Holman S, Anastos K, et al. Circulating vitamin D correlates with serum antimüllerian hormone levels in late-reproductive-aged women: Women's Interagency HIV Study. Fertil Steril.

2012;98(1):228-34. [PMCID] [DOI:10.1016/j.fertnstert.2012.03.029] [PMID]

24. Dennis NA, Houghton LA, Pankhurst MW, Harper MJ, McLennan IS. Acute supplementation with high dose vitamin D3 increases serum anti-Müllerian hormone in young women. Nutrients. 2017;9(7):719. [DOI:10.3390/nu9070719] [PMID] [PMCID]
25. Naderi Z, Kashanian M, Chenari L, Sheikhansari N. Evaluating the effects of administration of 25-hydroxyvitamin D supplement on serum anti-mullerian hormone (AMH) levels in infertile women. Gynecological Endocrinology. 2018; 34(5):409-12. [DOI:10.1080/09513590.2017.1410785] [PMID]
26. Sebiha Ozkan M, Jindal S, Keri Greenseid M, Jun Shu M, Gohar Zeitlian M, Cheryl Hickmon B, et al. Replete vitamin D stores predict reproductive success following IVF. Fertil Steril. 2010;94(4): 1314-9. [DOI:10.1016/j.fertnstert.2009.05.019] [PMID] [PMCID]
27. Chang E, Kim Y, Won H, Kim M, Lee W, Yoon T. Association between sex steroid, ovarian reserve and vitamin D levels in healthy fertile women. Fertil Steril. 2013;100(3):S326. [DOI:10.1016/j.fertnstert.2013.07.946]
28. Drakopoulos P, van de Vijver A, Schutyser V, Milatovic S, Anckaert E, Schiettecatte J, et al. The effect of serum vitamin D levels on ovarian reserve markers: a prospective cross-sectional study. Hum Reprod. 2017;32(1):208-14. [DOI:10.1093/humrep/dew304]
29. Farzadi L, Bidgoli HK, Ghojazadeh M, Bahrami Z, Fattahi A, Latifi Z, et al. Correlation between follicular fluid 25-OH vitamin D and assisted reproductive outcomes. Iran J Reprod Med. 2015; 13(6):361-6. [PMID] [PMCID]
30. Shapiro AJ, Darmon SK, Barad DH, Gleicher N, Kushnir VA. Vitamin D levels are not associated with ovarian reserve in a group of infertile women with a high prevalance of diminished ovarian reserve. Fertil Steril. 2018;110(4):761-6.e1. [DOI:10.1016/j.fertnstert.2018.05.005] [PMID]
31. Pereira N. Revisiting the relationship between vitamin D and ovarian reserve. Fertil Steril. 2018; 110(4):643. [DOI:10.1016/j.fertnstert.2018.07.001] [PMID]
32. Arefi S, Khalili G, Iranmanesh H, Farifteh F, Hosseini A, Fatemi HM, et al. Is the ovarian reserve influenced by vitamin D deficiency and the dress code in an infertile Iranian population?. J Ovarian Res. 2018;11(1):1-6. [PMID] [PMCID] [DOI:10.1186/s13048-018-0435-7]
33. Bittar FB, Castro CHM, Szejnfeld VL. Screening for vitamin D deficiency in a tropical area: results of a sun exposure questionnaire. BMC Endocr Disord. 2018;18(1):44. [PMID] [PMCID] [DOI:10.1186/s12902-018-0272-0]

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