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Original paper

# A pilot study on 25-hydroxyvitamin D status according to sun exposure in pregnant women in Antwerp, Belgium

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*Abstract*

*Introduction:* Vitamin D deficiency in utero or early neonatal life may have a major impact on children's health. Little is known on vitamin D deficiency in pregnant women in Belgium, non on the impact of wearing head and/or body cover.
*Objectives:* This was a preliminary exploration of the vitamin D status in pregnant women visiting the antenatal clinic in the Antwerp University Hospital.
*Method:* From August 1 2009 until November 30 2009 we systematically determined 25-hydroxy vitamin D (25-OH vitamin D) in each blood sample taken from pregnant women visiting the antenatal clinic. We also registered the degree of head/body cover and inquired for intake of vitamin supplements.
*Results:* Our population consisted of 171 women, mostly primiparous, of which 86% were not covered. The mean value of 25-OH vitamin D was 28 ng/ml. Non-covered women had a mean of 29,5 ± 12,2 (SD) ng/ml, the partially covered group had a mean of 17,2 ± 7,2 (SD) ng/ml and the completely covered group had a mean of 22,5 ± 12,9 (SD) ng/ml. The difference in serum concentrations between the 3 groups was statistically significant (Anova, $p < 0,00001$). There were significantly more covered than non-covered women with a vitamin D concentration lower than 30 ng/ml (OR6.2; 95% CI: 1,8-21,7; $p < 0,05$).
There was no effect of gestational age, maternal age, gravidity, parity and intake of supplements on vitamin D levels. There was a siginificant seasonal effect from summer to fall, with Vitamine D levels lowering from August to November (linear regression, $p < 0,05$).
*Conclusion:* Low vitamin D levels seem to be frequent and covered woman are at a higher risk of deficiency.

*Key words:* Pregnancy, vitamin D, fetus, nutritional intake, antenatal care.

## Introduction

Vitamin D is a fat-soluble vitamin obtained by the human body in two possible ways. There can be a dietary intake, mainly through fatty fish, eggs and fortified food as well as endogenous production, where transformation of 7-dehydrocholesterol into vitamin D in the skin occurs after exposure to ultraviolet B radiation. In the liver, vitamin D is hydroxylated to 25-hydroxyvitamin D. Subsequent hydroxylation in the kidney forms the active metabolite, 1,25-OH vitamin D.

In pregnancy, there is a 2-fold higher concentration of 1,25-OH vitamin D in maternal serum due to activity of placental 1-α-hydroxylase (Novakovic *et al.*, 2009).

Vitamin D not only influences bone mineralisation but has implications on maternal and fetal well-being. 25-OH vitamin D deficiency is associated with an increased risk of developing preeclampsia (Bodnar *et al.*, 2007; Haugen *et al.*, 2009), multiple sclerosis (Hayes *et al.*, 1997; Pierrot-Deseilligny, 2009) and schizophrenia (McGrath, 1999; McGrath *et al.*, 2003). There is also an association with type 1 diabetes (Stene *et al.*, 2000) and asthma (Brehm *et al.*, 2009; Erkkola *et al.*, 2009; Willers *et al.*, 2007) after deficiency in utero or in early life. Neonates from deficient mothers have lower birthweight

(Mannion *et al.*, 2006; Sabour *et al.*, 2006; Scholl and Chen, 2009) and at age 9 still demonstrate a lower bone mineral content (Javaid *et al.*, 2006). In vitro studies have suggested a protective effect of 25-OH vitamin D against malignancies such as breast-cancer and cancer of the colon. (McCullough, 2007; Thomas *et al.*, 1992).

Risk factors for developing deficiency have been identified; living in northern latitudes, limited sun exposure, dark skin, poor social circumstances and extensive clothing are amongst the most common ones (Baile *et al.*, 1979; Bodnar *et al.*, 2007; Feleke *et al.*, 1999; Islam *et al.*, 2002; McGuire *et al.*, 2009; Mulligan *et al.*, 2009; Sachan *et al.*, 2005; Sahu *et al.*, 2009; Taha *et al.*, 1984; Waiters *et al.*, 1999; Zeghoud *et al.*, 1991). This makes immigrants in northern countries, especially when dark skinned and/or covered, extremely vulnerable (Bowyer *et al.*, 2009; Clifton *et al.*, 2008; Datta *et al.*, 2002; Grover *et al.*, 2001; Henriksen *et al.*, 1995; Madar *et al.*, 2009; Mukamel *et al.*, 2001; Van der Meer *et al.*, 2006; Wielders *et al.*, 2006) (Clemens *et al.*, 1982).

Results of vitamin D status in the pregnant Flemish population have never been published before. This pilot study aims at determining the prevalence of vitamin D deficiency in the Antwerp population.

## Material and Methods

The pilot study ran from August 1, 2009 until November 30, 2009 after approval of the local ethical commitee was obtained. In each blood sample that was taken from pregnant women consulting the antenatal clinic, we determined 25-OH vitamin D. The nurse taking the blood samples put every patient in a category according to their sun exposure. There were three possible categories: not covered, covering of only the head and leaving arms exposed to sun or complete covering with no sun exposure except for the face.

Gestational age, gravidity and the use of vitamin supplements were noted. Because part of the period studied coincided with the month Ramadan, we also asked the women whether they were fasting or not.

Our laboratory uses the Elecsys 25-OH D3 immunoassay (Leino *et al.*, 2008) for determination of 25-OH vitamin $D_3$ levels. This immunoassay is performed on a Modular Analytics E170 apparatus (Roche Diagnostics, Manheimm, Germany). The measuring range is 4-100 ng/ml (10-250 nmol/l), the reference range for hypovitaminosis in our laboratory is < 30 ng/ml, corresponding the health based reference values. Vitamin D levels between 16-20 ng/ml are seen as mild deficiency, 6-16 ng/ml as moderate deficiency and values lower than 6 ng/ml as severe deficiency.

For the statistical analysis, we used SPSS Statistics 17.0 (SPSS Inc., Chicago, Illinois). Normality was tested with the Kolmogorov-Smirnov test, the means of vitamin D between all three groups were compared with Anova-analysis. The means of each group according to exposure were compared with an Independent Samples T-test. To compare the groups of women who used a prenatal vitamin and those who did not we also used the Independent Samples T-test.

Linear regression was used to analyse wether vitamin D level is influenced by gestational age, maternal age, parity, gravidity, sun exposure, intake of supplements and/or date of blood sample . For all tests significance was accepted at $p < 0.05$.

The odd's ratio between covered and non-covered women with vitamin D levels lower than 30 ng/ml was calculated, and 95% confidence intercal group were also compared using the chi squared test.

## Results

We determined 25-OH vitamin $D_3$ in 171 women (n = 171). The mean age of this population was 29,1 ± 4,6 (Standard Deviation or SD) years. The median gestational age was 24 weeks (range: 4-37), most women were primiparae (72/171, 42,1%). The number of fasting women was too small (4/171, 2,3%) to draw any conclusions.

17% (n = 29) of the women was taking a multivitamin preparation. They all used the same brand containing 10 microgram (400 IU) of vitamin D. In the entire population the mean 25-OH vitamin D value was 28 ± 12,4 (SD) ng/ml.

There was no effect of age, gravidity, parity, intake of supplements nor gestational age on the vitamin D level. There was however a statistically significant influence of date of blood sampling and sun exposure (p = 0,001).

The mean vitamin D value of women taking supplements was 28,5 ± 12,5 (SD) ng/ml, the group without supplements had a mean of 27,9 ± 12,5 (SD) ng/ml. The difference in means between these two groups was not significantly different (p = 0,8).

Of all women 86% (n = 147) was not covered, 10,5% (n = 18) wore head covers but had other body parts exposed to the sun, 3,5% (n = 6) was completely covered, leaving only the face open for sun exposure. There was a significant effect of degree of body covering on vitamin D level (linear regression, p < 0,001). The mean 25-OH vitamin D value in the non-covered group was 29,5 ± 12,2 (SD) ng/ml. There was a significant difference in vitamin D level between the three groups (Anova, p = 0,001) (Fig. 1).

The mean of the partially veiled group, 17,2 ± 7,2 (SD) ng/ml, was significantly lower than the mean of the non-veiled group (T-test, p = 0,001). The

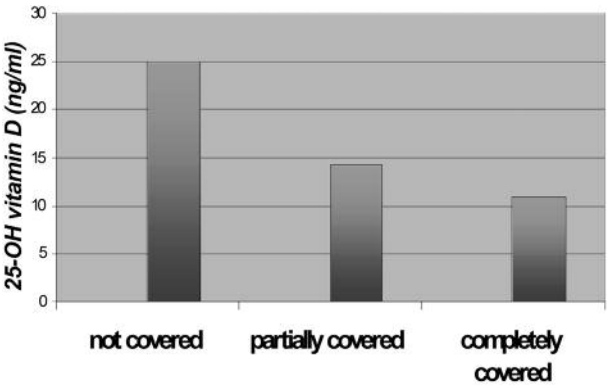


***Fig. 1.*** — Mean Vitamine D levels in three groups

mean of the completely veiled group, being 22,5 ± 12,9 (SD) ng/ml was not significantly higher than that of the partially veiled group and not significantly lower than the non-veiled group (T-test, $p > 0,05$).

When we only compare covered versus non-covered groups, there are significantly more covered than non-covered women with a concentration of vitamin D lower than 30 ng/ml (odds ratio 6,2; 95% CI: 1,8-21,7; $p < 0,05$).

## Discussion

The mean vitamin D value of our population, 28 ng/ml, was below the reference range used in our laboratory. This suggests a widespread shortage of vitamin D in our population, 1,75% was suffering from severe deficiency, 9,9% had moderate deficiency and 18,1% had mild deficiency.

The literature is not clear about the reference values for deficiency. The values used are based on concentrations that avoid development of rickets and osteomalacia (Vieth *et al.*, 2007). With new date on the role of vitamin D besides bone metabolism, some authors are pleading for higher cut-off values to determine deficiency (Norman *et al.*, 2007; Sachan *et al.*, 2005; Wagner *et al.*, 2008). Heaney (2005) states that 32 ng/ml should be considered as a minimum for normal physiology, Bischoff-Ferrari (2008) defines values of 36-40 ng/ml as optimal serum concentrations.

We found no effect of maternal age, gestational age, parity, gravidity and intake of supplements on the vitamin D level.

No consensus exists on the recommended intake and supplementation of 25-OH vitamin D during pregnancy. There have been many studies with different supplementation dosage (Datta *et al.*, 2007; Madelenat *et al.*, 2001; Saadi *et al.*, 2007; Sahu *et al.*, 2009; Yu *et al.*, 2009) and several authors agree that the current recommended intake of 200-600 IU (or 5-15 µg) is too low, daily requirements may be closer to 1000 IU (25 µg) or higher (Bisschof-Ferrari *et al.*, 2008; Hollis and Wagner, 2004; McCullough, 2007). The most commonly prescribed multivitamin preparation in Belgium, only contains 10 µg (400 IU) of vitamin D, a value that will not suffice to maintain or build sufficient levels. This fact is confirmed in our pilot study: no significant difference in vitamin D levels between women taking supplements and those who did not.

There clearly was an effect of sun exposure and date of sampling, probably because August has more sun hours than November. In the population studied, the non-covered women had higher mean serum concentrations of vitamin D compared to partially covered women. The higher mean values of the completely covered group were probably due to small group size and were not statistically significant compared with other groups.

However, we did not classify the participants according to their nationality nor their skin tone and as most women wearing head/body cover also have a darker skin, this is a fact that we should have taken into account.

Furthermore, most of the covered women are immigrants who often live in poorer social circumstances. Hence, their lower vitamin D levels might not be only attributable to wearing head/body cover but also to poor dietary intake. Although most of the vitamin D production comes from skin conversion, the dietary intake of vitamin D is something we'll have to examine in further studies, as well as darkness of skin and nationality.

As this was a pilot study, we only measured 25-OH vitamin D. In the future, we will start including other relevant parameters such as medical history, serum levels of calcium and parathyroid hormone.

## Conclusion

Low vitamin D levels are frequently found in pregnancy but the optimal serum concentration remains unknown. There is still no consensus about the recommended supplementation dosage. In this pilot study, we found that low vitamin D levels in the Antwerp population are frequent and that there is an effect of the seasonal moment of the year and degree of sun exposure. This makes the immigrant population wearing head/body cover at risk of deficiency. A large scale study is needed to come to clinical guidelines and recommendation for obstetricians.

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