Should an anti-inflammatory diet be used in long-term care homes?

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Abstract

Background: Inflammation is associated with the pathogenesis of several age-related chronic conditions such as diabetes, cardiovascular disease, arthritis and dementia. Most older adults residing in long-term care (LTC) homes have at least one of these conditions; they also have some degree of compromised nutritional intake due to management, personal and medical challenges. We hypothesized that an anti-inflammatory diet in LTC is necessary and feasible, and may lead to improvements in the health and wellbeing of residents.

Methods: A literature review was carried out to evaluate the evidence on effectiveness of anti-inflammatory diet changes in adults as well as the feasibility of LTC menu revision.

Results: Dietary components have both positive and negative influences on inflammation in older adults. LTC menu revisions using the anti-inflammatory diet popularized by Weil, which is designed as a food guide, are feasible. This diet could be used in LTC menu planning to complement and expand upon Canada’s Food Guide recommendations.

Conclusions: Implementation of a nutrient-dense, anti-inflammatory diet may lead to improved health and wellbeing among LTC residents.

Introduction

Long-term care (LTC) homes provide living environments for individuals with chronic conditions and limited functionality who require care or assistance. They must meet two goals: maintenance of health and quality of life [1]. Older adults may need care or supervision for an array of different reasons. As frailty increases with age, some of them have physically debilitating diseases or are terminally ill. The Canadian Community Health Survey found that chronic conditions such as arthritis/rheumatism, back problems, cataracts or glaucoma, heart disease, urinary incontinence, diabetes and cognitive diseases such as Alzheimer’s disease and dementia are very common in residents of LTC homes [2,3]. Most of these conditions are associated with chronic inflammation.

Nutrition is an important determining factor for successful aging, as it helps the body to maintain its mental and physical functioning, thus enabling active engagement in life [4]. The overall decreased food intake with age results in decreased intake of individual nutrients and a higher risk of nutritional deficiencies [5]. Although there is a possibility of
residents being admitted to LTC homes in a malnourished state, they may also become malnourished after their admittance, causing a worsening medical condition. Other reasons for malnutrition may be inability to meet the unique nutritional needs of residents due to inadequate menus, problems in swallowing and functional restrictions, and lack of sufficient personal assistance in dining [6].

In Canada, menu planning for LTC homes has followed the recent trend of “resident-centred care”, and involves consideration of many factors such as Dietary Reference Intakes (DRIs) in accordance with Canada’s Food Guide (CFG), residents’ preferences, and management issues such as food acquisition, preparation and the method of production [7]. Residents of LTC homes often report difficulty in consuming the foods and fluids of large size or volume that are recommended by Canada’s Food Guide (7). However, studies have reported that the menu cycle developed using food guidelines at a typical accredited institution in Canada is not sufficient in meeting the recommended adequate levels of vitamins and minerals [7,8]. Indeed, the fundamental assumption that planning menus using public health guidelines can achieve the nutritional requirements of institutionalized older adults was recently refuted [8]. The need to use more than one standard guideline to plan menus was highlighted, because DRIs are designed for healthy people and residents in LTCs may have comorbidities and conditions in which the requirement for certain nutrients is higher than that among healthy older adults [7].

**Relationship between diet and inflammation**

The development of several age-related diseases commonly present in the older adults, such as atherosclerosis [9], type 2 diabetes [10], Alzheimer’s disease [11], and osteoporosis [12] is attributed to chronic, low-grade inflammation [13]. Inflammation is the body’s automatic response to get rid of the initial cause of cell injury [14], and can be either acute or chronic. Acute inflammation is a self-limiting process where inflammatory mediators have short half-lives, due to prompt degradation in the presence of negative feedback mechanisms. This type of inflammation occurs following surgery, trauma or injury, and indicates that controlled inflammatory responses are important for maintaining normal homeostasis and health. Chronic inflammation results when the immune response to injury is not eliminated, leading to continued stimulation of the synthesis of proinflammatory cytokines, which contribute to the risk of developing many chronic diseases [15]. The damage caused by chronic inflammation accumulates slowly, and sometimes asymptomatically, for many years and can lead to severe tissue impairment [16]. Markers of inflammation are also reported to increase with age indicating greater risk among older adults [17].

**Factors affecting chronic inflammation**

The persistence of chronic inflammation is influenced by many factors such as genetics, stress, exposure to environmental toxins, diet [18] and exercise [19]. Some factors are positive, while others are negative. The inflammatory condition can be reversed by using foods, which are anti-inflammatory in nature [20,21,22]. To this end, various dietary components including long chain n-3 fatty acids, antioxidant vitamins, plant flavonoids, prebiotics and probiotics have been identified as having the ability to modulate a predisposition to chronic inflammatory conditions and thus may play a role in therapy [23]. An inverse association has been found between the risk of inflammatory diseases leading to chronic diseases and high intake of fruit, vegetables, healthy fats and whole grains [24, 25]. This suggests that some plant foods have anti-inflammatory potential [26, 27].

**Objective**

The prevalence of chronic diseases and compromised nutritional intake among LTC residents leads to the question of whether LTC homes need to consider menu solutions beyond basic food guides and DRIs in order to cope with the changing nutrient demands of aging. Older adults residing in LTC homes are reported to have several health conditions for which the underlying cause might be inflammation. We searched the literature regarding anti-inflammatory diets, and considered the feasibility of adding specific components to the diets of LTC residents.

**What is an anti-inflammatory diet?**
Many authors have described an anti-inflammatory diet [22,28,29]. They appear to have common features including a low glycemic load, low amounts of n-6 fatty acids and high levels of n-3 fatty acids [22]. Although the details of each anti-inflammatory diet differ, there are some common foods: fruits and vegetables, n-3 fatty acids such as fish or fish oil supplements, whole grains, lean protein sources such as chicken, and less red meat and full-fat dairy foods, low saturated and trans fats, limited refined foods and processed foods, alcohol in moderation, and spices [21,22,25,30,31]. Some of these features are similar to the Mediterranean diet, which is sometimes considered as a prudent form of anti-inflammatory diet [32,33].

Foods with a low glycemic load are beneficial as they lead to only gentle rises in blood glucose and insulin levels. A prolonged elevation of insulin levels is one of the major risk factors for development of chronic inflammatory diseases [34,35]. Also, the formation of pro-inflammatory compounds known as AGEs (advanced glycation end-products) by the chemical reactions of sugars and protein [36] are known to contribute towards oxidative stress and inflammation. The modern diet is a very rich source of AGEs because of excessive cooking or processing to enhance flavor, while maintaining quality, appearance, color and acceptability [37]. Even a single AGE-rich meal is well absorbed and contributes towards the total AGE pool in the body [38].

**Weil’s Anti-inflammatory Diet**

Andrew Thomas Weil is well known physician and author of many best-selling books about nutrition and healthy aging [39]. Weil has developed an anti-inflammatory diet by combining many foods in a pyramid format. Weil’s Anti-inflammatory Diet (WAID) has suggested serving sizes and foods from all the major food groups. This diet is primarily formulated to decrease the risk of age-related diseases and to achieve overall health [18]. The main characteristics of WAID include regulating blood glucose with low-glycemic load foods, lean protein sources, healthy fats, drinking water, and consuming high amounts of fibre from fresh fruits and vegetables, which also provide anti-inflammatory factors [18]. Further, this diet plan claims to have an appropriate balance of n-3 to n-6 fatty acids.

WAID provides specific guidelines regarding blood glucose regulation and preventing inflammatory processes due to formation of AGEs. It emphasizes consuming whole grains, beans, sweet potatoes, winter squashes and other vegetables, and fruits like berries, cherries, apples, and pears instead of bananas, pineapple, mango and papaya. It recommends having less meat and poultry, as they contain pro-inflammatory fats, and having more vegetable protein (e.g. soy, beans and lentils), whole grains, seeds, and nuts. Fish is recommended, but primarily as oily varieties containing n-3 fatty acids (e.g., wild Alaska salmon, sardines, herring, and black cod). Overall, WAID limits bread, white potatoes, crackers, chips, snack foods, pastries, sweetened drinks, refined and processed foods, and eliminates fast foods and foods made with high fructose corn syrup. The food groups comprising the WAID diet are shown in Table 1. Food items have recommended serving sizes and ranges [40].

**Table 1. Comparison of Weil’s anti-inflammatory diet with Canada’s Food Guide**

| Food Groups | Weil’s Anti-Inflammatory Diet | Canada’s Food Guide Serving Size* |
|-------------|------------------------------|-----------------------------------|
| Vegetables and fruit | 4-5 d (vegetables) minimum 3-4 d (fruits) | 7 (1 dark green, 1 orange vegetable) |
| Grain products | 3-5/d (whole & cracked grains) 2-3 wk (pasta) | 6.7 (female), 8.7 (male) (50% whole grains, variety of whole grains) |
| Milk & alternatives | 1/2 wk (soy beverage, tofu, cheese, yoghurt) | 3 (Select lower fat milk alternatives, fortified soy beverages) |
| Meat & meat alternatives | 2-3 d (beans & legumes) 2-6 wks (fish & seafood) 1-2 wk (other sources of protein) (e.g., eggs, tofu, skinless poultry, lean meats) | 2.3 (female), 2.8 (male) (beans, lentils and tofu, at least two Food Guide Servings of fish each week, select lean meat and alternatives) |
| Oils and fats | 5-7 d healthy fats (extra virgin olive oil, expeller-pressed canola oil) | 2-3 tbsp (canola, olive and soybeans) low in saturated and trans fats, limit butter, hard margarine, bird and shortening |
| Herbs & Spices (garlic, ginger, turmeric, cinnamon) | Unlimited amounts | - |
| Supplements | 2-4 d | - |
| Vitamins D (400 IU) | Daily | - |
| C = 6 oz cheese, 2 cups milk, 1/2 cup fruit, 1/2 cup grain, 1/2 cup vegetable, 4 tbsp fat, 2 tbsp oil, 2 tsp table spoon, 1 tsp = teaspoon, 1 d = day, 2 wks = weeks |

* Canada’s Food Guide serving recommended for <51 + y adults
How does Canada’s Food Guide compare to Weil’s Anti-Inflammatory Diet?

Canada’s Food Guide (CFG), which was revised in 2007, provides recommendations for planning menus based on foods found in four predefined food groups: Vegetables & Fruits, Grain Products, Milk & Alternatives, and Meat & Meat Alternatives [41]. This version of CFG was developed with a unique approach, which included a simulation of varied food choices among each food group and its impact on nutrient intakes. Dietary guidelines and food guides based on DRIs provide the appropriate nutrient intake for people [42]. However, it is assumed that individuals following the food guidelines will make choices from a mix of foods within each food group. Thus, individuals making poor food choices with significant deviation from food groups may not meet the set nutritional goals [43]. Though CFG provides good nutritional advice, its critics argue that it may not minimize the risk of chronic diseases, even with the 2007 revisions [44].

Both CFG and WAID are educational tools encouraging people to make better food choices in order to attain optimum nutritional status and health [18,41]. Table 1 illustrates that there WAID features food items that are present in the CFG, as well as additional ones. The food items which are common to both include: fruits and vegetables, particularly green and orange vegetables; low fat milk and alternatives (e.g. soy); meat alternatives such as lentils, beans, tofu; and weekly servings of fish, specifically those rich in n-3 fats; use of unsaturated fats; and water as the main beverage. CFG recommends making half of grain consumption wholegrain, while WAID emphasizes exclusively whole and cracked grains. The components common to both diets vary somewhat in terms of the number of servings and food groupings. For example, cheese and yogurt are categorized under Milk and Alternatives in the CFG but in the WAID are in the category of “Other sources of protein”. WAID is very specific regarding recommendations of Asian mushrooms, herbs and spices, tea, supplements, red wine and healthy sweets. CFG was developed for already healthy people to maintain their health, while WAID targets the inflammatory conditions arising with age.

Evidence for anti-inflammatory potential of WAID and CFG components

Several studies support the high intake of fruits and vegetables as a preventive measure against low grade inflammation [25]. Fruits and vegetables are excellent sources of essential vitamins, minerals, fiber, phytochemicals and antioxidants, all of which reduce inflammation [45]. For example, flavonoids and proanthocyanidins, which are found in fruits and vegetables, are known to have a protective mechanism against various inflammatory diseases [46] such as cardiovascular diseases (CVD) [47] and cancer [48]. It has been demonstrated that flavonoids are able to modulate enzymes and other agents in the inflammatory process such as cytokines, chemokines and adhesion molecules. Many published in vitro studies have identified the effects of flavonoids on inflammatory processes [49,50]. There is a strong association between dietary vitamin C from fruit and vegetables and plasma vitamin C concentrations, both being linked to a fall in markers of inflammation [51]. Inverse associations were reported between fruit and vegetable intake, antioxidants, folate, and total flavonoids and markers of inflammation and oxidative stress [52].

There is strong evidence for the anti-inflammatory properties of the additional foods and supplements that are included in the WAID, but are not specifically recommended in CFG. Nuts, which are categorized as healthy fats in WAID, have the ability to modulate inflammation as they contain n-3 fatty acids, which possess anti-inflammatory properties [53]. Evidence from large epidemiological studies suggests that frequent nut consumption (more than four times per week) reduces CVD risk by 37% [54], and it has also been suggested in some prospective studies [55] and randomized control trials [56] that such consumption also reduces the risk type of 2 diabetes. Improved insulin sensitivity and reduction in inflammatory markers such as IL-6 was reported with 30 g nut consumption per day in a clinical trial on subjects with metabolic syndrome [57]. Flax, which is also categorized under “healthy fats” in WAID, has been shown to impart protection against CVD. Flax supplementation has been reported in multiple clinical trials to cause a modest reduction total cholesterol and low-density lipoprotein cholesterol plasma levels in both normal and hypercholesterolemic patients. Lignan and dietary fibre found in flaxseed also have this hypocholesterolemic action. The n-3 fatty acids present in flaxseed oil have anti-proliferative mechanisms and both anti-atherogenic and anti-inflammatory potential [58]. Soy supplementation
along with lifestyle changes can lead to an improvement in endothelial function, some markers of inflammation and blood pressure in postmenopausal women with hypertension [59,60]. Asian mushrooms, when supplemented as an extract, showed mild antidiabetic effects and improvement in dyslipidemia, which is associated with diabetes in humans [61]. Herbs and spices such as turmeric and its active compound curcumin are believed to have disease-modifying properties. Evidence from in vitro, in vivo and human clinical studies suggests that they have anti-inflammatory, antioxidant and anti-cancer properties [62]. Cinnamon and ginger may have positive effects on insulin resistance, hyperglycemia, hyperlipidemia, and other symptoms linked to obesity [63]. Garlic possesses some anti-inflammatory and antiarthritic properties which may play a role in the treatment of inflammatory and arthritic diseases [64]. Green tea, when supplemented, demonstrated protective effects along with diminished oxidative DNA damage in a randomized, double-blinded and placebo-controlled phase trial [65]. Oolong tea extract (8 g/d) supplementation for 6 weeks in obese/overweight women reduced body fat content and body weight and improved lipid metabolism [66]. The extracts from green, oolong and black tea have some polysaccharides, which might help to reduce the prevalence of diabetes [67]. Dietary supplement consumption demonstrates mixed results [68,69], with the exception of vitamin D. Higher levels of 25(OH)D were associated with longer 6-minute walk distance in older adults, while shorter walk distances were correlated with increased levels of cortisol, high-sensitivity C-reactive protein, interleukin-6 (IL-6), and parathyroid hormone (PTH). Overall, increased frailty was associated with increased high-sensitivity CRP, higher IL-6, and lower 25(OH)D [70]. Red wine intake improved antioxidant defense mechanisms along with platelet responsiveness via modulation of inflammatory cytokines and cell adhesion molecules in an intervention trial [71]. Resveratrol, the active polyphenol in red wine, inhibits enzymes involved in the production of pro-inflammatory prostaglandins [72,73]. Finally, dark chocolate is associated with increased plasma total antioxidant capacity [74]. Cocoa flavonoids demonstrated beneficial effects in an adult population with elevated serum cholesterol levels in a clinical intervention trial, as these flavonoids lower lipid oxidation and decrease platelet aggregation [75].

Can LTC menus be anti-inflammatory?

An analysis of a recent menu at a large LTC home was carried out and compared with CFG serving recommendations [76]. The menu did not meet the CFG recommendations for food groups with the exception of Fruit & Vegetables. The menu featured higher-than-recommended amounts of saturated fats and sodium and was high in pro-inflammatory foods such as sugar. The diet quality of the LTC menu had a score of only 53 out of 100 using the Healthy Eating Index [77], suggesting that improvement is needed. As LTC residents tend to consume only 80% of the food offered to them [78], menu planning following minimum servings of CFG will result in inadequate nutrient intake. There is a need to incorporate healthier options and more nutrient-dense foods [79].

Although it is anticipated that many LTC homes will have successfully implemented healthy menu changes and may have evaluated the outcomes of these changes, few LTC menu interventions have been published. The incorporation of nutrient-dense foods into LTC menus has been successful in improving nutrient intake among LTC residents [80] and should be the first step in menu revision to ensure the provision of all nutrients including those considered to be anti-inflammatory. This could be achieved by judicious selection of food that is naturally nutrient-dense or by providing foods that are specifically fortified at levels appropriate for older adults in care. For example, as energy requirements are lower for older adults, it is reasonable to suggest that menus may not need to achieve the recommendations for Grain Products, especially as only half of the servings are wholegrain. Foods made with white flour could be eliminated, enabling achievement of the recommended intakes of Milk & Milk Products and Meat & Alternates. However, menus planners would need to ensure adequate intakes of the vitamins and minerals added to grains by fortification.

Next, pro-inflammatory foods could be replaced with anti-inflammatory foods; some examples are given in Table 2. For instance, replacing foods such as cakes and cookies with healthy dark chocolate desserts would be a way of improving anti-inflammatory food intake whilst ensuring menu acceptance. Novel recipes could be developed to incorporate nuts, flax, soy, and the recommended herbs and spices. In addition, guidelines could be developed for vitamin-mineral supplementation of LTC residents, as many residents currently may not even be provided with...
vitamin D supplements [81]. Alternatively, vitamin and mineral requirements may be achieved through food fortification [82] or oral supplements [83].

Table 2. Recommendations to incorporate additional components of WAID along with CFG

| Food Groups                                      | Recommendations                                                                 |
|-------------------------------------------------|-------------------------------------------------------------------------------|
| Cooked Asian mushrooms                          | Topping and filling in sandwich, salads                                      |
| Herbs & Spices (garlic, ginger, tumeric, cinnamon) | Salad dressing, recipes                                                       |
| Tea (white, green, oolong)                      | Adding to choice of hot/cold beverages without sugar                         |
| Supplements                                      | Vitamin D everyday*                                                          |
| Red wine                                        | Occasional                                                                   |
| Healthy sweets (plain dark chocolate)            | Choice in desserts                                                           |
| Nuts                                            | Breakfast cereal, salads, smoothies; consider nut butters                   |
| Flux                                            | Breakfast cereal, salads, smoothies                                           |

*Vitamin D supplementation already started in some health regions [85]

A limitation regarding the adoption of WAID into LTC is that the studies discussed here were not conducted among frail elderly people, and did not assess therapeutic outcomes. Although pro-inflammatory foods could be replaced with anti-inflammatory food options, cost, familiarity, personal and cultural preferences and eating/chewing difficulties must be considered. In agreement with Walker and Reamy [31], the additional components could be added to the current diets of older adults using a stepwise approach to ensure that the intervention imparts maximum benefit. Another study on nursing home residents suggested the incorporation of several enhanced foods in more than one meal to help achieve the optimal nutritional status [84].

Conclusions

The implementation of the Weil’s anti-inflammatory WAID over and above CFG has the potential to improve the health and wellness of LTC residents by ameliorating inflammation. It is suggested that anti-inflammatory components are added using a stepwise approach in accordance with the recommendations of a food guide such as CFG, with close regard to personal and cultural preferences, taste, and chewing and swallowing difficulties. LTC intervention trials involving recipe development, sensory evaluation and food substitution should be carried out. Those who have successfully undertaken LTC menu changes are challenged to evaluate and publish the outcomes of these interventions.

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