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The relationship between physical activity and vitamin D status in postpartum lactating and formula-feeding women

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ABSTRACT

Existing research shows an association between physical activity levels and vitamin D status in the elderly, men, women, children, and adolescent populations. This association has not yet been investigated in postpartum women. We hypothesized that based on the relationship between vitamin D and physical activity found in other populations, greater physical activity levels in postpartum women will be associated with higher serum 25(OH)D levels. A *post hoc* analysis of 286 postpartum women with self reported physical activity data from the America on the Move survey, and measured circulating serum 25(OH)D (measured by RIA) as an indicator of vitamin D status, was gathered at baseline (4–6 weeks postpartum), 4 months, and 7 months postpartum. The data were analyzed using SAS 9.4 (Cary, NC). 39.9% of women at visit 1 (baseline), 52.8% of women at visit 4 (month 4), and 55.9% of women at visit 7 (month 7) were meeting the NIH recommendation of 150 min of moderate intensity (3–6 METs) physical activity per week. Significant differences were seen in physical activity by race ($p = 0.007$). Caucasians were more likely to meet the standard recommendation than African Americans or Hispanics. Using multiple regression models to examine associations between duration of physical activity and 25(OH)D concentration, controlling for race, BMI, feeding type, and METs, it was found that at visit 1, an increase in physical activity was associated with an increase in 25(OH)D of 1.3 nmol/L ($p = 0.03$) and achieving at least 2.5 h/wk of physical activity had a trending association with an increase in 25(OH)D of 7.23 nmol/L ($p = .05$). At visit 4 (also controlling for treatment group and sun exposure) achieving at least 1.5 h/wk of physical activity was associated with an increase in 25(OH)D of 11.73 nmol/L ($p = .04$). By visit 7, no association between physical activity and maternal 25(OH)D was observed. In a repeated measures, mixed model analysis predicting maternal 25(OH)D during the study, achieving at least the recommended 150 min per week of physical activity (> 2.5 h) was not significantly associated with vitamin D status (pNS). While no definitive conclusions can be drawn regarding precise levels of physical activity influencing 25(OH)D levels in postpartum women, the data suggest that increased activity during the first 4 months after birth is associated with improved vitamin D status. Additional research is needed because of the inconsistency seen at visit 7.

1. Introduction

Sufficient maternal vitamin D levels in postpartum women are essential for transfer to breast milk for their infants. Breast milk is known to be the gold standard of nutrition for infants due to its essential nutrients and immune factors, however it is often naturally deficient in vitamin D [1]. The parent compound, cholecalciferol, is the most abundant form of vitamin D to transfer to the infant through breast milk; however, maternal cholecalciferol is quickly converted to 25-hydroxyvitamin D (25(OH)D) [2]. This is the basis for maternal vitamin D supplementation. According to a study published in 2015, maternal vitamin D supplementation at 6400 IU per day provides adequate levels of vitamin D to infants through breast milk [1]. Various factors such as race, sun exposure, and body mass index (BMI) are all associated with serum vitamin D levels.

Research has also shown an association between physical activity levels and vitamin D in the elderly, men, women, children, and adolescent populations. In a study conducted by Kluczynski et al., positive associations were found between 25(OH)D concentrations and duration of recreational activity and yard work in postmenopausal women [3]. A German study reported significant associations were found between walking duration and 25(OH)D serum levels in all seasons except summer in the elderly population [4]. A Tasmanian study found that after adjustment for sun exposure, higher physical activity at baseline and greater physical activity over the two year study period (assessed by a pedometer) was associated with increased 25(OH)D levels,

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suggesting that increases in 25(OH)D as a result of physical activity may be occurring by a mechanism other than sun exposure [5]. A study conducted in Australia found that self reported exercise frequency was a significant predictor of serum 25(OH)D concentrations in adolescents, and that a lack of physical activity is a potential factor that may contribute to the relatively high level of vitamin D insufficiency in adults across Australia [6]. While the data in women of child bearing age is sparse, one study conducted in Germany found that physical inactivity was a significant risk factor for maternal vitamin D deficiency after controlling for season, vitamin D supplementation, and time spent outdoors [7].

While studies have shown the effects of exercise on infant acceptance of breast milk, milk volumes and composition, and bone density in lactating women, none have examined the relationship between exercise and vitamin D in postpartum women [8–10]. Because of the importance of vitamin D in breast milk, whether a woman can proactively increase or sustain their vitamin D levels while breastfeeding by achieving a certain level of physical activity is a vital subject that has not yet been investigated.

This study was designed to investigate the relationship between vitamin D levels and physical activity in postpartum women. We hypothesized that based on the relationship between vitamin D and physical activity found in other populations, greater physical activity levels in postpartum women will be associated with greater serum vitamin D levels.

2. Materials and methods

2.1. Participants

Fig. 1 shows the enrollment and post hoc analysis of 564 women from a randomized, double-blind, comparative effectiveness trial of 3 doses of vitamin D supplementation in lactating mothers and their breastfeeding infants (November 2005–August 2012). The women were in good general health, without any underlying chronic conditions. The study was conducted at the Medical University of South Carolina (MUSC) and the University of Rochester (U of R). Approval was granted by MUSC's Institutional Review Board for Human Subjects HR 16536 and Clinical and Translational Research Center (CTRC; Protocol 752) and U of R's Institutional Review Board (14460) and CTRC (Protocol 1129), and registered via ClinicalTrials.gov NCT00412074. Following written informed consent, mothers were randomized to one of three vitamin D treatment groups: 400 IU, 2400 IU, or 6400 IU vitamin D3 per day for the duration of the study [1].

Of the 564 women who consented, 104 were excluded due to partial breastfeeding, health status, loss to follow-up, moves, loss of interest in study, and open label vitamin D supplementation. The remaining 460 were randomized, however 174 women were excluded from this post hoc analysis due to either lack of 25(OH)D measurement, lack of physical activity data, or both. 286 women were included in the final analysis (Fig. 1). 121 women were in the control group, 38 women were in the 2400 IU group, and 127 women were in the 6400 IU group.

2.2. Measurements

The following measurements were recorded in all women included in the study.

Physical Activity: Women in the study were given the America on the Move self reported exercise survey at visits 1, 4, and 7 (America on the Move Foundation, Inc., Aurora, CO). This survey collected the type of activity performed, the number of times done per week and average duration of each session. Using the current Compendium of Physical Activities, the exercise activities were converted to metabolic equivalents (METs) as a measure of exercise intensity [11].

Vitamin D: Maternal blood samples were obtained at baseline (4–6 weeks postpartum; V1), month 4 (V4), and month 7 (V7). Circulating 25(OH)D was measured by radioimmunoassay (Diasorin, Stillwater, MN) as an indicator of vitamin D status [1].

Sun Exposure/Skin Pigmentation: The Smart Probe 400 (IMS, Inc., Milford, CT) was used at each visit to measure degree of skin pigmentation on the mother's inner and outer lower arm as an index of sun exposure. Score had to decrease by a value of 5 to indicate the skin had darkened from sun exposure, from visit 1 to 4 and then 4 to 7.

BMI: Height and weight of each mother was recorded at the first outpatient visit to determine BMI (weight [kg]/height^2 [m^2]). During subsequent outpatient visits, only the mother's weight was recorded.

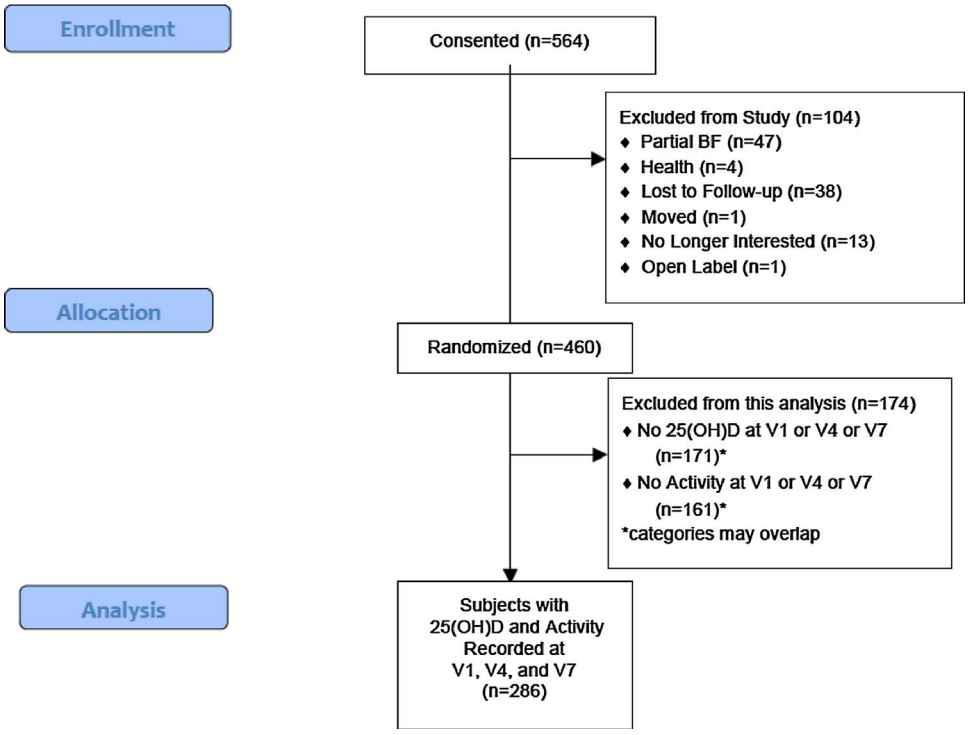

Fig. 1. Women included in post hoc analysis.