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# Original Research

## Association Between Vitamin D Levels and Menstrual Irregularities in Women of Reproductive Age

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***ABSTRACT:***

**Background:** Vitamin D, a secosteroid hormone traditionally associated with bone metabolism, has increasingly been implicated in reproductive physiology. Emerging evidence suggests that vitamin D deficiency may contribute to menstrual disturbances through its influence on ovarian folliculogenesis, steroidogenesis, and insulin resistance. Despite its potential role, the correlation between serum vitamin D levels and menstrual irregularities remains underexplored, particularly in women from low- and middle-income countries where hypovitaminosis D is widespread. **Aim:** To investigate the association between serum vitamin D levels and menstrual irregularities among women of reproductive age and to evaluate the prevalence of vitamin D deficiency in this population. **Materials and Methods:** A cross-sectional analytical study was conducted over a 10-month period, involving 300 women aged 18–40 years attending outpatient departments of obstetrics and gynaecology. Participants were categorized into two groups: those with regular menstrual cycles and those with menstrual irregularities (including oligomenorrhea, polymenorrhea, and amenorrhea). After obtaining informed consent, data on demographic characteristics, BMI, and menstrual history were collected. Serum 25-hydroxyvitamin D [25(OH)D] levels were measured using chemiluminescence immunoassay. Vitamin D status was categorized as sufficient (>30 ng/mL), insufficient (20–30 ng/mL), or deficient (<20 ng/mL). Statistical analysis was performed to determine the association between vitamin D levels and menstrual patterns. **Results:** Among the 300 participants, 132 (44%) reported menstrual irregularities. Vitamin D deficiency was observed in 64.4% of those with irregular cycles compared to 35.3% in the regular cycle group. The mean serum vitamin D level was significantly lower in the irregular group (17.2 ± 5.6 ng/mL) compared to the regular group (24.5 ± 6.8 ng/mL; $p<0.001$). A statistically significant inverse relationship was noted between vitamin D levels and the presence of menstrual irregularities ($p<0.001$). No significant correlation was found between BMI and vitamin D status. **Conclusion:** This study demonstrates a strong association between low serum vitamin D levels and menstrual irregularities in women of reproductive age. Vitamin D deficiency appears to be more prevalent among women with disrupted menstrual patterns, suggesting that vitamin D screening and supplementation could be an important consideration in the clinical evaluation and management of menstrual dysfunction.

**Keywords:** Vitamin D, Menstrual Irregularity, Hypovitaminosis D, Reproductive Health, 25(OH)D, Women of Reproductive Age

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## BACKGROUND

Vitamin D is a fat-soluble vitamin that plays an essential role in calcium and phosphate homeostasis and bone mineralization. However, recent advances in endocrinology have expanded its significance beyond skeletal health to include critical roles in immune modulation, cellular proliferation, insulin sensitivity, and reproductive physiology**[1]**. Vitamin D receptors (VDRs) are present in the ovaries, endometrium, and pituitary gland, suggesting a direct influence on reproductive hormone synthesis and menstrual cycle regulation**[2]**.

Menstrual irregularities ranging from oligomenorrhea and polymenorrhea to amenorrhea—are common gynecological concerns that may be reflective of underlying hormonal imbalances, metabolic derangements, or structural pathologies**[3]**. While polycystic ovary syndrome (PCOS), thyroid dysfunction, and hyperprolactinemia are frequently investigated, emerging evidence suggests that vitamin D deficiency may also play a contributory role in the

pathogenesis of menstrual disturbances. Hypovitaminosis D is thought to impair follicular development, reduce progesterone production, and exacerbate insulin resistancemechanisms that can collectively disrupt ovulation and menstrual regularity**[4,5]**.

Globally, vitamin D deficiency affects over a billion people, and its prevalence is especially high in South Asian countries including India. Despite abundant sunlight, cultural practices such as clothing styles, limited outdoor exposure, and dietary insufficiencies contribute to widespread deficiency across all age groups. Reproductive-aged women are particularly vulnerable due to increased physiological demands, and deficiencies during this phase may affect not only their reproductive capacity but also long-term metabolic health**[6,7]**.

Several studies have reported lower vitamin D levels in women presenting with menstrual irregularities, particularly those diagnosed with PCOS. However, there remains a lack of population-based data assessing this association in the general reproductive-age female population, independent of underlying endocrine syndromes. Moreover, inconsistent definitions of menstrual irregularity and varied thresholds for vitamin D deficiency have limited the generalizability of existing literature**[8,9]**.

This study was designed to bridge this gap by examining the association between serum 25-hydroxyvitamin D [25(OH)D] levels and the presence of menstrual irregularities among women aged 18 to 40 years. By identifying the prevalence of hypovitaminosis D in this group and analyzing its correlation with menstrual patterns, this study aims to inform preventive and therapeutic strategies that can improve menstrual health and overall reproductive outcomes.

## AIMS AND OBJECTIVES

This study was conducted to explore the emerging relationship between vitamin D deficiency and menstrual dysfunction in women of reproductive age. With increasing global recognition of vitamin D's role in endocrine and reproductive health, this study sought to generate clinically relevant data to support its evaluation as part of menstrual health assessment.

### Primary Aim

- To assess the association between serum vitamin D levels and menstrual irregularities among women of reproductive age.

### Primary Objective

- To compare the prevalence of vitamin D deficiency between women with regular and irregular menstrual cycles.

### Secondary Objectives

- To determine the mean serum 25(OH)D levels in women with and without menstrual irregularities.
- To evaluate the patterns of menstrual disturbances (e.g., oligomenorrhea, polymenorrhea, amenorrhea) and their correlation with vitamin D status.
- To assess the prevalence of vitamin D deficiency in the overall study population.
- To explore the association between BMI and vitamin D levels in the context of menstrual health.

## MATERIALS AND METHODS

### Study Design and Duration

This was a hospital-based, cross-sectional analytical study conducted over a period of 10 months, from February 2023 to November 2023. The study was carried out in the Department of Obstetrics and Gynaecology at [Institution Name], following approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants.

### Study Population

A total of 300 women aged 18 to 40 years attending outpatient gynecology clinics were recruited consecutively. Participants were divided into two groups based on their menstrual history:

- **Group A**: Women with regular menstrual cycles (cycle length 24–35 days, consistent flow and duration)
- **Group B**: Women with menstrual irregularities (oligomenorrhea, polymenorrhea, amenorrhea, or unpredictable cycles)

### Inclusion Criteria

- Women aged 18 to 40 years
- Naturally menstruating women not on hormonal therapy for the past 3 months
- Willing to provide informed consent

### Exclusion Criteria

- Diagnosed cases of PCOS, thyroid disorders, hyperprolactinemia, or diabetes
- Women on vitamin D supplementation or hormonal therapy
- Pregnant or lactating women
- Women with chronic renal, hepatic, or malabsorptive conditions

### Data Collection

After consent, all participants underwent a structured interview using a pre-tested questionnaire to document:

- Demographics (age, residence, educational status)
- Menstrual history (cycle length, regularity, flow, pain)
- Dietary and sun exposure history
- Physical activity and lifestyle habits

**Anthropometric Measurements**

- Height and weight were measured using standardized protocols.
- BMI was calculated using the formula: weight (kg) / height (m²).
- Participants were categorized into underweight, normal, overweight, and obese as per WHO BMI classification.

**Laboratory Evaluation**

A venous blood sample was collected from all participants in the follicular phase of their menstrual cycle. The following investigations were performed:

- **Serum 25-hydroxyvitamin D [25(OH)D]**: Measured by chemiluminescence immunoassay (CLIA)
- Vitamin D levels were categorized as:
  - **Sufficient**: >30 ng/mL
  - **Insufficient**: 20–30 ng/mL
  - **Deficient**: <20 ng/mL

**Outcome Measures**

- Primary outcome: Association between serum vitamin D levels and menstrual irregularity
- Secondary outcomes: Mean vitamin D levels, prevalence of deficiency, and relationship with BMI

**Statistical Analysis**

All data were entered into Microsoft Excel and analyzed. Categorical variables were expressed as frequencies and percentages. Continuous variables were presented as mean ± standard deviation. The Chi-square test was used to determine the association between categorical variables. Independent t-test was applied to compare mean vitamin D levels between groups. A p-value <0.05 was considered statistically significant.

**RESULTS**

A total of 300 women aged between 18 and 40 years were enrolled in the study, with the objective of examining the correlation between serum vitamin D levels and menstrual regularity. The participants were divided into two groups: those with regular menstrual cycles (n=168) and those with menstrual irregularities (n=132). Detailed analysis included demographic distribution, menstrual patterns, anthropometric indices, vitamin D status, and lifestyle factors. The findings reveal a significant inverse association between serum vitamin D levels and the presence of menstrual irregularities. Women with irregular cycles had significantly lower mean 25(OH)D levels and higher rates of deficiency. The results are summarized in the following tables.

**Table 1. Age-wise Distribution of Participants**

**Table 1** shows the age distribution among the study participants, with the highest number of women in the 26–30 age group.

| Age Group (Years) | Frequency | Percentage |
|---|---|---|
| 18–20 | 54 | 18.0% |
| 21–25 | 76 | 25.3% |
| 26–30 | 88 | 29.3% |
| 31–35 | 49 | 16.3% |
| 36–40 | 33 | 11.0% |

**Table 2. Distribution Based on Menstrual Cycle Regularity**

**Table 2** outlines that 44% of the participants had menstrual irregularities, while 56% reported regular cycles.

| Menstrual Pattern | Frequency | Percentage |
|---|---|---|
| Regular | 168 | 56.0% |
| Irregular | 132 | 44.0% |

**Table 3. Patterns of Menstrual Irregularities Observed**

**Table 3** breaks down the irregular menstrual patterns, with oligomenorrhea being the most common, followed by polymenorrhea.

| Type of Irregularity | Frequency (n=132) | Percentage |
|---|---|---|
| Oligomenorrhea | 72 | 54.5% |
| Polymenorrhea | 39 | 29.5% |
| Amenorrhea | 21 | 15.9% |

**Table 4. BMI Category Distribution Among Participants**

**Table 4** demonstrates that the majority of participants were within the normal BMI range, with no significant variation between groups.

| BMI Category | Frequency | Percentage |
|---|---|---|
| Underweight (<18.5) | 27 | 9.0% |
| Normal (18.5–24.9) | 183 | 61.0% |
| Overweight (25–29.9) | 63 | 21.0% |

| | | |
|---|---|---|
| Obese (≥30) | 27 | 9.0% |

**Table 5. Comparison of Mean Vitamin D Levels Between Groups**
**Table 5** shows a significantly lower mean vitamin D level in women with irregular cycles compared to those with regular cycles ($p<0.001$).

| Group | Mean ± SD (ng/mL) |
|---|---|
| Regular cycles | 24.5 ± 6.8 |
| Irregular cycles | 17.2 ± 5.6 |

**Table 6. Categorization of Vitamin D Status in Both Groups**
**Table 6** demonstrates a higher rate of vitamin D deficiency among women with irregular menstrual cycles.

| Vitamin D Status | Regular (n=168) | Irregular (n=132) |
|---|---|---|
| Sufficient (>30 ng/mL) | 48 (28.6%) | 11 (8.3%) |
| Insufficient (20–30) | 61 (36.3%) | 36 (27.3%) |
| Deficient (<20) | 59 (35.1%) | 85 (64.4%) |

**Table 7. Association Between Vitamin D Deficiency and Menstrual Irregularity**
**Table 7** confirms a statistically significant association between vitamin D deficiency and irregular menstrual cycles ($p<0.001$).

| Status | Vitamin D Deficient | Not Deficient | Total |
|---|---|---|---|
| Irregular Cycle | 85 | 47 | 132 |
| Regular Cycle | 59 | 109 | 168 |

**Table 8. Vitamin D Levels by Type of Menstrual Irregularity**
**Table 8** illustrates that amenorrheic women had the lowest mean vitamin D levels among the irregularity subtypes.

| Type of Irregularity | Mean 25(OH)D (ng/mL) |
|---|---|
| Oligomenorrhea | 18.9 ± 5.4 |
| Polymenorrhea | 16.3 ± 5.7 |
| Amenorrhea | 14.1 ± 4.8 |

**Table 9. Association of Sunlight Exposure with Vitamin D Levels**
**Table 9** indicates that limited sunlight exposure (<30 mins/day) was more common among participants with deficiency.

| Sunlight Exposure | Vitamin D Deficient (n=144) | Not Deficient (n=156) |
|---|---|---|
| <30 mins/day | 112 (77.8%) | 59 (37.8%) |
| ≥30 mins/day | 32 (22.2%) | 97 (62.2%) |

**Table 10. Lifestyle and Dietary Habits Across Groups**
**Table 10** shows that sedentary lifestyle and low dietary intake of vitamin D-rich foods were more prevalent in women with irregular cycles.

| Lifestyle Factor | Irregular Cycles (n=132) | Regular Cycles (n=168) |
|---|---|---|
| Sedentary lifestyle | 91 (68.9%) | 78 (46.4%) |
| Low dietary vitamin D | 102 (77.3%) | 89 (53.0%) |

**Table 1** showed the majority of participants were between 21–30 years, representing the peak reproductive age group. **Table 2** revealed that 44% of women reported menstrual irregularities. **Table 3** identified oligomenorrhea as the most common irregularity, followed by polymenorrhea and amenorrhea. **Table 4** indicated most participants had normal BMI, showing no major weight-based bias in the sample. **Table 5** established a significantly lower mean serum vitamin D level in women with irregular cycles. **Table 6** demonstrated that vitamin D deficiency was more prevalent among women with irregular menstruation, especially with 64.4% falling below 20 ng/mL.**Table 7** confirmed a statistically significant inverse relationship between vitamin D status and menstrual irregularity. **Table 8** showed that women with amenorrhea had the lowest mean vitamin D levels among subtypes. **Table 9** linked low sun exposure to higher rates of vitamin D deficiency. **Table 10** emphasized lifestyle factors—particularly sedentary behaviour and low dietary intake—as contributing to both vitamin D deficiency and menstrual disturbances.

## DISCUSSION

This study aimed to explore the relationship between serum vitamin D levels and menstrual irregularities in women of reproductive age**[10]**. The findings revealed

a significant inverse association between vitamin D levels and menstrual cycle regularity, with a notably higher prevalence of vitamin D deficiency among women experiencing menstrual disturbances. These results contribute to a growing body of evidence suggesting that vitamin D may play a regulatory role in female reproductive physiology**[11,12]**.

In the present study, 44% of women reported menstrual irregularities, and among them, 64.4% were found to be vitamin D deficient. This supports the hypothesis that hypovitaminosis D may be an underlying, often overlooked, factor contributing to menstrual dysfunction. Several mechanisms may explain this association**[13]**. Vitamin D receptors are widely distributed in the hypothalamic-pituitary-ovarian axis, and deficiency has been linked to impaired folliculogenesis, altered sex steroid secretion, and insulin resistanceall of which can disrupt menstrual cyclicity**[14]**.

Our finding of significantly lower mean serum vitamin D levels in women with menstrual irregularities (17.2 ± 5.6 ng/mL) compared to those with regular cycles (24.5 ± 6.8 ng/mL) is consistent with studies conducted by Irani and Merhi (2014) and Jukic et al. (2018), which reported similar associations. Notably, the lowest mean levels were observed in women with amenorrhea, further reinforcing the relationship between the degree of deficiency and severity of menstrual dysfunction**[15]**.

Sunlight exposure, an important natural source of vitamin D, was significantly lower among vitamin D-deficient women, with over three-fourths of those deficient receiving less than 30 minutes of sunlight daily. This is particularly relevant in the Indian context, where urbanization, indoor lifestyles, air pollution, and cultural practices limit effective UVB exposure despite geographic abundance of sunlight. In addition, inadequate dietary intake of vitamin D-rich foods was common, especially among women with irregular cycles, highlighting nutritional deficiencies as an exacerbating factor**[16,17]**.

Interestingly, while vitamin D deficiency was clearly associated with menstrual irregularities, there was no significant correlation between BMI and vitamin D status in our study. This differs from findings in some Western populations, where adiposity was a significant determinant of hypovitaminosis D. The discrepancy could be due to the overall leaner body composition of Indian women or differing lifestyle and dietary practices**[18]**.

The study also demonstrated the influence of modifiable lifestyle factors. Women with irregular cycles were more likely to have a sedentary lifestyle and poor dietary habits, suggesting a synergistic effect of behavioural and biochemical factors on menstrual health. These findings support the growing advocacy for lifestyle interventions as a first-line approach in managing menstrual and reproductive disorders**[19]**.

One of the strengths of this study was its focused exclusion of known confounding endocrine disorders like PCOS, thyroid dysfunction, and diabetes, ensuring a more isolated assessment of the vitamin D–menstrual health link. Additionally, robust sample size and standardised laboratory techniques enhanced the reliability of the results**[20]**.

However, the study is not without limitations. Being cross-sectional, it can establish association but not causality. Longitudinal or interventional studies are needed to confirm whether vitamin D supplementation can improve menstrual regularity. Furthermore, dietary intake and sun exposure were self-reported and may be subject to recall bias. Also, seasonal variations in vitamin D levels were not accounted for, which could influence the outcomes.

In conclusion, the study provides compelling evidence supporting the role of vitamin D deficiency as a contributing factor to menstrual irregularities among reproductive-age women. It underlines the need for routine assessment of vitamin D levels in women presenting with unexplained menstrual disturbances and reinforces the importance of public health strategies to address widespread hypovitaminosis D.

## CONCLUSION

This study establishes a significant inverse association between serum vitamin D levels and menstrual irregularities among women of reproductive age. Women with irregular menstrual cycles were found to have markedly lower vitamin D levels and a higher prevalence of deficiency compared to those with regular cycles. These findings highlight vitamin D deficiency as a potential modifiable factor contributing to menstrual dysfunction, independent of common endocrine disorders. Routine screening for vitamin D status, along with lifestyle and nutritional interventions, may serve as a valuable adjunct in the clinical management of women presenting with menstrual irregularities. Larger longitudinal and interventional studies are warranted to further clarify causality and therapeutic implications.

## REFERENCES

1. Łagowska K. The Relationship between Vitamin D Status and the Menstrual Cycle in Young Women: A Preliminary Study. Nutrients. 2018 Nov 11;10(11):1729. doi: 10.3390/nu10111729. PMID: 30423869; PMCID: PMC6265788.
2. Di Bari F, Catalano A, Bellone F, Martino G, Benvenga S. Vitamin D, Bone Metabolism, and Fracture Risk in Polycystic Ovary Syndrome. Metabolites. 2021 Feb 18;11(2):116. doi: 10.3390/metabo11020116. PMID: 33670644; PMCID: PMC7922814.
3. Lerchbaum E, Rabe T. Vitamin D and female fertility. CurrOpinObstet Gynecol. 2014 Jun;26(3):145-50. doi: 10.1097/GCO.0000000000000065. PMID: 24717915.
4. Thomson RL, Spedding S, Buckley JD. Vitamin D in the aetiology and management of polycystic ovary syndrome. ClinEndocrinol (Oxf). 2012 Sep;77(3):343-50. doi: 10.1111/j.1365-2265.2012.04434.x. PMID: 22574874.
5. Reis GV, Gontijo NA, Rodrigues KF, Alves MT, Ferreira CN, Gomes KB. Vitamin D receptor

polymorphisms and the polycystic ovary syndrome: A systematic review. J ObstetGynaecol Res. 2017 Mar;43(3):436-446. doi: 10.1111/jog.13250. Epub 2017 Jan 27. PMID: 28127831.
6. Arab A, Golpour-Hamedani S, Rafie N. The Association Between Vitamin D and Premenstrual Syndrome: A Systematic Review and Meta-Analysis of Current Literature. J Am CollNutr. 2019 Sep-Oct;38(7):648-656. doi: 10.1080/07315724.2019.1566036. Epub 2019 May 10. PMID: 31074708.
7. Zarei S, Mohammad-Alizadeh-Charandabi S, Mirghafourvand M, Javadzadeh Y, Effati-Daryani F. Effects of Calcium-Vitamin D and Calcium-Alone on Pain Intensity and Menstrual Blood Loss in Women with Primary Dysmenorrhea: A Randomized Controlled Trial. Pain Med. 2017 Jan 1;18(1):3-13. doi: 10.1093/pm/pnw121. PMID: 27296057.
8. Jarosz AC, El-Sohemy A. Association between Vitamin D Status and Premenstrual Symptoms. J AcadNutr Diet. 2019 Jan;119(1):115-123. doi: 10.1016/j.jand.2018.06.014. Epub 2018 Sep 1. PMID: 30177298.
9. Karacin O, Mutlu I, Kose M, Celik F, Kanat-Pektas M, Yilmazer M. Serum vitamin D concentrations in young Turkish women with primary dysmenorrhea: A randomized controlled study. Taiwan J Obstet Gynecol. 2018 Feb;57(1):58-63. doi: 10.1016/j.tjog.2017.12.009. PMID: 29458904.
10. Grzechocinska B, Warzecha D, Szymusik I, Sierdzinski J, Wielgos M. 25(OH)D serum concentration in women with menstrual disorders -risk factors for Vitamin D deficiency. Neuro Endocrinol Lett. 2018 Sep;39(3):219-225. PMID: 30431736.
11. Zeynali M, Haghighian HK. Is there a relationship between serum vitamin D with dysmenorrhea pain in young women? J GynecolObstet Hum Reprod. 2019 Nov;48(9):711-714. doi: 10.1016/j.jogoh.2019.03.002. Epub 2019 Mar 18. PMID: 30898624.
12. Singh V, Tamar N, Lone Z, Das E, Sahu R, Majumdar S. Association between serum 25-hydroxy vitamin D level and menstrual cycle length and regularity: A cross-sectional observational study. Int J Reprod Biomed. 2021 Dec 13;19(11):979-986. doi: 10.18502/ijrm.v19i11.9913. PMID: 34977455; PMCID: PMC8717082.
13. Tavakol S, Shakibapour S, Bidgoli SA. The Level of Testosterone, Vitamin D, and Irregular Menstruation More Important than Omega-3 in Non-Symptomatic Women Will Define the Fate of Multiple Scleroses in Future. MolNeurobiol. 2018 Jan;55(1):462-469. doi: 10.1007/s12035-016-0325-1. Epub 2016 Dec 13. PMID: 27966076.
14. Thys-Jacobs S. Vitamin D and calcium in menstrual migraine. Headache. 1994 Oct;34(9):544-6. doi: 10.1111/j.1526-4610.1994.hed3409544.x. PMID: 8002332.
15. Bertone-Johnson ER, Manson JE. Vitamin d for menstrual and pain-related disorders in women: comment on "improvement of primary dysmenorrhea caused by a single oral dose of vitamin d". Arch Intern Med. 2012 Feb 27;172(4):367-9. doi: 10.1001/archinte.172.4.367. PMID: 22371928.
16. Abdollahi R, Abiri B, Sarbakhsh P, Kashanian M, Vafa M. The Effect of Vitamin D Supplement Consumption on Premenstrual Syndrome in Vitamin D-Deficient Young Girls: A Randomized, Double-Blind, Placebo-Controlled Clinical Trial. Complement Med Res. 2019;26(5):336-342. English. doi: 10.1159/000500016. Epub 2019 May 17. PMID: 31104056.
17. Jukic AMZ, Upson K, Harmon QE, Baird DD. Increasing serum 25-hydroxyvitamin D is associated with reduced odds of long menstrual cycles in a cross-sectional study of African American women. FertilSteril. 2016 Jul;106(1):172-179.e2. doi: 10.1016/j.fertnstert.2016.03.004. Epub 2016 Mar 18. PMID: 26997249; PMCID: PMC4930882.
18. Thys-Jacobs S, Alvir MJ. Calcium-regulating hormones across the menstrual cycle: evidence of a secondary hyperparathyroidism in women with PMS. J ClinEndocrinolMetab. 1995 Jul;80(7):2227-32. doi: 10.1210/jcem.80.7.7608284. PMID: 7608284.
19. Ramezani N, Ostadsharif M, Nayeri H. Association of *BsmI* variant of vitamin D receptor gene with polycystic ovary syndrome: A case-control study. Int J Reprod Biomed. 2020 Oct 13;18(10):877-884. doi: 10.18502/ijrm.v13i10.7772. PMID: 33134800; PMCID: PMC7569712.
20. Sachdeva G, Gainder S, Suri V, Sachdeva N, Chopra S. Comparison of the Different PCOS Phenotypes Based on Clinical Metabolic, and Hormonal Profile, and their Response to Clomiphene. Indian J EndocrinolMetab. 2019 May-Jun;23(3):326-331. doi: 10.4103/ijem.IJEM_30_19. PMID: 31641635; PMCID: PMC6683693.