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Original

An ecological study on distribution of vitamin D level among pregnant women of Iran

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Abstract

Introduction: Vitamin D3 is a hormone that acts as immune modulator. Vitamin D deficiency is associated with pregnancy complications such as preeclampsia. Therefore vitamin D deficiency is important in pregnant women.

Objectives: This study is designed to investigate ecological distribution of 25-hydroxy vitamin D (25-OHD) level in the Iranian pregnant women.

Materials and Methods: The present s is an ecological study based on the geographical information presented in previous papers. Ecological map is designed according to northing (X) and easting (Y) of each individual location as well as 25-OHD level as the depth (Z) of the map.

Results: A total of 17 studies were selected from 2005 to 2016. The contour plot showed that eastern and north eastern areas of Iran had higher levels of 25-OHD whereas western and north western areas of Iran showed lower levels of 25-OHD. Around 49.72% of the total area of Iran showed 25-OHD level less than 21.09 ng/mL, 81.91% of the total area showed 25-OHD level less than 25.54 ng/mL and 96.51% of the total area showed 25-OHD level less than about 29.98 ng/mL.

Conclusion: This ecological study with a novel statistical methodology showed that mean of 25-OHD level in pregnant women was less than about 30 ng/mL in more than 96% of the total area of Iran. Because of the association of vitamin D level with pregnancy complications, surveillance interventions are necessary to change the current status.

Keywords: Vitamin D, Pregnancy complications, ecological study

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Introduction

Vitamin D3 (cholecalciferol) is a steroid hormone that acts as a modulator of calcium hemostasis (1). Other than this role, vitamin D3 is a modulator of immune system. Therefore vitamin D deficiency is associated with pregnancy complications including preeclampsia, infertility and low-birth weight (2,3). Vitamin D deficiency is a prevalent condition worldwide (4,5). Vitamin D deficiency is also prevalent among pregnant women (6). The importance of this condition intends physicians and researchers to use vitamin D supplementation. Studies showed that vitamin D supplementation can reduce risk of asthma exacerbation (7), preeclampsia (8) and some other immunological disorders. However this supplementation may not effect risk of cardiovascular disease (9) and may not reduce blood pressure (10). A Cochrane review believes that vitamin D supplementation can reduce risk of preeclampsia, however benefits of routine antenatal supplementation with vitamin D are not clear (11). Immunomodulatory effect of vitamin D3 is attributed to some mechanisms in which one of them is via increasing expression of the forkhead box P3 (FOXP3) a transcriptional factor increasing formation of regulatory T cells (12).

Objectives

Vitamin D3 level is associated with climate conditions. Therefore this study is designed to investigate ecological distribution of 25-hydroxy vitamin D (25-OHD) level in the Iranian pregnant women. Through ecological analysis, 25-OHD level in not investigated areas are estimated and percentage of areas with specific cutoff points of 25-OHD is calculated via software model.

Patients and Methods

Study design

The present work is an ecological study based on the geographical information presented in previous papers. Ecological map is designed according to northing (X) and easting (Y) of each individual location as well as 25-

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Implication for health policy/practice/research/medical education

This study introduces a new statistical method for spatial estimation and calculation of area percentage. In the present study this method was used for estimation of vitamin D level in uninvestigated areas of Iran. This method may be helpful for surveillances.

OHD level as the depth (Z) of the map. The source of geographical coordinates is Google.

Study population

The population of this study consists of Iranian pregnant women who were subjected for evaluation of 25-OHD level during their perinatal visits. To find this population, we used PubMed and Google scholar databases. Studies with sampling time older than 2005 were excluded. For each individual study, 25-OHD level with standard deviation (SD) and the trimester of evaluation were summarized. The geographical situation of Iran is shown in Figure 1.

Ethical issues

Human rights were respected in accordance with the Helsinki Declaration 1975, as revised in 1983. This study is a part of a thesis under supervision of the first author with ethics registration number IR.LUMS.REC.1396.369 in Lorestan University of Medical Sciences.

Statistical analysis

Contour plot was used to graph the ecological map using Stata 14 software (StataCorp LLC, USA). Investigation of not studied places was performed using Shepard interpretation model. This model is used for estimation the depth of missing places in figures which have been previously used in medical imaging such as mammography (13). Estimated area (percentage) of vitamin D deficiency according to different cutoff points was through color threshold analysis with ImageJ software.

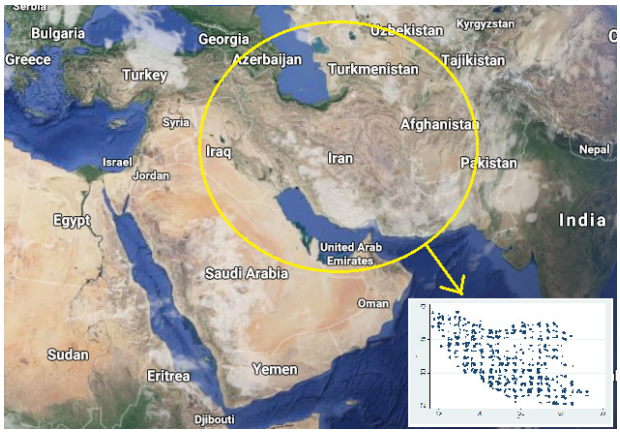

Figure 1. Geographical situation of Iran on earth. Screen from Google map (free to use in reports and presentations including in research papers available from https://www.google.com/permissions/geoguidelines/#maps-print).

Results

A total of 17 studies were selected with years of sampling range of 2005 to 2016 (14-29). The investigated cities were Zanjan, Isfahan, Kashan, Tehran, Booshehr, Shahrood, Mashhad, Rasht, Yazd, Karaj, Semnan, Masjedsoleiman, Shiraz and Qazvin. The sample sizes were from 55 to 1581. The lowest level of 25-OHD was for Zanjan (7.77 ng/mL) and the highest level was for Isfahan (52.20 ng/mL). Most studies were performed during the third trimester of pregnancy (Table 1).

The contour plot shows distribution of 25-OHD level in areas of Iran. Considering this plot, central, eastern and north eastern areas of Iran have higher levels of 25-OHD whereas western and north-western areas of Iran showed lower levels of 25-OHD (Figure 2). The depth of the contour plot was scaled in 20 colored levels. According to this leveling scale, color analysis was performed as the percentage of the selected colors out of the total area. Considering this analysis, 49.72% of the total area showed 25-OHD level less than 21.09 ng/mL, 81.91% of the total area showed 25-OHD level less than 25.54 ng/mL and 96.51% of the total area showed 25-OHD level less than about 29.98 ng/mL. The divided cutoff points are shown (Table 2).

Discussion

The present ecological study was designed to have a spatial estimation of distribution of 25-OHD level and vitamin D deficiency among pregnant women in different areas of Iran. Using this methodology helped us to find a disorder prevalence based on area rather than individuals; because a lot of individuals may live in small places whereas fewer individuals may live in large places. However, both methods are important for governments and surveillances.

The results of this study showed, the pattern of the distribution of 25-OHD level. Higher levels of 25-OHD in central and eastern areas of Iran may be due to better sun exposure of people in such places. If we consider 25-OHD <20 ng/mL as the vitamin D moderate deficiency cutoff point, and as we found that in 49.72% of the total area of Iran pregnant women have mean of 25-OHD less than 21.09 ng/mL, we can interpret that most of the pregnant women in 49.72% of the total area of Iran have moderate vitamin D deficiency. If we consider 25-OHD <25 ng/mL as the vitamin D mild deficiency cutoff point, and as we found that in 81.91% of the total area of Iran pregnant women have mean of 25-OHD less than 25.54 ng/mL, we can interpret that most of the pregnant women in 81.91% of the total area of Iran have mild or moderate vitamin D deficiency. Considering 25-OHD <30 ng/mL as the vitamin D insufficiency cutoff point, we found that in 96.51% of the total area of Iran, pregnant women had mean of 25-OHD less than 29.98 ng/mL. Thus, we can interpret that most of the pregnant women in 96.51% of

Table 1. Summary of the data obtained from previous papers

Author	Year of sampling	City	Coordinate		Sample size	25-OHD level (ng/mL)		Trimester	Reference
			Y	X		Mean	SD		
Kazemi	2005	Zanjan	36.68	48.50	67	7.77	1.56	3rd	(14)
Salek	2005	Isfahan	32.65	51.66	88	52.20	35.64	3rd	(15)
Asemi	2008	Kashan	33.98	51.41	142	14.66	7.55	3rd	(16)
Asadi	2011	Tehran	35.68	51.38	186	11.68	0.12	3rd	(17)
Khalesi	2011	Tehran	35.68	51.38	107	12.60	8.01	3rd	(18)
Hatami	2012	Booshehr	28.76	51.51	100	13.50	10.78	3rd	(19)
Abasian	2013	Shahrood	36.40	55.01	284	28.59	11.75	3rd	(20)
Akhlaghi	2013	Mashhad	36.26	59.61	190	27.25	4.0	3rd	(21)
Jaefarzadeh	2013	Shahrood	36.40	55.01	64	24.10	39.50	2nd	(22)
Jaefarzadeh	2013	Shahrood	36.40	55.01	155	25.9	45.60	1st	(22)
Mirbolouk	2013	Rasht	37.26	49.58	179	15.6	9.8	All	(23)
Pirdehghan	2013	Yazd	31.89	54.35	200	20.3	10.8	3rd	(24)
Hosseinzadeh	2014	Karaj	35.84	50.93	151	10.64	5.96	3rd	(25)
Rahbar	2014	Semnan	35.57	53.37	180	25.88	18.05	1st	(26)
Rostami	2014	Masjedsoleiman	31.96	49.28	1581	13.05	6.36	1st	(27)
Dabbaghmanesh	2015	Shiraz	29.59	52.58	132	12.28	6.18	2nd	(28)
Abotorabi	2016	Qazvin	36.27	49.99	55	19.6	6.8	2nd	(29)

25-OHD: 25-hydroxy vitamin D; SD: standard deviation.

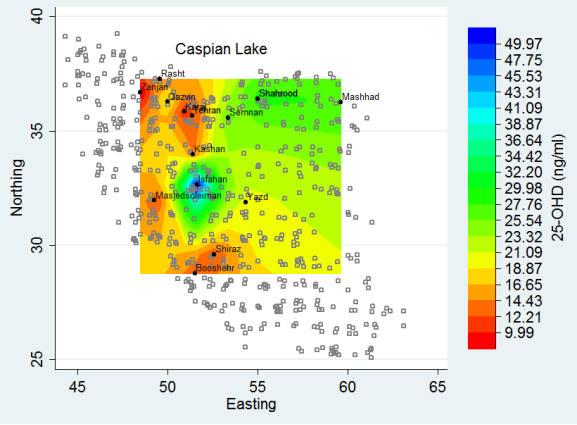

Figure 2. Contour plot of geographical distribution of vitamin D level among pregnant women of Iran. The black dots show the cities with data. Estimation of other places are via Shepard interpolation model. Z axis shows 25-OHD level (ng/mL).

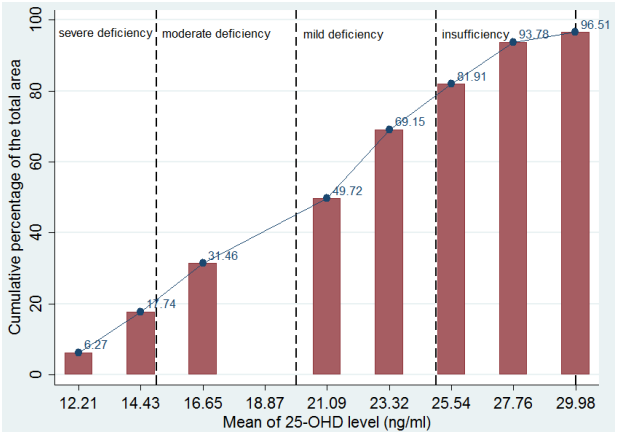

Figure 3. Cumulative percentage of the total area for individual amounts of 25-OHD.

Table 2. Estimated area of vitamin D deficiency (insufficiency) in Iran based on different cutoff points (calculated by ImageJ software)

25-OHD cutoff (ng/mL)	Estimated area (%)
<12.21	6.27
<14.43	17.74
<16.65	31.46
<21.09	49.72
<23.32	69.15
<25.54	81.91
<27.76	93.78
<29.98	96.51

the total area of Iran have mild or moderate vitamin D deficiency or vitamin D insufficiency (Figure 3).

So far, spatial and ecological studies have not been commonplace in Iran. Farhud et al performed an ecological study on the status of vitamin D in Iran. They found that the total level of vitamin D in Iran was 25.41 ng/mL. Their ecological distribution of 25-OHD level was different from our study (30). It may be due to that they used laboratory results instead of the data of previous studies. Additionally, our study was for pregnant women. Although the results of our study were controversial, this study introduced a new method for spatial estimation and calculation of area percentage.

Conclusion

This ecological study with a novel statistical methodology showed that mean of 25-OHD level in pregnant women was less than about 30 ng/mL in more than 96% of the total area of Iran. Because of the association of vitamin D level with pregnancy complications, surveillance interventions are necessary to change the current status. Ecological studies should be performed for prevalence of pregnancy complications such as preeclampsia.

Limitations of the study

Since the source of data was previous studies, there were a lot of provinces with missing area. However we were trying to introduce a new statistical method to detect distribution of vitamin D level among pregnant in this country.

Acknowledgements

This study is a part of a thesis under supervision of the first author with ethics registration number IR.LUMS.REC.1396.369. Since it was not a primary research, the ethics committee did not consider this work for separate evaluation. We thank Seyed Amir Yasin Ahmadi for his statistical analysis.

Authors' contribution

SA: supervision and design; FS: search and primary draft; SERA: Laboratory consultant and revision.

Conflicts of interest

The authors declare no conflict of interest.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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None.

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