Use of Infant Vitamin D Supplementation among Women Attending a Local Special Supplemental Nutrition Program for Women, Infants and Children (WIC)

Sina Gallo, RD, PhD, Department of Nutrition and Food Studies, George Mason University
Janine A. Rethy, MD, MPH, Obesity and Chronic Disease Prevention, Loudoun County Health Department
Amara Channell Doig, MPH, Department of Nutrition and Food Studies, George Mason University,
Jennifer Brady BS, Obesity and Chronic Disease Prevention, Loudoun County Health Department
David Goodfriend, MD, MPH , Loudoun County Health Department

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Abstract

Purpose: Breastfeeding without adequate vitamin D supplementation may predispose infants to vitamin D deficiency and rickets. The aim of this report was to determine the percent of women attending a local WIC program who met the infant vitamin D recommendation and to explore determinants of supplementation.

Methods: A cross-sectional de-identified survey was completed, via an online platform, by a sample of women attending two district clinics. The survey collected information concerning the respondent's youngest child on infant feeding at 3 months, vitamin D supplementation and knowledge. Meeting the vitamin D recommendation was defined as either receiving 400 IU daily through supplementation, consuming 32 oz. of infant formula or a combination of both.

Results: Among a sample of 163 women (72% Hispanic), 28% reported giving their infant a vitamin D supplement and 31% met the recommendation. Mothers who reported receiving recommendations from a health care professional were 26-times more likely to provide vitamin D supplementation (95 % CI: 5, 135, $p<0.01$).

Conclusions: Use of infant vitamin D supplementation was low in this predominately Hispanic sample of mothers. Counseling greatly affected vitamin D supplementation yet; most reported not receiving education from health care providers. Further research is warranted among a larger sample.

Introduction

As per the American Academy of Pediatrics (AAP), all infants receiving less than 32 oz. of vitamin D fortified formula per day are recommended to be supplemented with 400 IU of vitamin D daily from birth (Wagner & Greer, 2008) to prevent bone diseases such as rickets. There appears to be a worldwide re-emergence of rickets with noteworthy increases since 2000 (Prentice, 2013). Immigrant minority children appear at higher risk (Goldacre, Hall, & Yeates, 2014) possibly due to decreased reliance on cutaneous synthesis in sunny home countries when they move to more northern latitudes. Although rickets prevalence is not tracked in the US, children with darker skin color, born to a mother who is vitamin D deficient and breastfed without supplementation are at high risk (Bergström, Blanck, & Sävendahl, 2013; Thacher et al., 2013). Despite the many benefits to breastfeeding for both the mother and offspring (Eidelman et al., 2012), vitamin D content of breastmilk is limited (við Streym et al., 2016).

Vitamin D supplementation promotes bone health as children, who were vitamin D deficient, and received supplementation improved their bone mass (Winzenberg, Powell, Shaw, & Jones, 2011). Moreover, current vitamin D recommendations by the Institute of Medicine do not specifically consider non-bone health outcomes associated with vitamin D deficiency including cancer, obesity, and mental health diseases (Institute of Medicine, 2010). Vitamin D deficiency in infancy has been linked to increased respiratory tract infections and asthma (Feng et al., 2017); and supplementation may offer protection for type 1 diabetes (Zipitis & Akobeng, 2008). Although there appears to be a lack of consensus on the definition of optimal vitamin D (Holick et al., 2011; Institute of Medicine, 2010), it is clear that circulating levels <30 nmol/L (12 ng/ml) are associated with deficiency and bone diseases, yet suboptimal vitamin D status may be associated with a range of morbidities and constitute a larger public health concern.

Adherence to the AAP infant vitamin D supplementation recommendation is low in the US. Only 27% of all infants participating in the National Health and Nutrition Examination Survey (NHANES) 2009–2012 met the vitamin D supplementation recommendation (Ahrens, Rossen, & Simon, 2016) and infant supplementation use was only 16% among a large pediatrician network in Seattle, WA (Taylor, Geyer, & Feldman, 2010). Comparisons are difficult to interpret as usual dietary and supplement intake must be accounted for including vitamin D content of formula as well as infant age.

Purpose

Breastfeeding without adequate vitamin D supplementation may predispose already at-risk children to vitamin D deficiency and rickets (Thacher et al., 2013). Since 2009, the Special Supplemental Nutrition Assistance Program for Women, Infants and Children (WIC) has instituted a number of policies to incentivize breastfeeding (Whaley et al., 2012), yet there is a paucity of data on the proportion of infants who receive vitamin D supplementation and meet the recommendation among this group. More importantly, understanding what influences parental behavior regarding vitamin D supplementation particularly among ethnic minority populations will help inform policy and practice. Therefore, the primary aim of this study was to determine the percentage of infants meeting the AAP infant vitamin D recommendation as defined by use of vitamin D supplement, or total amount of vitamin D intake equaling or exceeding 400 IU/day. The secondary aim was to explore the barriers and facilitators to supplementation among a sample of mothers attending a local district WIC program.

Methods

Design

The design was a prospective cross-sectional de-identified self-report survey completed online in WIC waiting rooms. This design was appropriate to assess the prevalence of vitamin D supplement use among our target group. Study procedures were approved by both George Mason University and the

Virginia Department of Health's Institutional Review Boards. All responses were anonymous and de-identified. Informed consent was obtained.

Setting

WIC is a federal food assistance program which targets low-income, nutritionally at-risk women and children aged 0–5 years of age in the US; 53% of US infants are served by WIC. The program provides supplemental foods, education/counseling as well as screening/referrals to other health care professionals. Breastfeeding rates among WIC participants nationally are 32% (13% full, 19% partial) and 43% (10% full, 33% partial) in the local district where the study was conducted (U.S. Department of Agriculture (USDA), Food and Nutrition Services (FNS), 2017).

Sample

The target population was a convenience sample of women attending a local district WIC program. The sample inclusion criteria were adult women (≥18 years), able to understand English or Spanish and having a child aged ≤ 60 months (based on WIC eligibility). Overall 190 participants completed the survey; however, 27 were excluded (n=11 missing child age, n=16 child aged ≥60 months). The final sample size was 163. A sample size of 143 participants would be required to obtain a 95% confidence interval of ± 7.5% around a 30% estimate of use (Ahrens et al., 2016) based on vitamin D supplementation use.

Measurement

The survey collected information about household health and access to assistance programs, food and physical activity habits although, this report focuses solely on results from the infant vitamin D supplementation practices and knowledge section. Survey questions were written at a 5th grade level, closed-ended and based upon protocols and recommendations from the AAP and Academy of Breastfeeding Medicine (ABM). Both the Loudoun County Health Department and George Mason University Department of Nutrition and Food Studies were involved in the development and analysis of

the survey. Bilingual WIC staff reviewed and pilot-tested both English and Spanish versions of the survey to ensure consistency and clarity (Grawey, Marinelli, & Holmes, 2013). The majority of survey respondents in this local district report Spanish as their primary language; hence, the survey was only provided in English and Spanish. Food insecurity was defined based Hager et al., 2010 (Council on Community Pediatrics & Committee on Nutrition, 2015).

Survey respondents were asked to best describe their youngest child's infant feeding during their first 3 months as: breastfed only, formula fed only or mixed feeding (included mostly breastfed and mostly formula fed). These definitions were based on WIC food package categories ("Breastfeeding," n.d.) and ABM (Eidelman et al., 2012). Vitamin D supplementation practices including vitamin D intake from supplementation and formula was calculated based on information about supplementation frequency and information about average amount of formula intake at 3 months. The 3-month time point was selected as formula fed infants may not be receiving sufficient amounts of formula (<32 oz/day) to meet vitamin D needs and thus, are also vulnerable to deficiency. Respondents were classified as meeting the AAP recommendation if their child achieved 400 IU of vitamin D daily through supplementation, by consuming 32 oz. of infant formula or a combination of both. Questions about knowledge of vitamin D sources as well as sun exposure were also included.

Data collection

Information was gathered from women attending two local clinic waiting rooms (Loudoun county, VA) between June–August, 2016. The survey was administered on-site using an online survey platform, Qualtrics (2016, Provo, UT) and completed on portable devices (iPads). Bilingual study staff were on site to administer consent and survey, and to answer questions. No incentives were provided for survey completion; respondents were informed that their survey responses would be used to help improve community health services.

Statistical analysis

Mean (SD) was reported for descriptive continuous variables (maternal and child age, number of children) and n (%) for categorical variables (gender, education, race, ethnicity, country of birth, income, prenatal vitamin taken, feeding type [formula, breastfed, both], vitamin D recommended by a health professional). Continuous variables were compared using Student t-test or Mann Whitney U for non-normally distributed data and chi-square (Fisher's exact for small samples) for categorical variables. Predictors of vitamin D supplementation practices were explored using logistic regression models and presented as odds ratio (95% CI). Data were analyzed using SAS version 9.3 (Cary, NC) and statistical significance was set at $p \leq 0.05$.

Results

Table 1 describes demographic characteristics of survey respondents. There were no significant differences in demographics among respondents who met vs. did not meet the vitamin D recommendation (data not shown). Respondents consisted of ~9% (n=190) of all families enrolled in this local WIC agency at the time of the survey; however, only data for respondents with a child aged ≤ 60 months were included in this report (n=163). The median age of the respondents' youngest child was 10 months. Overall, the majority of respondents self-identified as Hispanic, the most common country of birth was El Salvador, and 65% reported Spanish as their primary language. Food insecurity was high as 51% reported being worried about running out of food over the last year.

Vitamin D supplementation practices at 3 months of age are shown in Figure 1. Overall, 28% of respondents reported using infant vitamin D supplementation and 31% met the AAP recommendation when their child was 3 months of age. The percentage of respondents who reported supplementation differed by infant feeding group ($p<0.01$) — supplementation was reported by 46% of the exclusively breastfed group compared to 23% of mixed group and 4.5% of the exclusively formula fed group. However, there was no difference in the percentage of respondents who achieved the AAP

recommendation by group. Based on those who reported giving their infant a vitamin D supplement, the mean age of starting supplementation was 1.5 months, and 23% of respondents introduced vitamin D supplementation before 1 month of age, as per the AAP recommendation.

Overall 43% of respondents were aware of the recommendation to give vitamin D daily and 38% of respondents reported receiving advice from a health care provider about vitamin D supplementation. Among those who received the vitamin D recommendation, 79% of respondents reported that it came from a physician, 17% from a WIC breastfeeding counselor, 2% from a nurse, and 2% from a nutritionist. The most common reasons for not giving a vitamin D supplement was that their physician did not recommend it (n=45), WIC did not recommend it (n=18), or they believed it was not necessary (n=18). Having a health care professional recommend vitamin D supplementation predicted a 26-times increased likelihood of vitamin D supplementation (95 % CI: 5, 135, $p<0.01$) (Table 2). When asked about the best source of vitamin D, 18% identified a vitamin D supplement while 64% reported that sun exposure is the only vitamin D source their child needs.

Discussion

In this study population group a large majority of infants were not receiving supplemental vitamin D. Lack of provider counseling regarding AAP vitamin D recommendations was reported as the main reason for non-adherence which may be putting these infants at high risk for deficiency and associated co-morbidities. Although our sample had a higher rate (33%) of breastfed infants (exclusively and mixed) meeting the vitamin D recommendation compared to a national NHANES sample (19%), there was a much lower rate for formula fed babies (e.g., 10% compared to 31% nationally) (Ahrens et al., 2016). Differences in data collection methods may explain these discrepancies. Our results were based on vitamin D estimated formula intake at 3 months, which is likely less than the necessary (e.g., 32 oz. per day to obtain 400 IU of vitamin D). Consistent with previous research (Perrine, Sharma, Jefferds, Serdula,

& Scanlon, 2010), our results suggest most infants, not only exclusively breastfed, will likely need to receive supplemental vitamin D. More respondents of exclusively breastfed infants reported supplementation, which suggests that mothers of formula fed infants may not be receiving the same messages as mothers of breastfed infants. In addition, we identified a lack of health care education regarding infant vitamin D supplementation as a main reason for not supplementing among our sample.

Vitamin D supplementation adherence rates in the US have historically been much lower than other countries — 74% of breastfed infants in Canada received supplementation (Health Canada, 2012) and good adherence (≥80% of infants) was reported by 59% of European countries surveyed (Uday, Kongjonaj, Aguiar, Tulchinsky, & Högler, 2017). Lack of parental education by health care professionals may explain these differences as physician' knowledge of the AAP recommendations has been positively associated with the likelihood of their recommending vitamin D supplementation (Sherman & Svec, 2009). Consistently, our results found that having a health care provider —physician, nurse, nutritionist — recommend supplementation predicted a 26-fold increased likelihood of supplementation. Another US study found only 36% of providers were recommending vitamin D (Taylor et al., 2010). The current study's survey results further confirm these results, showing incomplete knowledge and adherence to AAP infant vitamin D supplementation recommendations among primary care providers. Reasons for this may be due to lack of recognition of rickets as a concern, area and location of training as well as misconceptions regarding sun exposure (Shaikh & Alpert, 2004; Sherman & Svec, 2009). In addition, limited time during a physician visit for nutrition counseling highlights the important role of other health care professionals in supporting parental education regarding vitamin D sources and recommendations.

WIC nutritionists and breastfeeding counselors may be untapped resource for educating and supporting infant vitamin D supplementation. WIC does not provide vitamin D supplementation to families.

Vitamin D is an approved Medicaid supplement, which requires health screening and prescription by a provider for coverage. Although only 3 respondents in our sample found cost to be a deterrent to supplementation (data not shown), this issue needs to be further explored as food insecurity was high in this sample. A Turkish program to promote infant's vitamin D supplements, including free drops at health centers, found improvements in both infant vitamin D status and decreased rates of rickets (Hatun, Ozkan, & Bereket, 2011). Improving access to vitamin D supplementation alone (Millette et al., 2014) does not appear effective in increasing supplementation rates, without appropriate and tailored education (Madar, Klepp, & Meyer, 2009). Most participants (82%) in the present study were unable to correctly identify the best sources of vitamin D, which is an education gap and should be addressed. In addition to education on infant recommendations, different supplement preparations (alcohol vs. oil based), costs/insurance coverage, and supplement delivery methods for primary care providers could be included as part of WIC breastfeeding counseling. There is a need for more research to support the effectiveness of vitamin D education and possibly provision programs in the WIC setting.

Limitations

This study explored use of infant supplemental vitamin D among an understudied population (Furman, 2015). The data presented here are preliminary, do not represent all mothers participating in the WIC program and are limited in their lack of cultural specificity. Limitations of this survey include reliance on mother's memories and the possibility of recall bias although, previous work found good concordance of maternal recall of breastfeeding up to 6 years later (Amissah, Kancherla, Ko, & Li, 2017; Cupul-Uicab, Gladen, Hernández-Avila, & Longnecker, 2009). For the current survey, although the age of respondents' youngest children ranged from 0.5 to 48 months, the median age was 10 months. Reliability and validity of the survey were not tested. Although respondents' ability to correctly understand the survey may have biased results, questions were written at a 5th-grade level, and bilingual WIC staff reviewed and pilot-tested both English and Spanish versions of the survey. Results may have been biased by

respondents who provided socially acceptable responses; social acceptability was not assessed, but results concerning the percentage of respondents who reported supplementation overall and by infant feeding group (Figure 1A) do not seem to support a socially acceptable bias.

Conclusion

Low use and poor knowledge of infant vitamin D supplementation recommendations were found among women attending a local WIC program. Results also suggest exclusively formula fed younger infants may not be obtaining sufficient amounts of vitamin D. The advice of a health care provider had a significant positive effect on use, and results suggest a gap in healthcare providers providing that advice. Health care providers may benefit from concise and targeted education and accessible educational materials to assist them. Further research is warranted among a larger sample of mothers of infants as well as to explore challenges of supplementation from the perspective of both providers and users.

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Table 1. Respondent characteristics, presented for all (n=163)

Characteristic	Mean ± SD or n (%)
Mother's age, years	30.4 ± 7.2
Youngest child age, months[a]	10 [0.5, 48]
<3 months	15 (9.2)
3 to 6 months	31 (19.0)
6 to12 months	55 (33.7)
12 to 24 months	38 (23.3)
24 to 48 months	24 (14.7)
Child gender, male	84 (51.5)
Number of children[a]	2 [1, 7]
Education, highest level completed	
Elementary school (<6 years of education)	24 (15.4)
Some high school (7-11 years of education)	44 (28.2)
High school (includes GED, college, bachelor's and advanced degree)	88 (56.4)
Race	
American Indian/Alaska Native	3 (2.4)
Black/African American	17 (13.6)

White	23 (18.4)
Asian	6 (4.8)
Other	75 (60.8)
Ethnicity	
Latino/Hispanic	115 (72.3)
Non-Hispanic	44 (27.7)
Mother's country of birth (based on UN geographic region classification M49)	
North America[b]	38 (24.2)
South America	10 (7.0)
Central America and Caribbean (includes Mexico)	85 (54.1)
Other (Africa, Asia, Europe)	24 (14.6)
Federal poverty level[c]	
≤ 100%	97 (80.8)
>100%	27 (19.2)
Prenatal supplement taken during pregnancy	149 (94.9)

GED refers to General Equivalency Diploma; AAP refers to American Academy of Pediatrics

[a]Non-normally distributed data presented as median [range], analyzed using Mann Whitney U (nonparametric) test.

[b]All were US

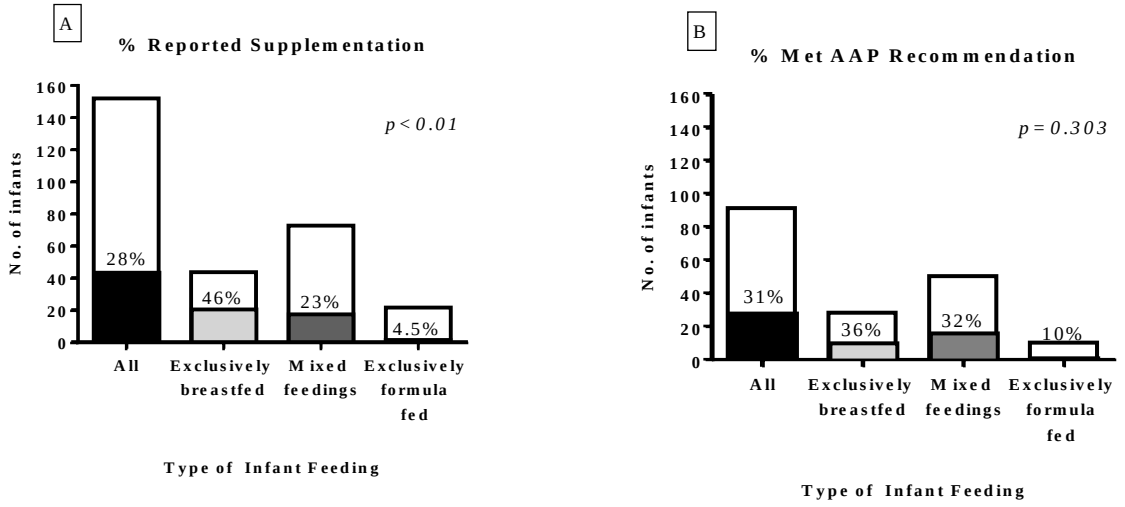
[c]Based on family income and number of people in household, for 2017 see: https://aspe.hhs.gov/poverty-guidelines

Table 2. Logistic regression model to identify factors associated with achieving AAP infant vitamin D recommendation, based on daily supplementation and/or average amount of formula at 3 months (n=74)[a]

Predictor / Explanatory Variables	Odds Ratio	95% Confidence Interval
Maternal age, years	1.02	0.91, 1.14
Number of children	0.75	0.41, 1.34
Education, highest level completed (reference = High school or greater)		
Elementary school	0.40	0.04, 3.83
Some high school	0.65	0.15, 2.81
Country of birth, North America (reference = Outside North America)	3.18	0.69, 14.60
Infant feeding type, 3 months (reference = Exclusively breastfed)		
Mixed feeding	2.10	0.50, 8.82
Exclusively formula fed	1.19	0.09, 16.70
Health professional recommended (reference = not recommended)	26.0	5.00, 135.0
R^2=48.4%		

Note. AAP refers to the American Academy of Pediatrics.
Infant vitamin D recommendation refers to Wagner & Greer, 2008.
[a]Sample limited to n=74 (n=25 achieved AAP recommendation, n=49 did not achieve AAP recommendation) as proc logistic procedure excludes any observations with missing values for the explanatory variables

Figure 1. A) Percent of total respondents who reported giving infant vitamin D supplementation, by infant feeding at 3 months (n=152)[a‡], B) Percent of total respondents meeting AAP recommendation (Wagner & Greer, 2008), based on daily supplementation and/or average amount of formula at 3 months, by infant feeding at 3 months (n=91)[a‡].



[a]Sample size reduced for presentation by infant feeding groups: n=13 missing; [b]n=3 missing;
[‡]Statistical significance reported in figures refers to differences by infant feeding groups.