HIGH SCHOOL EDITION
Journal of Student Research
Volume 12 Issue 2 (2023)

Analyzing the Prevalence of Fat-Soluble Vitamins in the Diets of Georgian Elderly Care Facilities

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ABSTRACT

Vitamin overdose is often not researched in comparison to its counterpart risk, malnutrition. As the general topic of vitamin overdose is already under-researched, I specifically looked at fat-soluble vitamins (Vitamins A, D, E, and K) in elderly care facilities in Georgia to determine if any posed the unrecognized risk of vitamin over supplementation. The examination of these risks are paramount since many elderly residents are dependent on the facility to provide food as well as their supplements. Thus, this would mean that even a facility-provided diet high in vitamins may assume a vitamin risk since supplementation on top of this diet is unnecessary and may lead to over supplementation. Other commonly researched risks are also explored by analyzing prevalence. Through a sequential mixed methods approach, I analyzed qualitative interviews on medical and dietary staff from 8 respective care facilities to determine dietary vitamin intake and content analyses on their meal plans for supplemental intake. The results of my study found that there were no conclusive vitamin deficiency risks, most vitamins were in the adequate range, and Vitamin A and potentially Vitamin D were at the highest risk for over supplementation. These factors may be due to the common emphasis of vitamins in diet (as opposed to supplements) and the frequent shift in supplement responsibility to medical professionals. Thus, future research should look at the extent of this issue in Georgia and potential prevention measures.

Introduction

Vitamins, a type of supplement that provides the body with targeted nutrients, have historically provided a way to counter many diet-related deficiencies such as scurvy, beriberi, and pellagra (Semba, 2012). Even now, they have grown to become an integral part of the diet of developed regions, especially since higher life expectancy has been met with the enlargement of numerous geriatric nutritional concerns (Flesner, 2004). In fact, among the users of vitamins in the United States, the elderly population constitutes the largest majority "with 34-49% of older adults regularly tak[ing] a MVMS [multivitamin]" (Blumberg et al., 2018). Alongside the prevalent use of these supplements has been heightening debates regarding the apparent versus genuine benefits of taking vitamins. Many studies have analyzed general vitamin risks including vitamin deficiency and vitamin overdose (Blumberg et al., 2018; Hamishehkar et al., 2016). One of the disastrous consequences of both risks is how they can lead to the development of life-threatening chronic or nutritional diseases, including lung cancer, prostate cancer, and rickets (Hamishehkar et al., 2016; Semba, 2012). There is limited research, however, in applying these vitamin-related issues to the well-being of elderly care residents, meaning that the absence of modulating diet in relation to broader vitamin matters may have fatal effects on the frail health of residents. Therefore, further research in evaluating the potential causes of elderly malnutrition through this lens must be done in order to adequately address its substantial consequences.

Pre-existing research suggests that malnutrition is already a well-researched problem in elderly residential settings because of the presumed lack of motivation and frailty of residents (Miettinen et al., 2017). Consequently, many nursing homes have already incorporated vitamin supplements in hopes of tackling these

deficiencies (Miettinen et al., 2017). As this has long been the focus of dietary concerns in residential facilities, it neglects other factors contributing to poor nutrition, such as vitamin over-supplementation. This gap is highlighted by a single study that found over-supplementation of Vitamin D in their study of the prevalence of supplement usage in long-term care facilities (Viveky et al., 2012). As the study had never anticipated vitamin over-supplementation, there may be many more unrecognized overdose problems within other residential facilities (Viveky et al., 2012). Therefore, it is in our best interests to investigate the levels of vitamins within elderly residential care homes.

Literature Review

To thoroughly analyze the prevalence of vitamins in elderly care facilities, it is important to look at the pre-existing research in this field of study. Through an extensive examination of the literature, I determined three emerging themes on this topic: the recurrent concern of malnutrition, vitamin roles in aging, and vitamin overdosage.

Malnutrition in Facilities

There are few studies looking at the extensiveness of vitamins in elderly diet; however, some studies do look at the extent to which vitamin risks pose a threat to its occupants. These studies examine how malnutrition is a growing issue in these establishments, mainly as a result of ineffective guidance policies (Gaskill et al., 2008; Verbrugghe et al., 2013). As found by Gaskill and her colleagues in eight distinct aged residential care facilities, "Half the residents were well nourished (50.5%) with 43.1% moderately malnourished and 6.4% severely malnourished." Similarly, Verbrugghe's research team recognizes that in a study of 23 nursing homes in Belgium "38.7% were at risk for malnutrition and 19.4% were malnourished." This suggests that malnutrition has maintained an issue in many facilities despite ongoing efforts, such as the aforementioned government policies and local support, to curb it. The studies are limited as they do not relate vitamins to the problem of malnutrition; instead, many look at other ways to determine malnutrition, such as screening tools and interviews on appetite (Isenring et al., 2009). Rather, it can only be inferred indirectly that vitamin deficiencies are a major basis of malnutrition since it causes issues like sarcopenia and frailty, also often linked to vitamin deficiency diseases (Bunn et al., 2018). By analyzing malnutrition alone, only an effect of the prevalence of vitamins is being inspected as opposed to the cause or vitamin deficiency itself.

Role of Vitamins in Aging Diet

Researchers similarly conclude that aging substantially impacts vitamin needs. According to Troesch et al., age and the closely related pathologies (such as cardiovascular diseases, dementia, and Alzheimer's disease) result in various changes to food intake and utilization. More specifically, they experience a decline in the ability to detect hunger, a decrease in the efficiency of the stomach (malabsorption), and a lower appetite because of reduced taste and teeth sensitivities. These, in addition to other factors such as decreased muscle mass, all lead to an increased risk for malnutrition (Troesch et al., 2012). While statistics show that 70% of people older than 65 are also susceptible to non-communicable diseases like diabetes, Troesch et al. explain that these threats could easily be reduced through changes in nutrition, thereby noting the major role diet plays in the wellbeing of the elderly.

Within diet, the vitamins levels required by residents to adequately improve nutritional status are further investigated by other researchers on this topic. According to Roman et al. (2008), an ideal diet for this age group is one that follows the Mediterranean diet, which generally follows this format: "abundant plant foods

(fruits, vegetables, breads, other forms of cereals, pulses, nuts and seeds); minimally processed, seasonally fresh and locally grown foods." This relates to our discussion since, as expected, this diet is high in vitamins that help curb the development of many of the aforementioned chronic illnesses (Vaquero et al., 2003). The vitamins in this diet can also be closely connected to the types of vitamins researched in this paper. Vitamin E, in particular, is ubiquitous through this dietary style and can be reflected in the high amounts present in the mentioned nuts, seeds, green leafy vegetables, and vegetable oils (Rizvi et al., 2014). The other vitamins, A (vegetables and cereal), D (saltwater fish and fish-liver oil), and K (spinach and plant oils), are also present (Corless, 1973; Thomas, 2006). Other diets like the vegan and vegetarian diet, target different food groups, also improving (Vitamin D) or reducing (Vitamin B12) elderly vitamin intake (Kwok et al., 2004; Woo et al., 2014). Thus, it would be beneficial to look at the type of diet that a residential facility adheres to, as it may have a direct influence on vitamin levels.

The pre-existing research summarizes the importance of specific vitamins in the diet of the elderly since they enhance wellbeing and diminish risks of common chronic ailments. The studies are limited, however, since many of the studies do not look at vitamins specifically in residential facilities but aim toward the more general risks of the elderly. Few studies also look at the dietary patterns in the facilities in relation to vitamin patterns, when analyzed may improve the ability to effectively implement nutritional changes.

Vitamin Over Supplementation

Unlike many of the studies mentioned, vitamin over-supplementation remains the least researched compared to the other themes. As it is natural to think of senior subjects as frail and sickly, few works investigate the other side of the spectrum. A study conducted by Goorang et al., recognizes that "some of them [institutionalized elderly residents] may face undernutrition and require more energy, protein and micronutrients"; nevertheless, her team still puts an emphasis on the fact that "taking too many drugs as well as dietary supplements, risk of duplicative use as well as drug-nutrient interactions is high in this population." While her group's study is one of the few whose demographic centers on institutionalized elderly people, it is still limited in that the results are not analyzed through an in-person examination but rather through looking at this topic through other studies' conclusions (Goorang et al., 2015). As mentioned earlier, research conducted by Viveky et al. found over-supplementation but likewise to Goorang et al., indirectly and unintentionally. Moreover, vitamin overdose seems to have negative implications on health, leading to polypharmacy, ineffective results, or chronic diseases (Hamishehkar et al., 2016; Viveky et al., 2012).

Previous research exposes a significant gap in knowledge on vitamin overdose in elderly residential homes. Furthermore, existing research on vitamin intake in residential homes tends to solely analyze it through the supplements the facility provides (Goorang et al., 2015; Viveky et al., 2012). As diet is one of the most important forms of vitamin intake, only investigating vitamin intake from supplements is not enough for determining the risks that the facility has (Bates, 1997). Including vitamin intake from the diet as well as acknowledging that the elderly do not intake all the vitamins they digest (malabsorption) may change the understanding of overall nutritional issues, perhaps even resulting in findings of vitamin overdose (Troesch et al., 2012).

Summary & Gap

Therefore, while most studies focus on the problem of malnutrition and others explore the specific roles that vitamins play in the elderly diet, few studies examine vitamin intake and almost no studies examine vitamin over-supplementation within residential homes. Moreover,
there are other gaps within this research, including failure to take into consideration meal plans (focus on only vitamin supplements may overlook vitamins within diet) and a vacancy in studies on American locations (Bamford et al., 2012; Flesner, 2004; Kwok et al., 2004; Viveky et al., 2012). This implies that future research should

not only consider dietary vitamin intake but also strive to examine if these issues are present in specific American regions. Altogether, these factors culminate into a larger gap of the vitamin risks, especially vitamin overdose, within American elderly residential facilities.

Therefore, in an attempt to address the aforementioned gaps, this research seeks to quantitatively investigate the prevalence of vitamins in Georgian elderly care homes by comparing the *overall* vitamin levels (dietary and supplement intake) of elderly residents to recommended RDA levels by experts. Studying prevalence will give an overall view of nutritional problems, especially insight into vitamin over-supplementation, as opposed to studying just one facet of the issue.

Hypothesis

I predict that vitamins, specifically Vitamin D, are sometimes unknowingly used in too high of a percentage in elderly residential diets because of the assumed malnutrition in care facilities (Viveky et al., 2012). I still believe some facilities are not giving enough vitamins, like Vitamin K, because of low-salt restrictions that may deplete this supply (Suttie et al., 1988).

Methodology

The research aims to answer the guiding research question: "to what extent are fat-soluble vitamins (Vitamins A, D, E, and K) integrated into the diets of elderly residents?" The question assumes that fat-soluble vitamins are of higher priority because of their higher risk; however, other over supplementation cases should not be ignored (Hamishehkar et al., 2016).

An exploratory sequential mixed-methods study was employed. An exploratory sequential mixed-method study involves "an initial qualitative phase of data collection and analysis, followed by a phase of quantitative data collection and analysis, with a final phase of integration or linking of data from the two separate strands of data" (Berman, 2017). This approach, thus, allowed for the quantitative and qualitative analysis of vitamin intake by the elderly. This approach is essential since conducting only one part of the study, such as the content analysis on meal plans (quantitative), would not have given detail on qualitative aspects like rationales for why certain vitamins are administered. Also, to address the shortcomings of other studies, I needed a study that allowed me to gather data using two different methods (from diet and from supplements). The overall vitamin intake, necessitating two methods, therefore fit nicely with the goal of a sequential mixed-methods study, which aimed for the final integration of the two separate data. Other procedures utilized by previous studies, such as a cross-sectional survey or longitudinal study design, ultimately found one type of data, only further widening the gap of determining intake solely through supplements (Chan et al., 1990; Subar & Block, 1990). These findings are supported by Vitolins et al. (2000), who also uses a mixed-method approach, only with different instruments.

My sequential mixed-methods design was comprised of two methods: an initial qualitative interview (with quantitative aspects to determine supplement intake) and a quantitative content analysis of meal plans. In addition to the gap of analyzing only supplemental vitamin intake, the previous methods' studies also do not have evidence of a study conducting a menu content analysis to determine dietary vitamin intake. This research thus performs a mixed methods and meal content analysis of dietary intake, adding to previous studies in this field.

Subjects

Those eligible for my study were Georgian elderly care facilities, such as LTCs and nursing homes, with standardized meal plans. A sample size of 8 facilities was appropriate because exploratory research serves to provide a basis to whether the problem exists at all and if it does, to allow other researchers to delve deeper into the issue. Therefore, a large sample size was not necessary. Georgian facilities were chosen to address the gap of a lack of research on American locations, as it addresses a specific American region. All staff interviewed played a role in the meals or supplements of residents to ensure that they had an accurate representation of the overall diet/supplements provided by the facility. Those without a standardized meal plan were excluded since it would be difficult to analyze dietary vitamin intake based on personal choices (which would also not be an issue caused by the facility).

Sampling Procedure

The sample follows a convenience sampling method, which is a nonrandom sampling targeting participants with easy accessibility (Alkassim & Tran, 2016). This design was chosen because it was the fastest way to get participants within a 2 month time frame. Covid-19 also made it harder to go to places like elderly facilities in-person (risking the health of residents), so some interviews were conducted via phone. Before the interview, I assured the anonymity of the staff members and did not include any names of staff or the facility (letters, such as "Facility A," were also used). An oral consent form was provided, stating the interviews were voluntary, and participants were recorded during the study so I could relisten to ensure valid data. Identifying information was also deleted after. The study was approved by the IRB, so ethical concerns were not violated.

Research Instruments

Interview Protocol & Qualitative Interviews

I have included an IRB-approved interview protocol that involves an in-depth process of notes about privacy, the recording process, and a request for the meal plan at the end of the interview. The protocol was based on the one modeled by Jacob & Furgerson (2012) but slightly modified the order to fit my mixed-methods approach (adding a step to collect the meal plan). In regards to the interview, the main goal was to give insight into the diets of residents (qualitative perspective and insight on lurking variables), specific diseases that may impact vitamin needs (lurking variable), and specific vitamin supplements and frequency of provision. To increase interpretive validity, quotes from participants were included in the results. All questions can be viewed and are justified in Appendix C. Interviews took from 5 to 30 minutes, and there were ten open-ended questions.

Food Frequency Questionnaire (FFQ) Calculator

To conduct my menu content analysis on vitamin levels within diet, I used a food frequency calculator. First of all, a quantitative content analysis is defined as "a research method in which features of textual, visual, or aural material are systematically categorized and recorded so that they can be analyzed" (Coe & Scacco, 2017). As my data required quantitative analyses of meal plans (visual/textual material) to determine dietary vitamin intake, this method was the only choice for this goal. To perform this content analysis, an instrument with the ability to calculate vitamin levels had to be chosen. A food frequency calculator "is based on the participant's frequency of consumption" and "amount of nutrient in the serving size indicated" (Pritchard et al., 2010). My rationale for a content analysis of a meal plan rather than a questionnaire is that it looks at exact food frequencies

rather than approximations by residents. I would also address a gap in previous literature. This instrument is also well-validated by this journal, which states, "The USDA National Nutrient Database for Standard Reference is the standard reference database reporting the amount of nutrients in over 7,500 foods commonly consumed in the United States." (Pritchard et al., 2010). It has been professionally used to calculate nutrient levels and up-to-date.

Recommended Dietary Allowance (RDA)

My final instrument for analysis is the Recommended Dietary Allowance, which lists the average nutrient levels recommended daily (*U.S. Department of Health*, 2020). Furthermore, these nutritional recommendations come from the Food and Nutrition Board of the Institute of Medicine, which is a trusted government source that makes "authoritative judgments" on food intake, health, and nutrition; this makes it an effective choice in comparing vitamin intake within facilities (*U.S. Department of Health*, 2020). All the fat-soluble vitamins of this study, A, D, E, and K, are included within these recommendations (*U.S. Department of Health*, 2020).

Analysis Method

Three measures were calibrated for each facility. A dietary intake average was calculated through vitamin levels obtained from the meal plans of the facility (inputting all menu items into FFQ Calculator as shown in Appendix F), supplement intake range was calculated from the interviews of the staff members (coded for dosage and frequency as shown in Appendix E), and overall intake was acquired by adding both together (as shown in Appendix G through tables for each facility). Averages for dietary intake was used since food choices usually were an in-between (0 to all snacks/sides) while supplements ranged widely. Residents in the facility were considered deficient if their dietary intake for the vitamin "was less than ⅔ of the recommended dietary allowance (RDA)" for ages 51 and older (Vitolins et al., 2000). On the other hand, greater than the upper limit recommended by the RDA was considered exceeding (Gloth, 2008). Data for all the facilities was then analyzed to determine the probable vitamin deficiency, overdose, or normal for each vitamin in each facility and then discussed in regards to interview themes.

Results

Quantitative Results

Meal Content Analysis

Meal plans were obtained from all eight facilities. Table 1 depicts the criteria (RDA) and the frequency of facilities that met the conditions for vitamin deficiency, normal (adequate vitamins), and exceeding upper intake level (UL) per vitamin. Two facilities (Facilities A and B), however, did not disclose any information about vitamins due to concerns with the privacy of residents or lack of knowledge. Thus, these two facilities were not included in Table 1; only dietary vitamin intake could be calculated from these facilities, which would skew the data on the combined dietary and supplemental intake of the other six facilities.

Table 1. Recommended Daily Allowances and Frequency of Facilities with Vitamin Deficiency, Adequate Vitamins, and Exceeding UL Per Vitamin.

	RDA	UL (Tolerable Upper Intake Level)	Lower Vitamin Intake (min)	Vitamin Deficiency (n)	Adequate vitamins (n)	Exceeding UL (n)
Vitamin A Male Female	3000 (IU) 2333.333 (IU)	10000 (IU)	2000 (IU)	0	3	3
Vitamin D 51-70 >70	600 (IU) 800 (IU)	4000 (IU)	400 (IU) 533.333 (IU)	0-2	3-5	0-2
Vitamin E	15 (mg)	1000 (mg)	10 (mg)	0-1	5-6	0
Vitamin K Male Female	120 (g) 90 (g)	ND ND	80 (g) 60 (g)	0	6	N/A

Note. n = number of facilities meeting those conditions (ranges are based on if the lowest/highest supplement ranges for facility resulted in different results)

Recommended Daily Allowance (RDA) based on USDA reference table.

ND = no data

As perceived through Table 1, all facilities for the four vitamins had a low or no concern with vitamin deficiency (consistently 0 or at most 2 facilities met condition), matching the overall predictions of Miettinen et al. (2017).

Results for adequate vitamin intake varied from vitamin to vitamin. Vitamin K manifested as normal in all six facilities. For Vitamin A, the number of facilities meeting the conditions for adequate vitamins or exceeding the UL were split (3/6 or 50% each). In terms of vitamin over supplementation, Vitamin A also assumed the highest risk since 8/8 or 100% of facilities already met the condition for adequate vitamin intake with just dietary intake. All other facilities for vitamin A dietary average intake were generally much higher with Facilities E (10146.985) and H (11193.25) even exceeding the UL of 10000 IU with average dietary intake alone. Looking at Vitamin D, most facilities achieved adequate total intake (50% to 83.3%), but 2 facilities were potentially over-supplementing the vitamin (2/6 or 33.3%). Finally, Vitamin E had almost no risks concerning exceeding the UL or falling short of the lower intake since likely 5/6 or all 6 facilities are in the adequate vitamin range (83.3% or 100%).

In short, these numbers answer my research question since I was able to determine the total fat-soluble vitamin intake from the residents of these six facilities; thus, this determines the "prevalence of fat-soluble vitamins in the diets of Georgian elderly care facilities." The major findings of the analysis of these risks were: vitamin deficiency was not a major concern in any of the facilities (first literature theme), most vitamins were in the adequate vitamin range, and while most vitamins did not exceed upper intake, Vitamin A (Facilities E,

D, H) and potentially Vitamin D (Facilities F and H) were at the highest risk for vitamin over supplementation (third literature theme). My final literature theme (diet) will be explored in the next section.

Qualitative Interviews

While the quantitative data provides much insight on my research question, I believed it was too basic to fully *analyze* the prevalence of fat-soluble vitamins in the diets of elderly residents – especially the elements that surround the prevalence. The interviews were analyzed by carefully transcribing the data (Appendix D) and then coding it to determine emerging themes. Specifically, the qualitative coding followed the layout of Fereday and Muir-Cochrane (2006), who guided this process in 6 essential stages: the development of a code manual based on interview questions (as shown in Appendix D), testing the codes, rereading the data, developing more codes, connecting the codes to find emerging themes (See Appendix E), and legitimizing these themes (Figure 1).

Themes:	Example Codes:
Dietary and Vitamin roles in Facility Factors contain any job that the participant has that deals with food (dietary) or vitamins. The facility's responsibilities towards vitamins can also be included.	• Preparing meals • Give prescription of vitamin based on doctor • Focus on vitamin in diet rather than supplement
Mandatory Guidelines for Vitamins These include restrictions on how much vitamins the facility can give a resident, state, or any other vitamin restrictions.	• Doctor or nurse practitioner's orders • Can't answer • Any state policy for licensed facilities
Causes for Vitamin Risks These are diseases, medical-related disorders, or other factors that the participant believes are causing vitamin concerns.	• Not really disease but deficiency • Age-related, degenerative (osteoporosis) • Lacking diet • Environment (country with little sun)
Feelings Regarding Vitamins These are any overall sentiments that participants feel towards vitamins in general, at their particular facility, or towards the elderly population.	• Essential to geriatric • Build immune system to prevent • Especially important during pandemic
Common Vitamins These are common vitamin supplements prescribed in the facility to residents.	• Vitamin D3 • Vitamin K2/potassium • Multivitamins

Figure 1. Prevailing Themes of Interview.

By condensing the interviews into these 5 respective themes and unique codes, they aid in developing a comprehensive understanding of the role that vitamins play in these facilities. Therefore, I explored the 2 most prevalent themes that impact this supplemental environment.

Dietary and Vitamin Roles in the Facility

Essentially, the theme contained roles that participants had in the facility, individual perceived responsibilities towards vitamins, and overall roles of the facility in placing vitamins in diet or supplements. Many facilities had similar feelings regarding their responsibilities towards vitamins. Rather than focusing on vitamins through supplements, they tended to focus on providing vitamins through diet (5 out of 8 facilities). According to Facility E, "And the dietician who works here, she's more like food first. They have wounds, they'll get a Zinc or Vitamin C, but it's not like we push push vitamins." Additionally, Facility H mentions, "we don't prescribe supplements…that's how we supplement as far as vitamins are concerned, we try to ensure that it's a well-balanced diet." Although worded differently, Facilities A, B, and C also expressed these same sentiments. This reasoning supports one of the factors analyzed in Bates' study (1997) since it shows how facilities do indeed place an importance on vitamins in diet, making an analysis of diet essential for vitamin prevalence. Thus, this factor is related to my research question since overall feelings of a dietary focus on vitamins would impact the table values of vitamin supplementation versus vitamin dietary intake, describing a significant element that impacts prevalence.

When asked to describe diets, menus, and roles in interview questions 2 and 10, facilities did not mention any specific diet they followed. Like mentioned above, facilities, rather, focused on trying to include vitamins through "a stability in it [through] balanc[ing] their diet…giving them chicken or you're giving them pork or beef, you have to get something that goes along with it that balances it out" (Facility B). This is contrary to what was expected in literature review theme 2, which hinted that specific overall dietary patterns were one of the factors that influenced the vitamin intake outcomes (Vaquero et al., 2003; Kwok et al., 2004; Woo et al., 2014). Thus, the findings of the majority of the facility following no overall dietary pattern answer the research question since they show an element (specialized diet or lack thereof) that seem to not substantially impact vitamin dietary prevalence results.

Mandatory Guidelines for Vitamins

Another prominent theme that emerged from my interview questions was the "Mandatory Guidelines for Vitamins" or the restrictions that facility staff followed when prescribing vitamins to residents. While I at first wanted to gain knowledge on specific restrictions that limited vitamin supplementation or ensured everyone was getting enough vitamins in their diet, all the staff I talked to in the facilities were only able to give me vague answers. None of the facilities could describe any specific restrictions they followed besides "the guidelines set by Georgia" or under "the guidance of the state" (Facilities C and F respectively). More commonly, participants mentioned that "we have to follow the physician's orders," "just follow doctor's orders," and other of the same ideas (Facilities F and G sequentially as well as B, D, C, E, and H). This was true in 7 out of 8 facilities. These results almost mirror the research done by Joseph Williams and Carol Williams (2020), where the participants (care home staff) all saw the vitamin "supplementation as the responsibility of the GP [medical professional]." The major findings of vitamin guidelines being centered on other medical professionals as well as the limits of the staff on describing specific guidelines show the role of most facility staff on the implementation of vitamins in residents' diets, thus answering the research question by describing how an element (staff/facility role limits) impacts vitamin prevalence.

Discussion

Many of the findings of my paper clashed with the predictions in my initial hypothesis. Although I predicted the under supplementation of Vitamin K in some facilities, Vitamin K deficiency posed an issue in none of the facilities. Shockingly, vitamin deficiency did not seem to be a problem at all since facilities had 0 dietary deficiency in Vitamin A and K and no conclusive deficiency risks in Vitamin D (ranged from 0 to 2) and Vitamin E (ranged from 0 to 1). This contrasts from what I found in my literature review since most of my other studies found malnutrition to be a growing concern in the elderly population (Gaskill et al., 2008; Verbrugghe et al., 2013). As I found no concern, this relates to my research question by showing that the overall prevalence of fat-soluble vitamins at these facilities were not characterized by vitamin deficiency. To further examine this contradictory trend and therefore this prevalence, I looked at the interview themes of "Dietary and Vitamin Roles" and "Mandatory Guidelines." My findings in these themes were important since they gave me insight into the roles that nurses and meal providers had in the implementation of vitamins in residential diets, thereby analyzing the aforementioned vitamin prevalence results (helping answer the research question more aptly).

Specifically, "Mandatory Guideline" noted how staff relied on other professionals for residential supplement intake, limiting staff roles in residential supplementation. Joseph and Carol Williams' (2020) wrote that this may be because "care home staff fear overstepping their role" and so they "defer to medical professionals to diagnose vitamin D deficiency." Thus, as staff job qualifications are perceived as limits to their role in vitamin supplementation, this suggests that most staff can only really implement vitamins to residents through diet (signified in interview theme "Roles"). According to Chen et al. (2007), "Most diets are low in Vitamin D and intake from the few vitamin D-rich or enriched foods typically occurs only intermittently," implying for vitamins that are not contained in many foods, achieving adequate vitamins levels through just diet is difficult. These trends mean that vitamin deficiency in facilities should've been more prevalent for non-dietary based vitamins, where staff had little influence, compared to dietary-based vitamins. However, my results contradict these themes since all vitamins in the facilities, regardless of dietary or non-dietary, had no significant results of deficiency.

This means an outside factor must have influenced these results since they are not supported by the overall perceptions of the facilities. One researcher remarks that change in facilities over the past years to implement supplement changes should be considered, which may be one factor that explains the lack of deficiency risks (Miettinen et al., 2017). However, my inclusion of both dietary *and supplement intake* in my tables may also have played a role, validating my methodology choice of a mixed-method study. My choice of interviews was also supported since my themes helped rationalize my results.

This is better signified by my next major finding since Vitamin A, a dietary-based vitamin, was unexpectedly high in all facilities. Table values for dietary intake alone show that all eight facilities had already met the adequate vitamin intake through diet. Ofoedu et al. (2021) bolsters this idea by recognizing how Vitamin A is "derived from diets in foods of animal origin," emphasizing the vitamin's ease in application to diet. Consequently, the other aspect of my hypothesis was partially supported since over supplementation was found but in a different way than I expected. I originally believed Vitamin D would be over supplemented as it was in Viveky et al. 's study (2017); however, there was no conclusive evidence to support this (only 0-2 facilities may be at risk). Rather, my research finds conclusive risks for over supplementation in Vitamin A in 3 facilities and almost 2 other facilities (Facilities C and F both had combined intakes over 9000 IU, almost exceeding UL of 10000). Thus, not only did my research determine that vitamin over supplementation was an actual risk in elderly facilities, but my finding also found an entirely new risk within vitamin over supplementation research: the risk of Vitamin A over supplementation in care facilities. In summary to the research question, the prevalence of Vitamin A was characterized to be high, sometimes even assuming over supplementation, in these facilities.

Conclusion

Considering the limitations, the methodology of the research for this field should be adjusted in future studies. As these facilities have been shown to be overall normal for vitamins E and K, I suggest that future studies shift their attention on the risks of vitamin over supplementation in Vitamin D and particularly Vitamin A. In regards to over supplementation, future studies looking into Vitamin B as well as C in facilities may also be valuable since these were prevalent vitamins in some facilities (C, D, E, F, G). This study, thus, not only filled gaps in previous research by providing insight on American locations and providing a unique procedure to analyze it, but it also opens the doors for more similar types of research in Georgian facilities.

I interviewed staff in dietary roles and nurses, but I suggest for future research to also interview medical professionals, such as physicians or doctors, of residents since they seem to know the guidelines for vitamins best (theme of "Mandatory Guidelines") and have the strongest role in vitamin supplementation (Miettinen et al., 2017). Even if knowledge on the effects of vitamin over supplementation are limited, the effects seem to have negative implications (Hamishehkar et al., 2016; Viveky et al., 2012); therefore, I recommend future researchers to focus on finding a way to effectively identify this risk in facilities.

Notwithstanding, I expect my findings to spark change in this field of knowledge by encouraging a movement to explore more trends to help reduce vitamin risks, such as over supplementation in Vitamin A, in facilities. The current knowledge is not sufficient if we want to counteract the struggles that current elderly residents face. Correcting faulty nutritional care is the first step in creating a supportive environment for the body and minds of residents. With age comes experiences of loneliness, the gradual loss of independence, "feelings of being a burden," and feelings of "less worth" (Ericson-Lidman, 2019). However, even if these feelings are inevitable, only through future research and a strive to raise cognizance of these issues can we create a society in which these experiences are eased and in which the people dear to us spend their final years in a place of comfort and peace.

Limitations

As mentioned, two facilities did not provide me information on vitamin supplement, meaning I was unable to calculate the combined vitamin and supplement intake from these facilities. Additionally, since I only inspected the menus of one day in each facility, they do not account for days in which the facility incorporates different levels (more or less) of each vitamin.

Also, I initially did not believe it was necessary to examine the outside activity of residents since I assumed it would be minimal (thus not significantly impacting Vitamin D levels). After delving into why Vitamin D intake was lower than I expected, I found MacDonald's study (2013) who analyzed the combined Vitamin D intake from diet and sunlight. Based on estimations by Holick, even a "few minutes sunlight a day can make 1,000 IU Vitamin D" (MacDonald, 2013). In regards to my own study, the inclusion of these statistics would have substantially increased Vitamin D levels, maybe even leading to Vitamin D overdose when adding them with dietary and supplement intake. Thus, these findings greatly limited my results and warrants the need for future studies accounting for sunlight quantities through surveys on exposure (MacDonald, 2013).

Acknowledgments

I would like to thank my advisor for the valuable insight provided to me on this topic.

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