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Prevalence of Hypovitaminosis D Among Jordanian Healthy Infants: A Descriptive Cross Sectional Study

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Purpose: To determine vitamin D deficiency and associated risk factors of hypovitaminosis D among Jordanian healthy infants.
Design and Methods: A total of 171 infants receiving a routine health check at a Maternal and Child Health Care Center were recruited. Plasma vitamin D 25-OHD level was assessed using a standard analysis of a blood sample. Other data collected included age, gender, birth order, season of birth, and mode of feeding.
Results: Prevalence of vitamin D deficiency (≤ 15 ng/mL) was 77% (132 out of 171 infants). Infants at risk of vitamin D deficiency were those between 1 to 6 months of age, male, third born or later, born in winter, and exclusively breastfed. The multivariate model showed birth order to be the largest contributor of vitamin D deficiency ($R^2 = 0.196$), followed by breastfed infants ($R^2 = 0.071$), infants born in winter ($R^2 = 0.037$), male gender ($R^2 = 0.028$), and infants aged between 1 and 6 months ($R^2 = 0.027$).
Conclusion: Hypovitaminosis D appears to be more common among healthy infants in Jordan. Hypovitaminosis D was found to be common among third or later exclusively breastfeed male infants aged 1 to 6 months who were born during winter.
Practice Implication: Maternal and child health nurses have a critical role to play in educating mothers about the importance of preventing hypovitaminosis D through adequate sun exposure and ensuring adequate supplementation. A higher dose of vitamin D supplementation for high-risk infants beyond the age of 1 year from developing countries should be administered.

HEALTHY INFANTS CAN be at high risk of vitamin D deficiency, which exists when the concentration of 25-hydroxy-vitamin D is ≤13 ng/mL in male infants and ≤ 18 ng/mL in female infants. This deficiency is not well recognized by mothers and may adversely affect infants' growth, development and overall health.

Vitamin D is available through exposure to sunshine, as well as in certain foods and drinks, such as cod-liver oil and fortified dairy products (Hoteit et al., 2014). However, vitamin D deficiency (hypovitaminosis D) continues to be a global health problem among young children (Bassil,

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Rahme, Hoteit, & Fuleihan, 2013). Although hypovitaminosis D was considered to no longer be a health issue among children in developed countries, there is recent evidence of hypovitaminosis D in countries such as Canada, Australia, United Kingdom (UK), and United States of America (USA) (Robinson, Hogler, & Craig, 2006; Ward, Gaboury, Ladhani, & Zlotkin, 2007). Estimates from developed countries suggest that the prevalence of hypovitaminosis D among infants, toddlers and older children is between 12 and 24% (Casey, Slawson, & Neal, 2010; Gordon, Feldman, & Sinclair, 2008).

Hypovitaminosis D among infants and young children is associated with several adverse conditions such as alteration of growth, autoimmune disease, and rickets (Casey et al., 2010; Gordon et al., 2008; Ward et al., 2007). A lack of vitamin D inhibits intestinal calcium absorption, which is critical for both skeletal development and maintenance of cellular function (Arabi, Rassi, & El-Hajj, 2010). Clinical manifestations of severe deficiency include hypocalcemic seizures, fractures, lower-limb deformities, abnormal dentition and delayed developmental milestones (Ward et al., 2007). Hypovitaminosis D can also affect overall health and well-being. There is evidence connecting vitamin D deficiency with an increased risk of type I diabetes, multiple sclerosis, rheumatoid arthritis, hypertension, cardiovascular heart disease, and many common cancers (Holick, 2008; Papandreou, Malindretos, Karabouta, & Rousso, 2010). Adequate levels of vitamin D may help to improve overall health of young children and reduce health risks, such as autoimmune conditions, infection and diabetes, as well as promote normal growth and development (Casey et al., 2010; Liu et al., 2006; Ward et al., 2007).

Reasons for Hypovitaminosis D in Infants

One common explanation for hypovitaminosis D among infants is related to limited exposure to the sun. Adequate sun exposure, as defined as 33 minutes daily, is considered the main source of vitamin D cutaneous synthesis after exposure to ultraviolet B rays (Gruiji, 2011). However, effects of sun exposure are altered due to northern latitude, darker skin, use of sun block, or clothing covering all of the body. Adequate intake of vitamin D rich foods (either naturally or fortified) can keep levels of vitamin D within normal range (Ward et al., 2007). (See Table 1 for the recommended levels and possible sources of vitamin D for infants.)

Jordan, a country in the Middle East, has a hot climate with ample exposure to sunlight. However, vitamin D deficiency is still common, even during the summer months (Batieha, Khader, & Jaddou, 2011). This may be related to the cultural custom of women covering themselves with a Hijab. The majority of Jordanian women reported Hijab use (89%) or full covering from head to toe in a Niqab (11%) (Batieha et al., 2011). These garments limit women's exposure to direct sunshine and contribute to lower vitamin D levels.

Low vitamin D levels in mothers during pregnancy and while lactating can adversely affect infants (Khuri-Bulos et al., 2013). Although human milk is the ideal nutrition source for infants in the first year of life, it does not provide adequate levels of vitamin D (Jain, Raychaudhuri, & Barry, 2011). Human milk contains relatively low levels of vitamin D (25–78 IU/L) compared to fortified milk or formula (352–400 IU/L) (Wagner & Greer, 2008), and is greatly affected by maternal vitamin D intake and UVB exposure (Gordon et al., 2008). Therefore, vitamin D concentrations are especially low in breast milk from mothers who are vitamin D deficient (Gordon et al., 2008).

Despite published guidelines and public health measures, research findings indicate that hypovitaminosis D may be an unrecognized public health problem among young children in Middle Eastern countries (Abdul-Razzak, Ajlony, Khoursheed, & Obeidat, 2011; Khuri-Bulos et al., 2013). However, no data

Table 1 Sources of vitamin D

Condition/Source	Level		Reference
	Male infants	Female infants	
1. Nutritional source of vitamin D			
a. Concentration of vitamin D in human breast milk	25–78 IU/L or 25 IU/L or less		Wanger and Greer (2008); Center for Disease Control and Prevention (2008).
b. Concentration of vitamin D in fortified milk or formula	88–100 IU per 250 ml (i.e. 352–400 IU/L).		Wanger and Greer (2008); Shakiba et al. (2014).
2. Sunlight (UVB) as a source of vitamin D	Depends on latitude, season, time of day, and skin type. One study found 33 minutes around noon on a clear midsummer day in the Manchester area (UK) with 3 such exposures a week was sufficient.		Gruiji (2011) Sufficient vitamin D from casual sun exposure? Photochemistry and Photobiology, 87: 598–601.