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Sex-dependent association between omega-3 index and body weight status in older Australians

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Background/objectives: Restricting energy intake for weight management in older adults has potential to adversely affect nutritional status and result in impairment of an already compromised immune system. Investigation of alternative strategies to combat adiposity and sustain lean muscle mass in older adults are warranted to minimise the risk of developing chronic diseases. Long chain omega-3 polyunsaturated fatty acids (LCn-3PUFA), including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), may play an important role through their impact on increased fat oxidation and reduced inflammation. This study aimed to examine the association between erythrocyte membrane LCn-3PUFA and anthropometric measures in an older population.
Subjects/methods: A cross-sectional sample of older adults (n = 620; age 65–95 years; 56.3% females) from the Retirement Health and Lifestyle Study (RHLS) was analysed. Anthropometric measurements, including height, weight, body mass index (BMI), waist (WC) and hip circumference (HC) were taken. The fatty acid composition of erythrocyte membranes was analysed via gas chromatography (GC) to determine the omega-3 index (%EPA plus %DHA).
Results: An inverse association was detected between the omega-3 index and anthropometric measures, BMI (r = −0.076, p=0.06), WC (r = −0.118, $p < 0.01$) and waist-to-hip ratio (WHR; r = −0.149, $p < 0.001$). Stratification of data by sex (females, n = 349; males, n = 271) indicated that these associations were sex-specific. Females displayed an inverse association between the omega-3 index and BMI (r = −0.146, $p < 0.01$) and WC (r = −0.125, $p < 0.05$). In contrast, no significant association between the omega-3 index and anthropometric measures was detected in males. After correcting for the potentially confounding effects of age, household income, fish oil supplement status, daily dietary energy intake and total physical activity times, the omega-3 index was inversely associated with BMI and WC in females but not males.
Conclusions: Omega-3 status was associated with weight status, particularly in older women but not in men. These results suggest the need for sex-based intervention trials to examine the role of dietary intake and/or supplementation of LCn-3PUFA in weight management of older adults.

1. Introduction

Increasing prevalence of overweight and obesity in older adults heightens the risk of developing and/or aggravating non-communicable illnesses, such as type 2 diabetes (T2D) and cardiovascular disease (CVD) [1,2]. In 2011–12, 72% of Australian adults aged 65 years or older were overweight or obese and within the 65–74 years age group, over one in three were obese (35.2%) compared with approximately one in four in 1995 (24.8%) [3,4]. The proportion of older adults in Australia is projected to increase from 14% in 2012 to 19% in 2031 and 24% in 2061, and obesity will likely continue to be a major cause of morbidity and mortality [5].

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Current weight management strategies include lifestyle interventions, such as increases in physical activity and dietary restrictions, and pharmaceutical drug therapy for the morbidly obese. Excess body fat can limit the ability of older adults to participate in physical activity, and the long-term use of drugs for long-term maintenance of weight loss poses potential health risks [6–8]. Diet-induced weight loss can be readily achieved in the short-term but only a small proportion can sustain weight loss in the long-term [9,10]. Excess body fat is associated with the accumulation of fat in adipose tissue as well as elevated levels of pro-inflammatory mediators which increase the risk of obesity associated inflammatory diseases [8,11,12]. However, excessive weight is preventable, and therefore safe and efficacious intervention strategies are warranted to combat obesity and related health issues in older adults.

Long chain omega-3 polyunsaturated fatty acids (LCn-3PUFA), specifically eicosapentaenoic acid (EPA; 20:5n-3) and docosahexaenoic acid (DHA; 22:6n-3), have the potential to play an important role in ameliorating metabolic dysfunction, assisting weight control and reducing the risk of inflammatory disease in older adults [11]. The mechanisms explored in the literature include: (1) increased fat oxidation and increased thermogenesis, both of which lead to a decrease in fat deposition in adipose tissue [13]; (2) greater satiety and suppression of appetite following a LCn-3PUFA rich diet [14,15]; (3) altered expression of genes involved in regulating lipid metabolism [13,14,16]; (4) increases in adiponectin (a hormone synthesised by adipocytes involved in regulating lipid metabolism) [17]; and (5) facilitation of the synthesis of anti-inflammatory eicosanoids (signalling molecules) and inflammation resolving resolvins and protectins (lipid mediators) [11,12,18].

Several animal intervention trials have suggested a role of LCn-3PUFA in changes to weight status [14,16,19,20] but human studies have generated conflicting results. Most recently, two observational studies have reported an inverse association between erythrocyte levels of LCn-3PUFA and body weight status measures [21,22]. Randomised controlled trials have been less convincing, potentially due to small sample size, the relatively short duration of trials, varying assessment measures of LCn-3PUFA, and differences in subject criteria and fish oil supplementation dosage [23–26].

The omega-3 index reflects long-term (over several months), habitual dietary intake of LCn-3PUFA [27–29]. Therefore, the omega-3 index is a valid biomarker and measurement tool for determination of LCn-3PUFA status [22].

The aim of the current study was to examine, for the first time in older adults aged 65 years and over, whether there is an association between the omega-3 index and measures of body weight status including body mass index (BMI), waist circumference (WC) and waist-to-hip ratio (WHR).

2. Subjects and methods

2.1. Subjects and study design

This cross-sectional, observational study included male and female adults aged 65 years or older from the Retirement Health and Lifestyle Study (RHLS), a large cross-sectional study of the health and lifestyle of older adults living on the Central Coast of New South Wales (NSW), Australia. Participants were eligible for the RHLS if they: were ≥65 years of age; their primary residence was located within the Wyong or Gosford Local Government Areas; and they had been living at their current address for ≥12 months. Participants were not eligible if: they were not living independently or were residing in a communal setting other than a retirement village; another member of their household was taking part in the study; they had language and/or other communicative difficulties that limited participation; or they were cognitively impaired and/or were unable to provide informed consent. Eligible participants took part in an interviewer-administered questionnaire that collected information relating to subject demographics, medical history, medications and supplement data, physical activity levels, smoking status and alcohol consumption. In addition, participants completed self-administered paper-based questionnaires (food frequency and additional medical history) and attended a clinic where fasting blood samples and anthropometric measures were taken. Participants were included in the present study if they had erythrocyte samples for the determination of membrane fatty acid composition.

Written informed consent was obtained from all participants and the study was approved by the Human Research Ethics Committee of the University of Newcastle (Reference No. H-2008-0431) and the Northern Sydney Central Coast Health Human Research Ethics Committee (Reference No. 1001-031M).

2.2. Biochemical analyses

Fasted (≥10 h) blood samples were collected by a trained phlebotomist in accordance with protocol. Blood samples were centrifuged at 3000 × g for 10 min to separate plasma from erythrocyte fractions. The fatty acid composition of the erythrocyte cell membranes were determined via direct trans-esterification of the washed erythrocyte fraction followed by standardised gas chromatographic analyses (GC) [30,31]. A known fatty acid mixture was used to compare with analysed samples to identify peaks according to retention time and their concentration was determined using a Hewlett Packard 6890 Series GC with Chemstations Version A. 04.02 software. The omega-3 index was determined by summing erythrocyte membrane EPA and DHA expressed as a percentage of total erythrocyte fatty acids (%EPA plus %DHA).

2.3. Anthropometric measurements

Anthropometric measurements including height, weight, WC and hip circumference (HC), were taken by research project officers according to World Health Organisation (WHO) recommendations [32]. Weight was measured using calibrated standardised portable digital scales (Tanita HD-316, Tanita Corporation, Tokyo, Japan; or Wedderburn UWPM150, Wedderburn Scales, Australia). Two weight measurements were taken to the nearest 100 g to calculate a mean weight. Height was measured using a portable stadiometer (design no. 1013522, Surgical and Medical Products, Australia). Two height measurements were taken to the nearest 0.1 cm to calculate a mean height. For both weight and height measurements, participants were required to remove shoes and any heavy items of clothing or heavy objects from pockets. Mean weight and height were used to calculate BMI (non-obese< 0 kg/m^2, obese≥30 kg/m^2). WC and HC were measured using a stretch resistant, flexible tape. Two measurements were taken to the nearest 0.1 cm to calculate the mean values. WC was measured at the midway point between the lowest rib and iliac crest; HC was taken at the greatest posterior protuberance of the buttocks. Mean WC and HC were used to determine a WHR. For all anthropometric measures, if the two measurements varied more than the set tolerances of 800 g for weight, 1 cm for height, and 2 cm for WC and HC measurements were repeated until two measurements were within protocol. Health risk categories for both WC and WHR are based on current Australian guidelines [7,33,34]. In relation to WC, the guidelines indicate that adults are at increased disease risk if WC≥94 cm (for males) or WC≥80 cm (for females), or at greatly increased risk if WC≥102 cm (for males) or WC≥88 cm (for females) [7,34]. For WHR, adults are at increased disease risk if WHR>0.9 (for males) and WHR>0.8 (for females) [33,34].