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Research article

Effects of Short-Term Docosahexaenoic Acid Supplementation on Markers of Inflammation after Eccentric Strength Exercise in Women

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Abstract

The omega-3 fatty acid docosahexaenoic acid (DHA) has anti-inflammatory and anti-nociceptive (pain inhibiting) effects. Because strenuous exercise often results in local inflammation and pain, we hypothesized that DHA supplementation attenuates the rise in markers of local muscle inflammation and delayed onset muscle soreness (DOMS) that occur after eccentric strength exercise. Twenty-seven, healthy women (33 ± 2 y, BMI 23.1±1.0 $kg \cdot m^{-2}$) were randomized to receive 9d of 3000 mg/d DHA or placebo in a double-blind fashion. On day 7 of the supplementation period, the participants performed 4 sets of maximal-effort eccentric biceps curl exercise. Before and 48h after the eccentric exercise, markers of inflammation were measured including measures of muscle soreness (10-point visual analog pain scale, VAS), swelling (arm circumference), muscle stiffness (active and passive elbow extension), skin temperature, and salivary C-reactive protein (CRP) concentrations. As expected, muscle soreness and arm circumference increased while active and passive elbow extension decreased. The increase in soreness was 23% less in the DHA group (48h increase in VAS soreness ratings: 4.3±0.4 vs. 5.6±0.5, p=0.02). Furthermore, the number of subjects who were able to achieve full active elbow extension 48h after eccentric exercise was greater in the DHA group (71% vs. 15%, p = 0.006), indicating significantly less muscle stiffness. No between-group differences were observed for passive elbow extension (p = 0.78) or arm swelling (p = 0.75). Skin temperature and salivary CRP concentrations did not change from baseline to 48h after exercise in either group. These findings indicate that short-term DHA supplementation reduces exercise-induced muscle soreness and stiffness. Therefore, in addition to other health benefits that n-3 fatty acids have been associated with, DHA supplementation could be beneficial for improving tolerance to new and/or strenuous exercise programs and thereby might facilitate better training adaptations and exercise adherence.

Key words: Delayed-onset muscle soreness, omega-3 fatty acids, fish oil.

Introduction

Dietary supplementation with the omega-3 fatty acids (n-3), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), has been shown to have anti-inflammatory effects and to be beneficial for preventing and treating inflammatory and autoimmune diseases such as arthritis, inflammatory bowel disease, and psoriasis (Balvers et al., 2010; Proudman et al., 2008; Simopoulos, 2002). Furthermore, DHA has been shown to have antinociceptive (pain inhibiting) effects by binding to the long chain fatty acid receptor, G-protein coupled receptor-40 (GPR40) in nerve tissue (Nakamoto et al., 2011). Based on these findings, it seems plausible that n-3 supplementation could be useful for preventing inflammation and delayed onset muscle soreness (DOMS) from strenuous exercise. However, few studies have evaluated this possibility and the results have been mixed. Two studies of men showed that 4 weeks of n-3 supplementation attenuates the increase in serum inflammatory markers during a 1- to 4-day period after eccentric exercise (DiLorenzo et al., 2014; Tartibian et al., 2011); one of these also reported a marginally significant reduction in DOMS during a short-term strength training program (DiLorenzo et al., 2014). In contrast, two studies reported no benefits from 4-6 weeks of n-3 supplementation; however, both had important limitations. One had a very small sample size (n = 5 in both the n-3 and placebo groups) (Lenn et al., 2002) and the other used an uphill walking protocol that did not measurably increase in inflammation or soreness (Bloomer et al., 2009).

In a preliminary study from our laboratory (Jouris et al., 2011) we reported that short-term (7 days) high-dose n-3 supplementation (3000 mg/d DHA+EPA) attenuates DOMS by 15%. However, the study was limited in that there was no blinding and the study design may have resulted in a treatment sequence effect. Therefore, the purpose of the present study was to confirm our previous findings, and that of others, by using a randomized, double-blinded, placebo-controlled trial. Furthermore, because all previous studies included men, or men and women, we studied women only. Finally, in light of evidence that DHA may have more potent anti-inflammatory effects than EPA (Weldon et al., 2007), and in light of the aforementioned antinociceptive effects of DHA (Nakamoto et al., 2011), we used DHA supplementation alone (i.e. no EPA). We hypothesized that 7d of 3000 mg/d DHA supplementation attenuates DOMS and markers of inflammation, as measured 48 h after eccentric strength exercise.

Methods

Participants and screening

Healthy women aged 20-60 y were recruited from the Saint Louis, Missouri metropolitan area. Volunteers completed a medical history and medications questionnaire, which was used along with criteria from the American

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College of Sports Medicine (American College of Sports Medicine, 2014) to classify each individual as low, moderate, or high risk for medical complications during exercise. Both moderate- and high- risk individuals were excluded. Volunteers were also excluded if they consumed n-3 supplements within the last 6 months, if they had a history or diagnosis of hypertension, clotting disorders, diabetes, exertional rhabdomyolysis, or if they were currently taking non-steroidal anti- inflammatory drugs, aspirin, or anticoagulants. Subjects were also asked to refrain from taking anti-inflammatory medications while enrolled in the study. Although the inclusion and exclusion criteria did not specify the exercise training status of the participants, none of the participants had a history of strength training and most (75%) were not actively performing endurance exercise training (additional details provided in Results section and Table 1). Informed written consent was obtained from each subject. The study was approved by the Saint Louis University Institutional Review Board.

Study design

The study was a randomized, double-blinded, placebo-controlled trial, in which subjects were randomly assigned in a 1:1 ratio to receive DHA or placebo. All outcomes were assessed after 7 days of supplementation and immediately prior to the soreness-inducing eccentric exercise protocol and again 48 hours after the eccentric exercise protocol. Supplementation continued through the 48-hr follow-up period.

Dietary and physical activity control

Participants were instructed verbally and in writing to follow a low n-3 diet throughout their participation in the study, starting 3 weeks prior to the study supplementation period. A list of high n-3 foods was provided to help the participants avoid major sources of dietary n-3. Participants were instructed to abstain from strenuous upper body exercise and stretching during the study and to not change other aspects of their physical activity routine (or lack thereof).

Supplementation and placebo

For 7 days before the eccentric strength exercise and 2 days afterwards, participants took 3000 mg/d DHA or matching placebo (containing corn and soy oil with no n-3). The DHA and placebo capsules were identical in appearance and were both manufactured and provided by DSM Nutritional Products, Inc., Dobbin, MD. The DHA was obtained from Crypthecodinium cohnii algae, which synthesizes negligible amounts of EPA. Participants were provided with a verbal explanation and a handout with a description of the supplement dosing regimen. Participants were also advised to split the daily dose of DHA to take half with the morning meal and half with the evening meal. For compliance monitoring, a supplement diary was provided for recording the days and times of capsule consumption. Furthermore, at the end of the supplementation period, capsule counts were performed to assess compliance.

Strength assessment

Muscular strength (1-repetition maximum, 1RM) for preacher bench biceps curls was estimated by using the 1RM Berger prediction method (Berger, 1961). Before the assessment, a light warm-up set of arm curls (3-5 repetitions with a 2.3 kg dumbbell) was performed to familiarize the participant with the exercise. For the assessment, the participant selected a dumbbell weight so that at least one repetition, but no more than 15 repetitions could be performed before reaching fatigue. The participant then performed as many repetitions as possible. The number of repetitions completed and the weight were used to predict 1RM based on tabular conversion factors (Berger, 1961).

Eccentric exercise

The objective of the exercise protocol was to induce a substantial rise in inflammation and soreness in the biceps muscle 48 hours after exercise. Using 120% of the subject's 1-RM, subjects performed four sets of eccentric biceps curls on a preacher bench with the non-dominant arm. The rest period between sets was 3 minutes. During each repetition, the technician lifted the weight for the participant to the fully flexed elbow position. The participant lowered the weight over 4 seconds in a controlled manner until the elbow was fully extended. Repetitions were performed without rest until the participant was unable to lower the weight slowly and in a controlled manner (i.e. $\geq$ 4s) for 2 consecutive repetitions.

Measurement timing for muscle soreness ratings and markers of inflammation

Inflammatory markers and soreness ratings were measured immediately before and 48 h after eccentric strength exercise. The 48 h post-exercise time period was used, as this is the timeframe during which inflammation peaks (Miles et al., 2008).

Muscle soreness: Muscle soreness was assessed by using a visual analog pain scale (VAS), for which the participants placed a mark on a 10 cm line to indicate the degree of soreness. The distance in centimeters from the left end of the scale to the mark was used to reflect soreness. The validity and reliability of the VAS as a measure for subjective soreness has been established (Gallagher, Bijur, Latimer, & Silver, 2002). VAS ratings were collected during two procedures. "Palpated" VAS ratings were based on the pain experienced by the participant while the investigator palpated/massaged the affected biceps with moderate force; this assessment was always performed by the same investigator. "Fully extended" soreness measures were made while the participants fully extended the elbow of the affected arm. If the elbow could not be fully extended (due to pain and stiffness), the participant was asked to extend as much as possible. The prevalence of inability to fully extend the elbow was also used as an indicator of soreness/pain.

Muscle stiffness: Before and 48-hr after the arm curls, a sagittal digital photograph was taken of the arm hanging in passive elbow extension (i.e. under the effects of gravity only) while the subject stood upright. Prior to taking the photograph, the tip of the acromion, the lateral

epicondyle of the humorous, and the styloid process of the ulna were highlighted with a black marker for easy identification in the photograph. These bony landmarks and a goniometer were used on the computer image to measure passive elbow extension. Digital photos were used in lieu of direct goniometry on the human subject so that pre-exercise and 48-hr post exercise passive elbow extension could be measured simultaneously, thereby minimizing day-to-day variability in the measures.

Swelling: Swelling was assessed by measuring the upper arm circumference at the mid-brachium, perpendicular to the long axis of the arm, with a spring-loaded anthropometric tape measure (American College of Sports Medicine, 2014).

Skin temperature: Skin temperature was measured directly over the biceps mid brachium using an infrared sensor (DermatempTM Infrared Temperature Scanner. Model # DT1000, Exergen Corp, Newton, Mass). Infrared thermometers are both reliable and valid devices for measuring skin surface temperature (Burnham et al., 2006).

Systemic inflammation: Salivary concentrations of the acute phase protein, C-reactive protein (CRP), were used as a marker of systematic inflammation. Approximately 1 mL of salvia was collected immediately before and 48 h after the strength exercise by using the passive drool method in accordance with guidelines from the assay kit manufacturer. Saliva samples were stored in a -80 degree freezer for later analysis. CRP concentrations were quantified by using ELISA with a commercially available assay kit for salivary CRP (item # 1-3302, Salimetrics, Inc, Carlsbad, CA).

Statistical analysis

Paired T-tests were used to compare baseline and 48 h follow up values for the outcomes. Between-group comparisons of the magnitude of change in outcome variables were performed using analysis of covariance (ANCOVA); age, BMI, and baseline values for the outcome variable were included as covariates but were removed if they were not important predictors ($p < 0.15$) of the outcome. Between-group comparisons of frequencies (percentages) were performed with Fisher's exact tests. P-values ≤ 0.05 were considered significant. Analyses were performed with SPSS (version 23) and GraphPad QuickCalcs software.

Results

Participants: Forty-two women provided informed written consent and were enrolled in the study (Figure 1). One woman dropped out of the study for personal reasons. After the first fourteen subjects completed the initial protocol it became evident that the protocol was only causing low levels of muscle soreness and it was not sufficient for evaluating the study hypotheses. Therefore, the protocol was revised to induce greater muscle soreness by increasing the number of sets from 2 to 4 and increasing the duration of rest between sets from 1 to 3 min. Thus, the analyses for the present report are based on data from 27 women who completed the revised (more demanding) protocol.

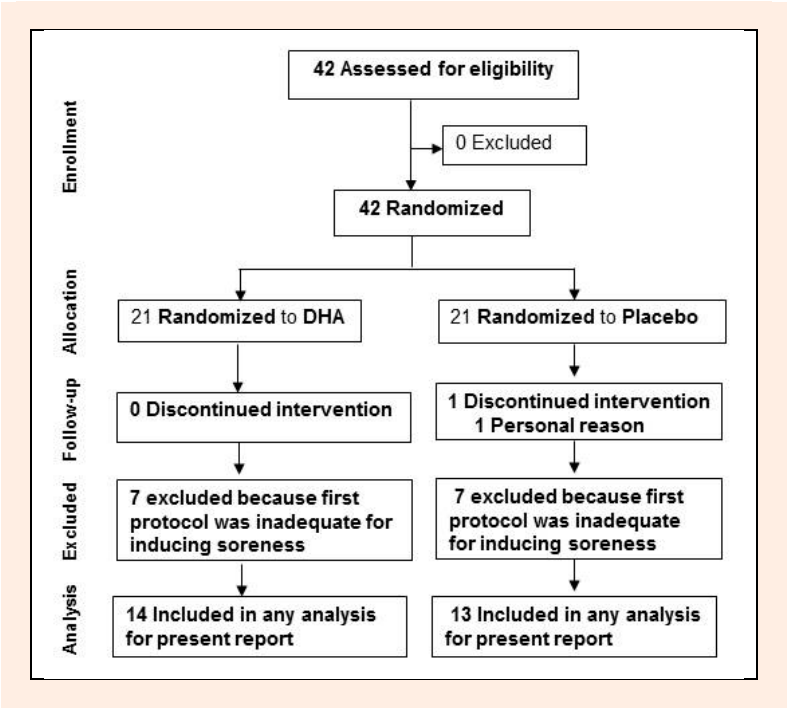

Figure 1. Consort diagram. Forty-two individuals were consented and randomized into either the DHA (n=21) or placebo group (n=21). Only one participant (placebo group) withdrew from the study and this was for personal reasons. After the first 14 subjects completed the initial protocol, it became evident that the protocol was causing low levels of muscle soreness and was not sufficient for evaluating the study hypotheses. Therefore, the protocol was revised to induce greater muscle soreness by increasing the number of sets from 2 to 4 and increasing the duration of rest between sets from 1 min to 3 min. Consequently, the data from the first 14 subjects (7 in DHA and 7 in placebo) were excluded. Thus, data used in analysis for the present report is based upon the subjects that completed the revised protocol (n=27).

Table 1. Baseline characteristics of the study participants. Values are means (±SE) or counts (%).

	DHA (n=14)	Placebo (n=13)	Between-group P-value
Age, yr	31.9 (3.1)	33.3 (2.4	.73
Height, m	1.63 (.02)	1.68 (.01)	.07
Weight, kg	60.3 (2.8)	66.1 (4.8)	.30
BMI, kg·m^{-2}	22.7 (1.1)	23.5 (1.6)	.67
1RM, kg	6.1 (.3)	6.5 (.4)	.39
120% 1RM, kg	7.3 (.4)	7.8 (.4)	.39
Active participation in strength training, number of subjects	0 (0%)	0 (0%)	1.00
Active participation in endurance exercise training, number of subjects	5 (36%)	2 (15%)	.24
***Frequency endurance exercise, sessions/week**	3 (2)	3 (2)	.54
Pill Compliance (%)	94 (2.7)	95 (1.9)	.84

BMI, body mass index; 1RM, one repetition maximum. Between-group p-values are from independent t-tests for quantitative data or Fisher's exact tests for frequencies.

As depicted in Table 1, there were no differences between groups for baseline characteristics. Overall, the participants were young to middle-aged, with a mean BMI in the normal weight range. Predicted 1RM for the unilateral preacher-bench biceps curls was ~6 kg (Table 1). Some (~26%), but not most of the women, actively participated in regular vigorous endurance exercise (defined as strenuous activity resulting in heavy sweating and large increase in pulse or breathing rate) when they enrolled in the study. None participated in strength training within 6 months of study participation (Table 1).

Pill compliance: Pill compliance was 94±3% in the DHA group and 95±2% in the placebo group and did not differ between groups (p = 0.84) (Table 1).

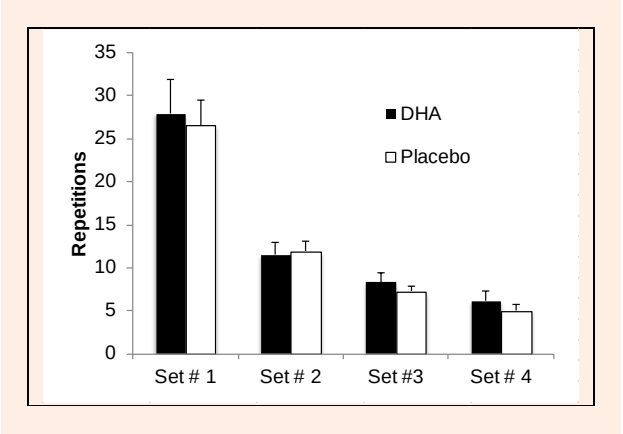

Figure 2. Eccentric exercise performance. The weight used for eccentric exercise and the number of repetitions performed did not differ between groups. This figure shows both the DHA and placebo groups performed fewer reps with each successive set despite giving maximal effort for every set, providing evidence that the protocol caused substantial muscle fatigue.

Eccentric exercise performance: The weight used for eccentric exercise (Table 1) and the number of reps performed (Figure 2) did not differ between groups (p = 0.39 and p = 0.61, respectively). Both the DHA and placebo groups performed fewer repetitions with each successive set despite giving maximal effort for every set (Figure 1), providing evidence that the protocol caused substantial fatigue.

Post-exercise soreness: Evidence of increases in muscle soreness between baseline and 48 h follow-up were observed with both soreness measures (VAS ratings during massage (p < 0.0001) and elbow extension (p < 0.0001)). DHA supplementation attenuated the magnitude of increase in soreness ratings as measured with the VAS scale during muscle palpation (Table 2). Soreness ratings acquired during active elbow extension were not altered by DHA supplementation; however, as described below, many subjects were not able to achieve full elbow extension.

Active and passive elbow extension: All participants were able to achieve full active elbow extension at baseline. However, while most (71%) of the DHA group participants were still able to achieve full active elbow extension 48 hr after eccentric exercise, only 15% of the placebo group subjects were able to do so (p=0.006), indicating less exercise-induced soreness and stiffness in response to DHA supplementation (Table 2). Although eccentric exercise resulted in a reduction in passive elbow extension in both groups, the magnitude of reduction did not differ between both groups (p = 0.78, Table 2).

Swelling: Arm circumference increased significantly in both DHA and placebo groups, indicating that measurable swelling occurred in response to eccentric exercise. However, there was no difference in the magnitude of swelling between groups.

Skin Temperature: There was no significant change in skin temperature between baseline and 48 h follow-up in either group, indicating that local muscle inflammation does not increase skin temperature.

Systemic inflammation: Salivary CRP data were not normally distributed and were therefore log-transformed for analyses. CRP concentrations did not increase in either the DHA or placebo group, nor were there between-group differences. This finding suggests that single-arm eccentric biceps curls do not produce enough local inflammation to alter systemic inflammatory markers.

Discussion

Results from the present study indicate that short-term DHA supplementation reduces exercise-induced muscle inflammation as evidenced by 23% lower soreness ratings in the DHA group than in the placebo group. Further

Table 2. Markers of inflammation and soreness in response to eccentric strength exercise. Data are means (±SE) or counts (%).

	DHA (n = 14)	Placebo (n = 13)	Between-group p-value
Soreness rating, palpated, cm			
Baseline	.0 (.0)	.0 (.0)	
48h follow- up	4.3 (.4)	5.6 (.5)	
Change	4.3 (.4)	5.6 (.5)	.02
Within group P value	<.0001	<.0001	
Soreness rating, full elbow extension, cm			
Baseline	.0 (.0)	.1 (.1)	
48h follow- up	5.1 (.5)	5.5 (.6)	
Change	5.1 (.5)	5.4 (.5)	.62
Within group P value	<.0001	<.0001	
Inability to fully extend elbow at 48h follow-up, count (%)	4 (29%)	11 (85%)	.006
Passive elbow joint angle, degrees of extension			
Baseline	167 (2)	166 (1)	
48h follow-up	155 (3)	155 (2)	
Change	- 12 (2)	- 11 (2)	.78
Within group P value	<.0001	.0004	
Arm circumference, cm			
Baseline	27.2 (1.1)	28.6 (1.5)	
48h follow- up	27.6 (1.1)	29.1 (1.5)	
Change	.4 (.1)	.5 (.1)	.75
Within group P value	.0002	<.0001	
Skin temperature, ˚C			
Baseline	31.0 (.2)	30.7 (.3)	
48h follow- up	30.7 (.0.2)	30.5 (.4)	
Change	-.3 (.2)	-.2 (.2)	.55
Within group P value	.16	.34	
C-Reactive Protein (salivary), log pg/mL			
Baseline	7.67 (.21)	8.50 (.36)	
48h follow-up	7.71 (.21)	8.58 (.36)	
Change	.03 (.06)	.07 (.09)	.74
Within group P value	.55	.46	

Within-group p-values are from paired t-tests comparing baseline and 48h follow-up values. Between-group p-values are from analysis of covariance tests in which change-scores were the dependent variables, study group (DHA vs. placebo) was the independent variable, and age, BMI, and baseline values for the outcome were included as covariates. Between-group comparisons of frequencies (percentages) were performed with a Fisher's exact test. Soreness ratings were collected by using a 10 cm visual analog scale.

more, due to DOMS and muscle stiffness, many participants were unable to fully extend the elbow joint 48 h after eccentric exercise but this affected significantly fewer women in the DHA group (29% vs. 85% were unable to fully extend). These findings of less soreness and stiffness, and better preservation of range of motion in the days after strenuous exercise would likely have functional implications during activities performed in that time period.

Results from the present study support those from other studies, which indicated that n-3 is beneficial for recovery from strenuous exercise. However, they also advance knowledge in several respects. First, because all previous studies included men alone (Bloomer et al., 2009; DiLorenzo et al., 2014; Tartibian et al., 2011) or a pooled sample of men and women (Jouris et al., 2011; Lenn et al., 2002), our study provides much needed evidence for benefits specific to women. Secondly, we studied the effects of DHA alone, rather than DHA+EPA. Because 4 of the 5 previous studies used DHA+ EPA, it was not clear if one or both species of n-3 contributed to the observed effects. The present study showed benefits from DHA alone, which supports the findings from the only other study that used DHA alone (albeit in men) (DiLorenzo et al., 2014). Although EPA is often considered the more anti-inflammatory species of n-3, some evidence indicates that DHA has more potent anti-inflammatory effects than EPA (Weldon et al., 2007). Furthermore, through its actions on nerve tissue, DHA also has antinociceptive effects (Nakamoto et al., 2011) that could be responsible for the attenuation in DOMS that we observed. Therefore, studies on the effects of DHA alone are important. Lastly, because most previous studies used longer-term n-3 supplementation (4-6 weeks), findings from the present study and from our previous study (Jouris et al., 2011) are unique and provide evidence that much shorter term (1 week) n-3 supplementation is beneficial for blunting DOMS after strenuous exercise.

The main dietary sources of DHA and EPA in the Western diet are fish and fish oil and most of the seminal studies on the health benefits of n-3 consumption have come from studies of fish and/or fish oil consumption. A concern about fish and fish oil supplements is contamination with toxins, such as organic pollutants (e.g. polychlorinated biphenyls, PCBs) (Schecter et al., 2010) and mercury (Myers et al., 2007; Nielsen et al., 2014) both of which have health implications. Although many of the most commonly consumed types of fish in the US (shrimp, canned light tuna, salmon, pollock, and catfish)

are low in contamination levels, some species (e.g. king mackerel, golden bass/snapper, swordfish, shark, and white albacore tuna), and some locally caught fish have levels of mercury that warrant concern (U.S. Department of Health and Humans Services and U.S. Environmental Protection Agency, 2004). Furthermore, although many fish-oil supplements have been purified to remove some toxins, the purification processes are not fully effective for lipid soluble toxins, such as dioxins and PCBs (Fernandes et al., 2006; Hoh et al., 2009). In contrast, the DHA used in the present study was extracted from algae that were grown in controlled laboratory setting without exposure to the industrial pollutants that contaminate fish. Thus, algae-derived DHA does not have detectable levels of the pollutants (Doughman et al., 2007) and may consequently have a more favorable benefit-to-risk ratio.

Although DHA supplementation had beneficial effects on delayed onset muscle soreness and active range of motion, several other markers of muscle inflammation failed to show benefit. In both groups, arm circumference increased by ~2% after eccentric exercise, suggesting that swelling/edema was present; however, DHA did not attenuate this response. Furthermore, passive elbow extension decreased by ~7% and was unaffected by DHA supplementation. In one respect, the lack of effect on passive elbow extension angle is surprising, because DHA supplementation increased the number of subjects who could achieve full active elbow extension. However, it is possible that active elbow extension was limited by pain, which DHA reduced. In contrast, passive extension did not cause pain and may have been more dependent other factors, such as swelling and edema, which were not affected by DHA supplementation. It is also possible that beneficial effects of DHA supplementation on swelling and relaxed arm angle were not evident because 48 hours after exercise was not enough time for swelling and stiffness to fully develop. In support of this possibility, one study showed that swelling and stiffness do not peak until 4 days after eccentric exercise (Cleak and Eston, 1992). Taken together, it does not appear as though DHA supplementation affects swelling but it does affect pain. This is consistent with what was observed in our earlier study (Jouris et al., 2011) and is also consistent with the notion that some of the benefits of DHA supplementation may be attributable to its anti-nociceptive effects (Nakamoto et al., 2011).

Localized heat is a common clinical indicator of inflammation in response to acute injuries such as sprains and strains. Despite the likelihood that eccentric exercise causes low-grade muscle damage, skin temperature did not increase during the 48-hr after eccentric exercise in the present study. Furthermore, we saw no evidence of increases in systemic inflammation, based on salivary CRP concentrations, perhaps due to the small muscle mass involved. These results remained non-significant after excluding the 7 women who routinely performed endurance exercise training. Because these markers of inflammation did not change in response to eccentric exercise, they cannot be used as evidence for or against the effects of DHA supplementation on inflammation.

Alternative strategies are available for treating or preventing DOMS. For example, non-steroidal anti-inflammatory drugs (NSAIDs) are commonly used (Bouchard, 2012). However, NSAIDs may hinder the recovery process (Schoenfeld, 2012), partly by interfering with exercise-induced proliferation of satellite cells (Mikkelsen et al., 2009). In contrast, n-3 do not appear to have major side effects at doses of 3000 mg/d or less (Food and Drug Administration, 2004) and they may help promote muscle adaptations to exercise training (Smith et al., 2011a; 2011b). Furthermore, chronic n-3 consumption likely has other health benefits, such as cardioprotection (Lavie et al., 2009), prevention of cognitive decline (Fotuhi et al, 2009) and protection against some forms of cancer (Rose and Connolly, 1999). Although additional research is needed to determine if habitual ingestion of n-3 (from fish, fish oil, or algae) is associated with better recovery from strenuous exercise, these findings in aggregate suggest that n-3 may be a preferred approach for preventing exercise-induced DOMS.

Conclusion

Results from the present study suggest that 1 week of 3000 mg/d of DHA supplementation reduces exercise-induced muscle soreness and stiffness but does not appear to attenuate the mild swelling that results from eccentric exercise. These findings add to a growing body of evidence for the beneficial effects of n-3 supplementation on both health outcomes and exercise recovery and adaptations. DHA supplementation may be warranted for people undergoing new exercise training programs and for those undergoing intensification of exercise training to help minimize muscle soreness and stiffness, and thereby facilitate ongoing training and competition.

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Key points

- Seven days of 3000 mg/day supplementation with algae-derived docosahexaenoic acid (DHA) attenuates the delayed onset muscle soreness and stiffness, and protects against the loss of joint range of motion that is caused by strenuous eccentric exercise.
- This benefit was observed in women, and supports the findings from other studies that were conducted on men or a combination of men and women
- The benefits from algae-derived DHA appear to be similar to those reported in other studies that used a combination of DHA and eicosapentaenoic acid (EPA) derived from fish oil
- The findings of better recovery from strenuous exercise with DHA supplementation, paired with other research which demonstrated that DHA and EPA protect against chronic diseases suggest that DHA is an attractive option
- These findings have relevance to athletic populations, in that DHA would be expected to facilitate recovery and allow for better performance during training and competition. However, DHA supplementation might also benefit non-athletic populations, such as individuals starting new exercise programs and patient populations that are prone to muscle soreness (e.g. physical therapy patients).

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