OBJECTIVE: To investigate whether circulating 25-hydroxyvitamin D3 (25(OH)D3) concentration in pregnancy is associated with neuropsychological development in infants.

METHODS: The Spanish population-based cohort study INFancia y Medio Ambiente Project recruited pregnant women during the first trimester of pregnancy between November 2003 and February 2008. Completed data on 1,820 mother-infant pairs were used. Maternal plasma 25(OH)D3 concentration was measured by high-performance liquid chromatography in pregnancy (mean 13.5 ± 2.1 weeks of gestation). Offspring mental and psychomotor scores were assessed by trained psychologists at age 14 months (range, 11–23) by using the Bayley Scales of Infant Development. β-Coefficients with 95% confidence intervals (CIs) of mental and psychomotor scores associated with continuous or categorical concentrations of maternal plasma 25(OH)D3 were calculated by using linear regression analysis.

RESULTS: The median plasma value of 25(OH)D3 in pregnancy was 29.6 ng/mL (interquartile range, 21.8–37.3). A positive linear relationship was found between circulating concentrations of maternal 25(OH)D3 concentrations in pregnancy and mental and psychomotor scores in the offspring. After adjustment for potential confounders, infants of mothers with 25(OH)D3 concentrations in pregnancy >30 ng/mL showed higher mental score ($\beta = 2.60; 95\%\ CI\ 0.63–4.56$) and higher psychomotor score ($\beta = 2.32; 95\%\ CI\ 0.36–4.28$) in comparison with those of mothers with 25(OH)D3 concentrations <20 ng/mL.

CONCLUSIONS: Higher circulating concentration of maternal 25(OH)D3 in pregnancy was associated with improved mental and psychomotor development in infants. Pediatrics 2012;130:e913–e920.
Vitamin D deficiency is a public health issue worldwide. Growing evidence based on animal studies is linking vitamin D to brain development and functioning. Potential effects of vitamin D during brain development include neurotrophic actions, neuroprotective effects, and changes in brain structure and gene expression. It is unknown how evidence from animal studies translates to humans, but it is possible that vitamin D status during brain development affects cognitive functioning later in life.

Studies in humans examining the effects of blood concentrations of 25-hydroxyvitamin D3 (25(OH)D3) on brain development and cognitive functioning are limited and inconclusive. Several studies in middle-aged and older adults have shown positive associations between serum concentrations of 25(OH)D3 and cognitive function. Whether circulating concentration of 25(OH)D3 during the second trimester of pregnancy (from 12 to 23 weeks of gestation), with 11.6% during the first trimester (<12 weeks of gestation), and <1% late in pregnancy (from 24 to 36 weeks of gestation). Samples were processed immediately and stored from −70 to −80°C until analysis. Maternal plasma concentrations of 25(OH)D3 were quantified by high-performance liquid chromatography method by using a BioRAD kit according to Clinical and Laboratory Standard Institute protocols. Detection limit was 5 ng/mL, and interassay coefficient of variation was 4.5%. The assay was validated by German Programmes of External Evaluation of Quality (DGKL-RFB-Referentinstituk fur Bionalytik), and results were satisfactory in 100% of the cases.

**METHODS**

**Design and Study Population**

Data come from 4 prospective population-based pregnant cohort studies in Spain embedded in the Infancia y Medio Ambiente (Environment and Childhood) Project (www.proyectoinma.org). In brief, between November 2003 and February 2008, a total of 2844 women who fulfilled the inclusion criteria (≥16 years of age, intention to deliver at the reference hospital, no problems of communication, singleton pregnancy, and no assisted conception) were recruited during the first prenatal visit in 4 areas of study: Valencia (39°N latitude, n = 855), Sabadell (41°N latitude, n = 657), Gipuzkoa (42°N latitude, n = 638), and Asturias (43°N latitude, n = 494). Overall, 2505 (97%) women were followed until child’s birth. Circulating 25(OH)D3 concentrations in pregnancy were determined in 2389 women, and, among them, neuropsychological assessment was performed in 2112 (89% of eligible) infants. Exclusion criteria were birth at <37 weeks of gestation (n = 82), unknown gestational age (n = 16), underlying pathology (n = 17), poor-quality neuropsychological assessment (n = 124), and missing information on potential covariates (n = 53). Ultimately, 1820 (86% of eligible) mother-infant pairs were analyzed (Fig 1). The study was approved by the ethical committees of the centers involved in the study, and written informed consent was obtained from the parents of all children.

**Assessment of Maternal Circulating 25(OH)D3 Concentrations**

A single maternal blood specimen was drawn during pregnancy (mean, 13.5 ± 2.1 weeks of gestation). Most blood draws (88%) were done during the second trimester of pregnancy (from 12 to 23 weeks of gestation), with 11.6% during the first trimester (<12 weeks of gestation), and <1% late in pregnancy (from 24 to 36 weeks of gestation). Samples were processed immediately and stored from −70 to −80°C until analysis. Maternal plasma concentrations of 25(OH)D3 were quantified by high-performance liquid chromatography method by using a BioRAD kit according to Clinical and Laboratory Standard Institute protocols. Detection limit was 5 ng/mL, and interassay coefficient of variation was 4.5%. The assay was validated by German Programmes of External Evaluation of Quality (DGKL-RFB-Referentinstituk fur Bionalytik), and results were satisfactory in 100% of the cases.

**Assessment of Infant Neuropsychological Development**

Neuropsychological development was assessed at age 14 months (range, 11–23 months) by using the Bayley Scales of Infant Development that assess age-appropriate mental (163 items) and psychomotor (81 items) development. All testing was done by specially trained psychologists. Interobserver differences were quantified, and 3 sets of quality
controls were undertaken. The inter-
rater reliability, estimated by intraclass
 correlation, was 0.90 for mental scale
and 0.96 for psychomotor scale. Fur-
thermore, internal consistency de-
termined by the Cronbach
\( \alpha \)-coef-
icient was 0.70 for mental scale and 0.73 for
psychomotor scale. Raw scores were
standardized for child's age in days at
testing by using a parametric method
for the estimation of age-specific refer-
ence intervals. Normal distribution
was adopted as starting point for
model building. The parameters of the
distribution (M and S curves, for the
mean and SD, respectively) were mod-
eled as a fractional polynomial (FP)
function of age. FP models for the M and
S curves were found by grid search of
the powers in
\( P = \{-3, -2, -1 -1/2, 0 \ (\log), 1/2, 1, 2, 3\} \)
allowing up to FP with degree 3. Once
the best powers in FP models have been
chosen, the regression coefficients were
estimated by maximum likelihood. Re-
siduals were then standardized to a
mean of 100 points with a SD of 15
points to homogenize the scales.

Potential Confounders
Based on previous knowledge, the fol-
lowing were considered a priori po-
tential confounding factors because of
their possible associations with mater-
nal circulating 25(OH)D3 concentration
and neuropsychological test scores:
child's gender, birth weight, maternal
age, parity, maternal country of origin,
parental social class, maternal educa-
tion level, maternal pre-pregnancy BMI,
and maternal smoking and alcohol con-
sumption during pregnancy. Questions-
naires during the first trimester of
pregnancy obtained information about
parity (0 vs 1 or more), maternal age,
maternal country of birth (Spanish
versus foreign), parental social class
(defined as maternal or paternal oc-
cupation during pregnancy based on
the highest social class by using a
widely used Spanish adaptation of the
international ISCO88 coding system)
(I–II, managers/technicians; III, skilled;
IV–V, semiskilled/unskilled), maternal
education level (primary or less, sec-
ondary, university degree), and ma-
ternal pre-pregnancy BMI based on
measured height at recruitment and
pre-pregnancy self-reported weight
(normal weight/underweight \([ \leq 24.99]\),
overweight \([25–29.99]\), obese \([ \geq 30]\)).
Information on maternal smoking (no
versus yes) and alcohol consumption
during pregnancy (no versus yes, defined
as consumption of alcohol beverages
at least 1 time/month) was collected
through questionnaires during the third
trimester. All questionnaires were ad-
ministered face-to-face by trained inter-
viewers. Information related to child's
gender, birth weight, and gestational
age was obtained from clinical records.

Statistical Analysis
Maternal circulating 25(OH)D3 concen-
trations were normally distributed.
Clinically defined 25(OH)D3 cut points
were used: \(<20 \text{ ng/mL} \) (reference
group), 20 to 30 ng/mL, and \( \geq 30 \text{ ng/}
\text{mL} \). Differences in baseline charac-
teristics of participants across categories
of maternal 25(OH)D3 concentrations
were compared by using \( \chi^2 \) tests for
categorical variables, analysis of vari-
ance for continuous variables with
normal distribution, and Kruskal-Wallis
tests for variables with skewed dis-
tributions. To adjust for month at blood
collection, 2 approaches were used.
In the first approach, we used “deseason-
alization” of 25(OH)D3 concentrations.
In this approach seasonality of 25(OH)D3
was tested by fitting the data to a sine
function with a period of 12 months
in a nonlinear regression cosinor
model. Then, the predicted 25(OH)D3
concentrations based on month at

---

**FIGURE 1**
Flowchart of study population.
blood collection for each subject, derived from the sinusoidal model, were subtracted from the actual observed value. Subsequently, the overall mean was added and the resulting deseasonalized 25(OH)D$_3$ concentrations were analyzed. In the second approach, we used raw 25(OH)D$_3$ concentrations for the regression analysis in which we adjusted for month at blood collection. The results of these 2 approaches were essentially the same. Thus, the results using deseasonalized 25(OH)D$_3$ concentrations are presented in the main article, and the results using raw 25(OH)D$_3$ concentrations and adjusting for month are presented in the supplemental material (Supplemental Table 3). Linear dose-response relationship between maternal 25(OH)D$_3$ concentrations during pregnancy and infant neuro-psychological development scores was assessed by using adjusted generalized additive models by graphical examination and likelihood ratio.$^{32}$ To examine the relationship between infant neuro-psychological development and maternal 25(OH)D$_3$ concentrations, we used multivariable linear regression models. We treated circulating concentrations of 25(OH)D$_3$ as continuous (effect per 10 ng/mL) and clinically defined categories. Analyses were first adjusted for area of study (base model). Next, a fully adjusted model included child’s gender, birth weight, maternal country of origin, maternal age, parental social class, maternal education level, parity, maternal pre-pregnancy BMI, and maternal smoking and alcohol consumption in pregnancy. There was no evidence that the associations of maternal 25(OH)D$_3$ concentrations with infant’s neuro-psychological scores differed between genders (all $P$ values for interaction $>0.2$), and all results are presented for both genders combined. To preclude potential residual confounding, we assessed whether the associations were consistent across strata defined by maternal pre-pregnancy BMI, parental social class, and maternal education level. Analyses were conducted by using Stata software, version 11.1 (StataCorp, College Station, TX) and R statistical package version 2.13.0.

**RESULTS**

The study population included 49.7% male children and 58% firstborn. Ninety-two percent of mothers were born in Spain, and maternal mean age at child birth was 31.9 (4.2) years. Twenty-two percent of mothers had a low educational level (primary or less) and 33% were from high social class. Twenty-six percent of women were overweight/obese before pregnancy. Sixteen percent of women reported tobacco smoking and 19.6% alcohol consumption during pregnancy. Compared with excluded participants, those who were included in the present analysis showed higher birth weight, higher social class, and mothers tended to smoke less during pregnancy, but did not differ in other main baseline characteristics (Supplemental Table 4).

The median plasma value of 25(OH)D$_3$ in pregnancy was 29.6 ng/mL (inter-quartile range, 21.8–37.3). A total of 356 (19.5%) pregnant women had vitamin D deficiency [25(OH)D$_3$ concentration <20 ng/mL], and 574 (31.5%) had vitamin D insufficiency [25(OH)D$_3$ concentration 20–30 ng/mL]. The characteristics of participants according to clinically defined cutoff points of circulating 25(OH)D$_3$ concentrations during pregnancy are shown in Table 1. Concentrations of circulating 25(OH)D$_3$ in pregnancy differed among areas of study, with Valencia area showing the highest concentrations and Asturias the lowest concentrations. Increasing trends across the clinically defined 25(OH)D$_3$ categories were observed for maternal age, parity, and maternal alcohol consumption. Decreasing trends across the categories of 25(OH)D$_3$ were found for lower parental social class and education level.

### Table 1 Characteristics of Participants According to Maternal Circulating 25(OH)D$_3$ Concentrations in Pregnancy

<table>
<thead>
<tr>
<th>Area of study</th>
<th>Serum 25(OH)D$_3$ Concentration</th>
<th>$P$ Value Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;20 ng/mL ($n=356$)</td>
<td>20–30 ng/mL ($n=574$)</td>
</tr>
<tr>
<td>Area of study</td>
<td></td>
<td>----------------</td>
</tr>
<tr>
<td>Valencia (39°N latitude)</td>
<td>20.2</td>
<td>29.6</td>
</tr>
<tr>
<td>Sabadell (41°N latitude)</td>
<td>30.3</td>
<td>23.2</td>
</tr>
<tr>
<td>Gipuzkoa (42°N latitude)</td>
<td>24.7</td>
<td>27.2</td>
</tr>
<tr>
<td>Asturias (43°N latitude)</td>
<td>24.7</td>
<td>20.0</td>
</tr>
<tr>
<td>Child’s gender (male)</td>
<td>51.1</td>
<td>50.2</td>
</tr>
<tr>
<td>Birth weight, g</td>
<td>3300 (435)</td>
<td>3283 (419)</td>
</tr>
<tr>
<td>Maternal age at child’s birth, y</td>
<td>31.5 (4.5)</td>
<td>31.6 (4.1)</td>
</tr>
<tr>
<td>Parity (1 or more)</td>
<td>36.8</td>
<td>41.6</td>
</tr>
<tr>
<td>Maternal country of birth (non-Spanish)</td>
<td>9.0</td>
<td>6.8</td>
</tr>
<tr>
<td>Parental social class</td>
<td>I/II Managers/technicians</td>
<td>28.4</td>
</tr>
<tr>
<td></td>
<td>III Skilled manual/nonmanual</td>
<td>26.1</td>
</tr>
<tr>
<td></td>
<td>IV/V Semiskilled/unskilled</td>
<td>45.5</td>
</tr>
<tr>
<td>Maternal education level</td>
<td>Primary or less</td>
<td>23.9</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>43.5</td>
</tr>
<tr>
<td></td>
<td>University degree</td>
<td>32.6</td>
</tr>
<tr>
<td>Maternal pre-pregnancy BMI</td>
<td>Normal weight/underweight (&lt;24.99)</td>
<td>68.3</td>
</tr>
<tr>
<td></td>
<td>Overweight (25–29.99)</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>Obese (&gt;=30)</td>
<td>9.3</td>
</tr>
<tr>
<td>Smoking at third trimester (yes)</td>
<td>20.2</td>
<td>16.4</td>
</tr>
<tr>
<td>Alcohol during pregnancy (yes)</td>
<td>18.0</td>
<td>16.4</td>
</tr>
</tbody>
</table>

Values are percentages for categorical variables and mean (SD) for continuous variables.
Maternal plasma concentrations of 25(OH)D3 showed a seasonal distribution (P < .05, Fig 2). Maximum fitted concentrations of maternal plasma 25(OH)D3 were observed in blood samples collected in August, and concentrations reached their nadir in February (Fig 2). A positive linear relationship was found between circulating concentrations of maternal 25(OH)D3 in pregnancy and both mental (Fig 3A) and psychomotor (Fig 3B) development scores in the offspring. In multivariable models, each 10 ng/mL increase in 25(OH)D3 in pregnancy resulted in up to 0.79 and 0.88 points increase in mental and psychomotor development scores in offspring, respectively (Table 2). In the basic model with adjustment for area of study, infants of mothers with 25(OH)D3 concentrations >30 ng/mL showed an advantage of 3.17 and 2.42 points in the mental and psychomotor scores, respectively, in comparison with those of mothers with 25(OH)D3 concentrations <20 ng/mL (model 1) (Table 2). Although attenuated, these associations remained significant after adjustment for potential confounders including child’s gender, birth weight, maternal country of origin, maternal age, parental socio-economic status, maternal education level, parity, maternal pre-pregnancy BMI, and maternal smoking and alcohol consumption in pregnancy (model 2) (Table 2). In addition, the associations did not differ according to maternal pre-pregnancy BMI, maternal social class or education level (all P values for interactions >0.1).

DISCUSSION

To our knowledge this is one of the first large-scale prospective pregnancy cohort studies to examine the association between maternal circulating 25(OH)D3 concentrations in pregnancy and offspring neuropsychological development in infancy. Higher concentrations of circulating 25(OH)D3 in pregnancy were associated with improved mental and psychomotor scores. Infants of mothers with 25(OH)D3 concentrations >30 ng/mL (clinically considered as optimal levels) showed an advantage of 2.6 and 2.3 points in mental and psychomotor scores, respectively, in comparison with those of mothers with 25(OH)D3 concentrations <20 ng/mL (considered as deficient levels). The association remained significant after adjusting for a wide range of potential confounding and intermediate factors.

The main strengths of this study include its population-based prospective design and large sample size as well as examination of the associations with plasma measurements of 25(OH)D3 concentration, a reliable indicator of vitamin D status that also quantifies the outdoor exposure, rather than dietary reports that are likely to be influenced by reporting bias. Possible confounding was addressed in multivariable analyses adjusted for a wide range of potential confounding factors. Finally, we found a strong positive linear relationship at lower concentrations of maternal circulating 25(OH)D3 (below 50–60 ng/mL), which supports the robustness of the findings; however, the generalization of this assumption at higher concentrations is limited owing to the small number of observations (ie, “sparse data bias”).

The study has some limitations. First, only a single 25(OH)D3 measurement per subject was available that could not reflect maternal long-term status during the entire pregnancy. Dealing with misclassification of estimated long-term vitamin D exposure by season of blood draw was accounted estimating deseasonalized 25(OH)D3 concentrations based on a sinusoidal model. Second, we did not assess the effect of circulating 25(OH)D2 concentrations, but, normally, majority of the 25(OH)D is in D3 form. Third, the lack of information of infant’s vitamin D status is another limitation. Fourth, we could not measure 25(OH)D3 concentrations in all recruited subjects, which made selection bias possible. Participants were more likely to be female and parents had higher social class and education level; however, there was no evidence that the association between circulating maternal 25(OH)D3 concentrations in pregnancy and infant’s neuropsychological scores differed between genders, parental social class, or maternal education level. Fifth, parental intelligence, an important determinant of infant mental development, was not evaluated. However, parental education level and social class did not confound or modify
the associations, but their inclusion in the model cannot completely eliminate possible residual confounding by parental intelligence. Finally, we did not account for maternal physical activity and outdoor exposures (indicators of maternal fitness), which may result in some residual confounding.

Two previous prospective studies have assessed the effect of maternal serum 25(OH)D₃ concentrations in pregnancy on offspring neurodevelopment.¹⁹,²⁰ The first study based on 178 mother-child pairs reported no association between circulating maternal 25(OH)D₃ concentrations, measured at 32 weeks of pregnancy, and offspring cognition performance at age 9 years.¹⁹ However, in accordance with our results Whitehouse et al²⁰ have recently reported insufficient maternal serum 25(OH)D₃ concentrations, measured at 18 weeks of pregnancy, to be associated with offspring language impairment at 5 and 10 years of age in a prospective study on 743 mother-child pairs. Lack of power in the Gale et al¹⁹ study and differences in timing measurements (exposure and outcome) could explain controversial results between studies. Measurement of 25(OH)D₃ concentrations in Gale et al¹⁹ study was performed in late pregnancy (median 32 weeks), whereas Whitehouse et al study and the current study determined 25(OH)D₃ concentrations earlier in pregnancy (mean, 18 and 13 weeks of gestation, respectively). Our results suggest that optimal concentrations of circulating 25(OH)D₃ as early as 13 weeks of gestation may have an impact on neuropsychological development in infancy, and vulnerability of the developing brain to vitamin D deficiency may be manifested early in pregnancy. The similarity in the effect magnitude of vitamin D deficiency in pregnancy on mental and psychomotor skills points out that different brain areas are affected and strengthen the idea that effects may occur during early development when brain structures begin to form and are thus vulnerable to damaging influences.²⁴ Furthermore, deficiencies in neuromotor development are associated with processes occurring early in fetal life.²⁵,²⁶

TABLE 2 Association Between Maternal Circulating 25(OH)D₃ Concentrations in Pregnancy and Neuropsychological Scores in Infants (n = 1820)

<table>
<thead>
<tr>
<th></th>
<th>Model 1b</th>
<th></th>
<th>Model 2c</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>(95% CI)</td>
<td></td>
<td>(95% CI)</td>
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<tr>
<td>Mental development score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous variable (per 10 ng/mL)</td>
<td>0.99 (0.33 to 1.65)</td>
<td>0.79 (0.14 to 1.45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Categories (ng/mL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td></td>
<td>Ref.</td>
<td></td>
<td>Ref.</td>
</tr>
<tr>
<td>20–30</td>
<td>2.14</td>
<td>(0.08 to 4.19)</td>
<td>1.88</td>
<td>(−0.14 to 3.91)</td>
</tr>
<tr>
<td>&gt;30</td>
<td>3.17</td>
<td>(1.19 to 5.16)</td>
<td>2.60</td>
<td>(0.63 to 4.66)</td>
</tr>
<tr>
<td>Psychomotor development score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous variable (per 10 ng/mL)</td>
<td>0.94 (0.29 to 1.60)</td>
<td>0.88 (0.22 to 1.54)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Categories (ng/mL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td></td>
<td>Ref.</td>
<td></td>
<td>Ref.</td>
</tr>
<tr>
<td>20–30</td>
<td>0.80</td>
<td>(−1.21 to 2.83)</td>
<td>0.86</td>
<td>(−1.16 to 2.88)</td>
</tr>
<tr>
<td>&gt;30</td>
<td>2.42</td>
<td>(0.47 to 4.37)</td>
<td>2.32</td>
<td>(0.36 to 4.28)</td>
</tr>
</tbody>
</table>

a Deseasonalized maternal 25(OH)D₃ concentrations based on month at blood collection for each subject derived from the sinusoidal model.

b Adjusted for area of study.

c Adjusted for area of study, child’s gender, birth weight, maternal country of origin, maternal age, parental social class, maternal education level, parity, maternal pre-pregnancy BMI, and maternal smoking and alcohol consumption in pregnancy.

FIGURE 3
The relation (and 95% CI) of maternal circulating concentration of 25(OH)D₃ in pregnancy* (ng/mL) with mental (A) and psychomotor (B) developmental scores in infants. *Deseasonalized maternal 25(OH)D₃ concentrations based on month at blood collection for each subject derived from the sinusoidal model. General additive models adjusted for area of study, child’s gender, birth weight, maternal country of origin, maternal age, parental social class, maternal education level, parity, maternal pre-pregnancy BMI, and maternal smoking and alcohol consumption in pregnancy. The symbols (+) on the x axis indicate 25(OH)D₃ observations.
Studies assessing vitamin D status on cognitive functioning beyond childhood are scarce. A large population-based cross-sectional study conducted on 1676 adolescents aged 12 to 17 years has reported null association of different domains of cognitive function with 25(OH)D3 concentrations. However, the cross-sectional design and the different timing at outcome assessment make the comparison with our study difficult. Nevertheless, our results are consistent with previous studies conducted in elderly adults. Seven cross-sectional studies have reported lower concentrations of circulating 25(OH)D3 in pregnancy was associated with improved mental and psychomotor development in infants. Efforts to maintain an adequate vitamin D status in pregnancy could make a positive impact on infants’ neuro-psychological development if the associations are causal. Moreover, given the magnitude of vitamin D deficiency worldwide among pregnant women, the present results have important public health implications, and population-level consequences of vitamin D deficiency in pregnancy on brain development may be more profound in settings with higher prevalence of vitamin D deficiency. Additional studies are warranted to assess long-term effects of maternal vitamin D status in pregnancy on neuropsychological development in offspring.

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(Continued from first page)

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Circulating 25-Hydroxyvitamin D₃ in Pregnancy and Infant Neuropsychological Development

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