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RESEARCH ARTICLE

CROSS-SECTIONAL ANALYSIS OF VITAMIN D CONSUMPTION IN NON-INSTITUTIONALIZED AGING ADULTS IN THE US POPULATION: NHANES 2011-2012

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ABSTRACT

Background: Nutrient intake declines as a person ages. Vitamin D supplementation in older adults could potentially prevent skeletal disorders and other diseases when nutrient consumption is inadequate.
Objective: To determine the mean consumption of vitamin D consumed through nutrient intakes and supplement consumption in middle-age and older adults in the United State whom participated in the National Health and Nutrition Examination Survey (NHANES) in the 2011-2012 cycle.
Methods: The dietary intake of vitamin D (mcg) in 8,389 individuals of all age groups, who participated in the NHANES in the 2011-2012 cycle was analyzed using the respondent's dietary survey responses. The mechanism of assessment and outcome measures was conductedusing IBM SPSS software packages (version 24.0).
Results: The findings of this study demonstrated that older adults consumed less nutrient vitamin D than other age groups. The analysis of supplement consumption provided evidence that middle-age and older adults consume more vitamin D through supplements when compared with other age groups.
Conclusion: Nutrient consumption is critical to maintaining good health, especially in older adults. In the aging adult population, vitamin D supplementation can offset the decreasing consumption of vitamin D in food intake.

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INTRODUCTION

A wholesome diet is a very essential part of a healthy lifestyle. The consumption of a well-balanced diet, along with physical activity, maintaining a healthy weight and other lifestyle changes, contribute to a healthier life (President's Council on Fitness, Sports & Nutrition, 2017). The American Heart Association (AHA, 2017),American Cancer Fund (ACF, 2017) and other US recognized health organizations recommend these diet and lifestyle changes to combat diseases and mortality due to the awareness of some of the nutritional benefits in health and disease. However, the nutritional consumption of other nutrients contributes to more disease prevention and treatments than originally understood. Nutritionists and other health care providers have studied various foods and their micronutrients. The micronutrients found in foods are known to be essential players in the treatment and prevention of disease. Furthermore, a lack in the consumption or inadequate consumption of many of these nutrients can be detrimental to one's well-being.

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This is especially true in older adults. As people age, the risk of acquiring a chronic disease increases. Some of these diseases include an increased chance for heart disease, cancer and other chronic diseases such as stroke, chronic lower respiratory diseases, Alzheimer's disease and diabetes (CDC, 2013).Heart diseases and cancer have led to both disease prevalence and in the cause of death in the US. These diseases may be present in all ages, but become more prevalent as a person ages. According to Mandelblatt*et al*. (2003), almost half of all new cases and nearly two-thirds of deaths from breast cancer occur among womenaged 65 years or older. While heart disease and cancer deaths are declining, the rate of Alzheimer's disease is increasing (Tejada-Vera, 2013). According to the National Center for Health Statistics (NCHS, 2013), Alzheimer's disease is the fifth leading cause of death in the age 65 to 85 years with influenza and pneumonia also being a contributing factor to deaths among older adults (NCHS, 2013).Another illness that afflicts the aging population is hypertension. High blood pressure is a major risk factor for cardiovascular disease, the leading cause of illness anddeath among older adults(CDC, 2012).For older adults, the effects of chronic conditions and geriatric

syndromes can cause impaired mobility that can lead to dependence in activities of daily living and other adverse outcomes (Branch *et al*., 2012) such as depression and injuries secondary to falls and automobile crashes. This in turn,can lead to increased risk of death (Satariano, *et al*. 2012). Among older adults, falls are the leading cause of death. There is a wide range of injuries associated with fall among elderly and that can be moderate to severe injuries. Furthermore such injuries includes, but not limited to, head traumas (Sterling, 2001) andhip fractures (Hayes *et al*., 1993; and Parkkari *et al*., 1999). While prescription medicine and alternative therapies are available to combat these diseases, exercise and improvements in the diet are considered beneficial. It is worth mentioning that diets rich in fruits and vegetables may reduce the risk of some cancers and chronic diseases. Fruits and vegetables provide essential vitamins and minerals, fiber, and other substances that are important for good health (CDC, 2013). With many of the diseases found in aging adults, vitamin D is a potential benefit used for prevention and treatment of disease.

Vitamin D known as calciferol, comprises a group of fat-soluble steroids, which includes vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol) (Binkley, *et al*., 2011). Both vitamin D2 and vitamin D3 are found in dietary supplements or fortified foods. One of the main functions of vitamin D is its ability to increase calcium absorption. Maintaining adequate levels of calcium is vital for bone development, growth and remodeling. Studies have shown evidence that hips fractures are reduced when vitamin D supplements are consumed (Biscoff-Ferrari, 2005) and may be more effective when taken with calcium (Boonen, 2007). Flicker (2005) concluded that vitamin D could potentially prevent falls in individuals with a normal and deficient vitamin D status. While vitamin D is known for its skeletal effects, it is also known for preventing and treating heart diseases, cancer, autoimmune diseases and more non-skeletal disease. The elderly are especially susceptible to vitamin D deficiency. VanDam *et al*. (2007) added that since vitamin D in foods is low, an adequate vitamin D status will be hard to achieve. The notion that the food consumption of vitamin D is not sufficient to maintain a sufficient vitamin D status is widespread. There are additional factors asides from low vitamin D in foods that may cause a low vitamin D status in the healthy individual. These factors would include UV-B absorption and supplement absorption. Harris *et al*. (1998) found evidence that vitamin D absorption is the same in young and old individuals (males). If sufficient UV-B radiation absorption or food consumption is unobtainable, vitamin D supplementation is available. Vitamin D supplements are available over-the-counter. If high doses are required to offset severe vitamin D deficiency, physicians may prescribed vitamin D supplements to increase the vitamin D levels in the body.

Bailey *et al*. reported that males and females over the age of 71, years had the lowest prevalence of meeting the adequate intake (AI) and that supplementation was associated with meeting the AI required for that age group. Ross *et al*. reported the Institute of Medicine's recommended daily allowance(RDA) of 600 IU/d for ages 1–70 years and 800 IU/d for ages 71 years and older, corresponding to a serum 25-hydroxyvitamin D level of at least 20 ng/ml (50 nmol/liter). In the elderly, vitamin D supplementation is important in maintaining an adequate vitamin D status due to the reduction in the intake of vitamin D in food consumption. To determine the mean consumption of vitamin D consumed through nutrient intakes and supplement consumption in middle-age and older adults in the United State whom participated in the National Health and Nutrition Examination Survey (NHANES) in the 2011-2012 cycle the main goal of the study was to determine the mean consumption of vitamin D consumed through nutrient intakes and supplement consumption in middle-age and older adults in the United State whom participated in the National Health and Nutrition Examination Survey (NHANES) in the 2011-2012 cycle.

MATERIALS AND METHODS

This is a descriptive quantitative study which measured the mean consumption of vitamin D (mcg) in the middle-age and elderly populations and compared the results with the mean consumption of younger age groups. Methods for this quantitative study included a cross-sectional analysis of adult and children, both male and female, and included all ethnic groups who participated in the NHANES from 2011-2012. NHANES is a program of studies designed to assess the health and nutritional status of adults and children in the United States. It is a major program of the National Center for Health Statistics (NCHS) which is part of the Centers for Disease Control and Prevention (CDC). The data reported from the studies were collected from combined interviews and physical examinations. NHANES surveys use a stratified, multistage, probability sample of the civilian noninstitutionalized U.S. population. Information from the NHANES data sets were used to thoroughly explain the methodology prior to the study analysis(National Center for Health Statistics, 2014). The resources forstudywas open to the public and therefore it has been exempt from human subjects ethics review. Nutrient consumption of vitamin D included the reported dietary consumption of vitamin D (mcg), which was obtained in food. Supplement consumption included the intake of all dietary supplements with the ingredient of vitamin D2, vitamin D3 or both (vitamin D2D3). Data collected from the supplement and nutrient survey responses were analyzed to conclude this study. This was accomplished by comparing the means of the nutrient vitamin D group (NVD) and the Supplement Vitamin D groups (SVD) using the IBM SPSS Analytics Version 24.0. The level of significance was set to 0.05 with a 95% confidence interval (CI).

RESULTS

The findings of this study demonstrated that aging adults consumed less nutrient vitamin D than other age groups in 2011-2012. In nutrient consumption, middle-aged and older adults consumed a vitamin D consumption means ranged between 4.57 and 4.80 mcg, while middle-aged and older adults consumed a vitamin D consumption mean range of 28.85 and 41.99 mcg; respectively. The young adult group had similar consumption means for nutrient consumption. However, evidence was found thatyounger age groups consumed more vitamin D through foods. Referring to supplement consumption, it was observed that middle-aged and older adults consume more vitamin D through supplement consumption when compared to younger age groups. This data can be seen in table 1 and is illustrated in Figures 1 and 2. An ANOVA analysis was performed to compare the means of vitamin D consumption (mcg) between groups. It was determined that there is a statistically significant difference between means ($p<.001$) for groups using the nutrient and the supplement consumption methods.

Table 1. Vitamin D Consumption (mcg) by Age Groups

Consumption Method	Age Group	Sample Size (n)	Mean Consumption (mcg)*
NVD (mcg)	Infant	456	8.52
CY3	Toddler	834	6.56
	Child	1146	5.69
	Teen	1152	5.13
	Young Adult	1714	4.60
	Middle-Aged	2055	4.57
	Older Adult	1032	4.80
	Total	8389	5.25
SVD (mcg) CY3	Infant	61	10.49
	Toddler	200	8.96
	Child	191	10.53
	Teen	100	15.69
	Young Adult	291	24.97
	Middle-Aged	590	28.85
	Older Adult	499	41.99
	Total	1932	26.53

Analysis for mean consumption comparison by age groups.
**Missing data is excluded for age groups and consumption values, data is otherwise unweighted*

were the same.More details of these results are found in Table 2. In reviewing the results of the supplement consumption of vitamin D (Table 3), the middle-aged adult group was found to have a significant mean difference, however, there was evidence that the older adults consumed more vitamin D through supplements when compared to all other groups with the exception of the middle-aged group. Significant differences in consumption (mcg) were found betweenthe older adult group and the infant (p = 0.031), toddler (*p<0.001*), child (*p<0.001*), teen (p = 0.022), and the young adult group (p =0 .033).

DISCUSSION

According to the literature, nutrient consumption is a key element in maintaining good health, especially in older adults. Results from this study revealed that aging adults consume less vitamin D through nutrient consumption when compared to the younger age groups.

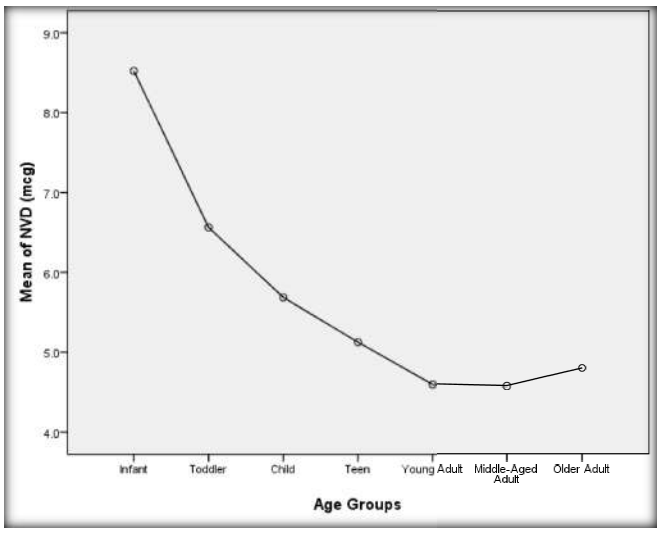

Figure 1. Mean plot of vitamin D consumption (mcg) through nutrient intake by age groups

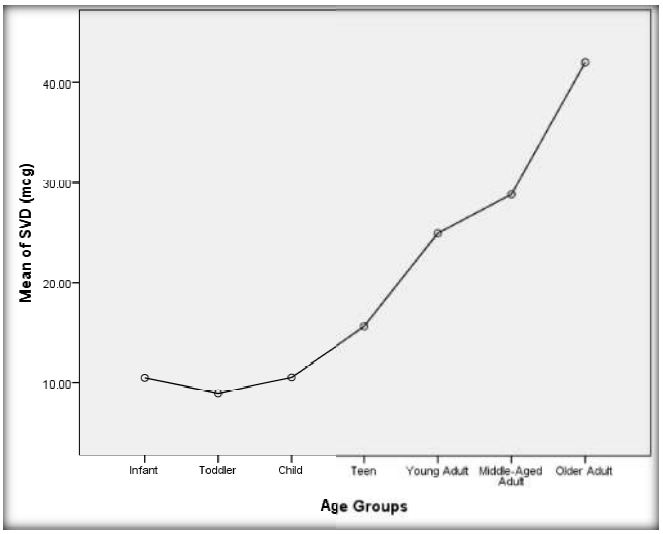

Figure 2. Mean plot of vitamin D consumption (mcg) through supplementation by age groups

Table 2. Mean (±SE) Consumption Comparison of NVD within Age Groups*

Dependent Variable	Age Groups	Age Groups	Mean Difference	Std. Error	Sig.
NVD (mcg)					
	Middle-Aged Adult	Infant	-3.95*	0.27	0.001
		Toddler	-1.99*	0.22	0.001
		Child	-1.11*	0.20	0.001
		Teen	-0.55	0.20	0.069
		Young Adult	-0.02	0.17	1.000
		Older Adult	-0.23	0.20	0.917
	Older Adult	Infant	-3.72*	0.30	0.000
		Toddler	-1.76*	0.25	0.000
		Child	-0.88*	0.23	0.002
		Teen	-0.32	0.23	0.791
		Young Adult	0.21	0.21	0.956
		Middle-Aged	0.23	0.20	0.917

Analysis for mean consumption comparison within age groups.
**Missing data was excluded for age groups and consumption values, data was otherwise unweighted.*

A Tukey post hoc analysis was performed to compare the differences in means within the age groups for both nutrient and supplement consumption and illustrated in Table 3. Results indicated that there were statistically significant differences in the vitamin D nutrient consumption of middle-aged adults when compared with the infant (*p<0.001*), toddler (*p<0.001*) and child groups (*p<0.001*). The quantitative outcomes of vitamin D nutrient consumption of older adults

The quantitative outcomes obtained from this study demonstrated vitamin D supplement consumption ranked the highest among middle-age and older adults when compared with other age groups. Several documented studies signaled the traumatic as well as rise in treatment cost associated with vitamin D deficiency or intake. Looker *et al*. (2002) and Parfitt *et al*. (1982) have shown in detailed cohort study that there was evidence of vitamin D deficiency in the aging population in

Table 3. Post Hoc Comparisons of Mean (±SE) Consumption of NVD and SVD within Age Groups:**

Dependent Variable	Age Groups	Age Groups	Mean Difference	Std. Error	Sig.*
SVD (mcg)	Middle-Aged	Infant	18.36	10.03	0.528
	Adult	Toddler	19.89*	6.10	0.020*
		Child	18.31	6.21	0.051
		Teen	13.16	8.07	0.662
		Young Adult	3.88	5.34	0.991
		Older Adult	-13.14	4.54	0.058
	Older Adult	Infant	31.50*	10.12	0.031*
		Toddler	33.03*	6.24	0.001**
		Child	31.46*	6.35	0.001**
		Teen	26.30*	8.17	0.022*
		Young Adult	17.023*	5.50	0.033*
		Middle-Aged	13.14	4.54	0.058

Analysis for mean vitamin D consumption comparison versus age groups.
** Significant at the indicated level.*
***Missing data is excluded for age groups and consumption values, data is otherwise unweighted*

which triggered significant medical conditions. Results from this comparative consumption study agree with previous findings. Data obtained from this investigation also observed an inadequate mean intake of vitamin D through nutrients for the middle-aged. Russell *et al*. (1999) suggested that theelderly population was vulnerable to compromised nutrient intake due to the decrease energy needs which necessitate a decrease in food intake. Inadequate nutrient intakes have been reported in the rural-dwelling elderly population and this was also associated with vitamin D deficiency. These reports coincide with the lower mean consumption of the aging adults in this study. With the increase in consumption of supplements, there was an increase of vitamin D levels in the elderly (Bailey *et al*., 2010). Regardless of strict regulations and policies and somehow the lack of strong enforcement led to previously mentioned observations. It is obvious that vitamin D supplements are necessary to meet the RDA in the elderly, however, it is still not fulfilled in the practice fields. . This study proves that as an individual ages, theirvitamin D supplement consumption increases, and warrants the necessity of monitoring the healthy aspects of food intake.

Conclusions

With the advances in technology and early detection of diseases led to a major growth in ageing population. In health care setting an increase in aged population leads to greater health concerns, however, the desire to consume food for energy decreases. Without proper nutrition, the probability of poor health, immobility, disease and death becomes exacerbated. This study examined the mean vitamin D consumption of the aging population and provided evidence that vitamin D consumption through nutrients is lower in the aging population when compared to younger age groups. Nevertheless, it is observed that the aging population consumes more vitamin D through supplement consumption when compared to the younger age groups.

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