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Review Article

Micronutrient Food Fortification for Residential Care: A Scoping Review of Current Interventions

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A B S T R A C T

Purpose: Malnutrition is common in residential care environments, primarily due to poor intake. Micronutrient deficiency, although poorly investigated to date, is also reported to be high. Improving the nutrient density of consumed foods is a potential mechanism to promote increased nutrient intake. A scoping review was conducted to: (1) explore the evidence on micronutrient food fortification strategies, (2) identify candidate nutrients and food vehicles for successful food fortification, and (3) identify gaps for future research.

Methods: The scoping review framework of Arksey and O'Malley was used. A comprehensive search strategy of 4 electronic databases (MEDLINE, EMBASE, CINAHL, and Web of Science) was completed. Two reviewers were involved in screening and data extraction for all selected articles.

Results: A total of 4394 relevant articles were identified for screening, and application of inclusion/exclusion criteria resulted in 6 food fortification studies (8 citations; 1 study had 3 citations). Overall, vitamin D (n = 5 studies) and calcium (n = 4 studies) were the most common micronutrients fortified; milk products, margarine, bread, and pureed foods were fortification vehicles. Most studies fortified below the RDA recommendation and did not include clinical outcomes. Samples were small and intervention periods were short (3–6 months).

Conclusions: Fortification is a viable strategy for improving the nutrient density of foods consumed in residential care. Although disparate, this literature suggests the potential for further undertaking of fortification to prevent micronutrient deficiencies among residents and future research should consider multinutrient preparations and clinical outcomes.

Malnutrition, primarily due to inadequate food and micronutrient intake, is a common problem in long-term care (LTC).[1–4] Malnutrition affects every facet of functioning and key outcomes are quality of life, morbidity, and mortality.[5–10] Older adults living in residential environments are especially at risk for poor food intake due to multiple interrelated factors at the resident (eg, dementia), staff (eg, training, number assisting at meals), and home levels (eg, quality of menu).[11] In a research agenda recently developed for residential and LTC environments, improving the nutrient density of food was in the top 10 of listed priorities to promote food intake and improve nutritional status and quality of life of residents.[12] Although less commonly studied than protein-energy malnutrition in LTC, micronutrient needs have become an area of interest for improving the health and quality of life of persons living in LTC[13,14] and recent investigations demonstrate that even at the menu planning level, work needs to be done to improve nutrient density.[15]

At present, there is no consensus on the best way to prevent or treat micronutrient malnutrition in LTC residents.[13,14] Oral nutritional supplements (ONS) are commonly prescribed for LTC residents with low food and fluid intake to address malnutrition and improve outcomes.[16–20] Yet, cost, compliance, taste fatigue, and wastage are common problems with their use in LTC.[16–20] Vitamin-mineral supplementation as single- or multinutrient preparations are also

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commonly used.[21] For example, vitamin D supplementation can improve status in older adults living in residential environments.[22] Yet, challenges also exist with this strategy, including additional costs to the resident, staff administration time, polypharmacy, drug-nutrient interactions, and compliance.[23–25] Further, potential for toxicity is possible[22,26] and clinical benefits of single-nutrient supplementation are coming into question.[27] Both of these strategies are commonly used to treat deficiency, although vitamin D supplementation is used to prevent deficiency in this highly vulnerable group.

Fortified foods have been proposed as a "food first" approach to improving nutrient intake of LTC residents[13] and could promote nutrient density in key foodstuffs, without adding calories. Fortification is focused on prevention rather than treatment of deficiency; thus, fortification may be a way to promote nutrient density for all older adults in residential care. Enhancement of food with energy and protein has been a longstanding strategy for LTC,[28–30] but micronutrient fortification is not standard practice.

The aims of this scoping review were to (1) explore the available evidence on the efficacy of micronutrient fortification in residential care, (2) determine which nutrients and foods could successfully be used for food fortification, and (3) identify gaps that need to be addressed with further research.

Methods

The current study used a scoping review, as this methodology is recommended for areas of research that have yet to be thoroughly reviewed, and allows researchers to quickly explore existing literature to identify research gaps when the research conducted to date in a specific area is diverse.[31] This scoping review included 5 stages as detailed by Levac et al[31] using the Arksey and O'Malley framework.[32]

The initial search was broadly focused on micronutrients and residential care, including intake and intervention studies, as it was unclear how best to ensure inclusion of all fortification studies. Residential care was defined as any longer-term living situation for older adults that provided at minimum 2 or more meals per day; this included care homes and nursing homes where nursing care for activities of daily living is provided, as well as retirement homes, where older adults typically only receive meals and housekeeping services. In consultation with a health research librarian, the authors selected the following initial key search terms: "long-term care" (geriatric home, long-term care, nursing home, nursing home patient, residential facilities, retirement home) AND "fortified food" (diet fortified, dietary supplement, diet therapy, formulated food, food analysis, food enhanced, food enriched, fortified food, nutrition therapy, specialized food). Four nonoverlapping databases were selected for the search, including Ovid MEDLINE, Ovid EMBASE, EBSCO CINAHL, and Web of Science. Searches were iterative, and terms were changed, refined, and finalized to ensure a comprehensive search. Articles published from 2000 were included; the search was initially completed to December 2012, and was updated in April 2015. Key articles were also hand-searched for further citations.

Inclusion and exclusion criteria were applied to the titles and abstracts of all citations. Inclusion criteria were as follows: the citation evaluated a fortification intervention; the study sample was from residential care; the study was conducted in North America, Europe, Mediterranean (Greece, Italy, Portugal, Spain, Turkey) and Scandinavian countries (Denmark, Finland, Iceland, Norway, Sweden), New Zealand, and Australia; the full citation could be accessed; and was published in English. Where studies examined multiple participant groups (eg, community, retirement, and LTC), only results specific to residential participants were included and if results were merged across sectors, the citation was excluded, unless most participants were from residential care. Studies were also excluded if they did not evaluate the intervention, used ONS in an arm of the study, and did not have at minimum biomarkers as an outcome to determine efficacy. These criteria were used in the initial screening process of titles, abstracts and, where required, full text, conducted by the first author (IL) and a second reviewer (KP, AD, LD, KS). Any articles in question to be included in the review were examined by the senior author (HK).

Initial data extraction was completed by the first author. All included citations were reviewed by at least 2 authors of this article, ensuring that 100% of extracted data were confirmed. Data extracted included participant age (mean ± SD), sample size, study design, intervention details (type, dose, duration), biomarkers of micronutrient status, clinical outcomes, and changes in outcome variables for intervention and control groups.

Fortification dosage levels were compared with the Institute of Medicine's recommended dietary allowance (RDA), which provides a reference to meet nutrient requirements for nearly all (97%–98%) individuals in a particular gender and age group (eg, males >70 years old).[33] To promote comparison of biochemical markers across studies, reference ranges were used from the American Medical Association (AMA)[34] for normal values and the Centers for Disease Control and Prevention (CDC)[35] for low and deficient values; where required, study units were converted for this comparison.

Results

Search Results

The search strategy resulted in 4394 unique articles (Figure 1), with 958 full articles examined for inclusion/exclusion. The screening criteria resulted in 6 studies[23,36–40] trialing food fortification (8 citations, as 1 study had 2 further articles).[41,42] The 2 most common micronutrients included in intervention food fortification studies were vitamin D (n = 5 studies)[23,36,37,39,40] and calcium (n = 4 studies).[36,37,39,40] Folic acid (n = 2),[23,38] the B-vitamins, and vitamins C and E (in a single multinutrient study)[23] were also included in formulations. Studies were conducted in France (n = 3 studies),[37,39,40] with 1 study conducted each in Romania,[36] Canada,[23] and Spain.[38] All citations were published between 2009 and 2014. As vitamin D and calcium were the most commonly studied, these 2 micronutrients are discussed in detail, followed by a discussion of "other micronutrients."

Vitamin D and Calcium

Vitamin D and calcium were fortified together in 4 studies (Table 1). Food vehicles included cheese,[37,39] yogurt,[41] and buns.[36] Dosages were 100[37,39] to 5000 IU[36] vitamin D per day and elemental calcium of 302 mg[37] to 800 mg[40] per day. Randomized controlled trials (RCTs) were used by 2 studies with a sample size of 21[39] and 59 residents,[40] and length of study of 6 and 8 weeks, respectively; one study was a crossover clinical trial.[39] The other studies used a pretest/posttest 1-group design with the length of study being 1 month (n = 35 residents)[37] and 1 year (n = 45 residents).[36] This last study had 2 further citations: 1 describing clinical outcomes that changed as a result of fortification[42] and 1 based on a 3-year follow-up, demonstrating changes in key markers after discontinuation of the fortified bun.[41]

Three of the 4 studies were conducted by Bonjour et al[37,39,40] and trialed formulations that were below the RDA for both vitamin D and calcium. Range of dose in these studies were from 13% to 50% RDA for vitamin D, and 25% to 67% RDA for calcium. The 2009 study by Mocanu et al[36] trialed the safety and efficacy of a pharmacological dose of vitamin D (5000 IU, 625% RDA) in a bun. The accompanying dose of calcium was 320 mg (27% RDA).

All studies reported an increase in 25(OH)D, with the largest increase found with the pharmacologic dose (5000 IU/d).[36] All but 1