

# Diet and Osteoarthritis

## *Sharing Strategies for Reduced Pain and Improved Function When the Evidence Is Limited*

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Osteoarthritis is a debilitating joint disease impacting millions of people around the world, but for which few effective treatments exist. It is influenced by both mechanical and systemic factors, each of which may be mitigated by appropriate dietary interventions. Unfortunately, few patients are given advice beyond, “lose some weight.” The effect of weight loss on pain and function is recognized, but less known is the evidence that diet quality may impact pain and function. In this article, we discuss evidence-based weight loss strategies and the additional role of an anti-inflammatory diet on both the progression and severity of osteoarthritis. We present a case from our family medicine practice to demonstrate how evidence-based medical nutrition therapy can be used to help patients with osteoarthritis achieve symptom relief. *Nutr Today*. 2021;56(2):55–61

Osteoarthritis (OA) is a degenerative joint disease affecting more than 302 million people globally<sup>1</sup> and is characterized by localized inflammation and progressive bone and cartilage degradation. It primarily affects joints in the hands, hips, and knees and causes structural damage, which results in pain, tenderness, stiffness, disability, and a decreased quality of life (QOL). Although often recognized as a disease of older adults, OA is associated with higher rates of depression, suicidal ideations, and high healthcare costs for people throughout life stages.<sup>1–4</sup>

The development of OA is influenced by genetics, trauma, mechanical factors, and age<sup>2,4,5</sup> and is significantly

associated with excess body weight and cardiometabolic comorbidities.<sup>2–9</sup> Individuals who are overweight and obese are, respectively, at a 2 and 4 times greater risk of developing OA.<sup>2,3</sup> Although this association is often attributed to the increased mechanical load on weight-bearing joints, emerging research now demonstrates the role of low-grade systemic inflammation on the development and progression of the condition.<sup>2,5,6,8–14</sup> For example, individuals who are overweight and obese are also at a 2 times greater risk of hand OA, a non-weight-bearing joint.<sup>5</sup>

### OA and Systemic Inflammation

Excess body weight may influence OA progression through both joint load, and the release of proinflammatory adipokines, the increase in oxidative stress, and the increase in circulating free fatty acids—all of which have been associated with accelerated cartilage breakdown in some observation or laboratory studies.<sup>5,10,11,14,15</sup> Its contribution on these mechanical and systemic factors not only impact the progression of the disease but may also lead to greater symptom severity, pain, disability, and decreased QOL, even independent of radiographic severity.<sup>2,8,11,16</sup> Therefore, interventions that target not only excess body weight but also the subsequent systemic inflammation are important in the successful management of OA.

### Guidelines for the Management of OA

There is no cure for OA, and recommendations for its management include only strategies for symptom relief. Therapies recommended by the American College of Rheumatology and the Arthritis Foundation include nonsteroidal anti-inflammatory drugs, glucocorticoid injections, biomechanical supports, joint replacement surgeries, physical activity with muscle strengthening, and weight loss, and they discourage the use of dietary supplements. They do not discuss evidence-based strategies for healthy weight loss, nor the impact of inflammatory components in the diet.<sup>1</sup> *The Nutrition Care Manual*, published by the Academy of Nutrition and Dietetics (Academy), also offers little specific recommendations for the management of OA beyond weight loss to reduce joint load. The Academy does emphasize that patients should follow a diet consistent with the US Dietary Guidelines.<sup>17</sup>

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We review the case of an elderly woman with OA referred to East Carolina University's Family Medicine Center for weight management and discuss the dietary options for managing her condition.

## CASE INTRODUCTION

Ms M.C. is a 70 year-old woman, 61 in. tall and 265 lb (body mass index, 50.2 kg/m<sup>2</sup>) with a waist circumference of 57 in when first seen by a registered dietitian nutritionist (RDN) 3 years ago. She has a medical history of hypertension, hyperlipidemia, metabolic syndrome, vitamin D deficiency, gastroesophageal reflux disease, osteoporosis, stage III chronic kidney disease (CKD3), and OA of the hands, knees, and spine. At that time, she reported taking daily aspirin, lisinopril, metoprolol XL succinate, cholecalciferol, hydrochlorothiazide, pantoprazole EC, simvastatin, sodium bicarbonate, a 1000-mg omega-3 fatty acid supplement, and a Centrum Silver multivitamin. Her blood pressure and lipids were well controlled.

At a meeting with her physician regarding her OA, Ms M.C. reported increasing OA pain, rating it a 9 out of 10, and described it as a “throbbing and burning pain” that worsened when standing and walking. She noted that she has been living with this for many years but that it had recently worsened and interfered with her activities of daily living. Her physician noted swollen joints in her arms and legs during the physical examination. Ms M.C. takes Tylenol for her pain, per her physician's recommendation, but stated that it offers little relief. Because of her CKD3, nonsteroidal anti-inflammatory drugs were not a treatment option, so her physician referred her for medical nutrition therapy. Although Ms M.C. was skeptical that diet changes would help, she kept her appointment with the RDN to satisfy her physician.

## Weight Management for OA

Weight loss is recognized as an effective way to improve OA symptoms, with a strong body of evidence demonstrating its benefit on pain, physical functioning, and QOL, regardless of the weight loss strategy or dietary approach used.<sup>1,2,6,18</sup> Significant relief can be achieved with a 5% to 10% reduction in body weight and occurs in a dose-response manner, with a greater reduction in body weight having a greater impact on symptom, functional, and clinical improvements.<sup>1,2,4,6</sup> Weight loss impacts OA through both a reduction in mechanical load on weight-bearing joints and an attenuation of proinflammatory factors that contribute to pain and cartilage degradation. A randomized controlled trial (RCT) among patients with OA who were overweight or obese found that a 4-fold reduction in load during movement resulted from each unit of body weight lost.<sup>19</sup> For example, a 250-lb person losing 5% of his/her body weight (12.5 lb) would achieve a 50-lb reduction in knee-joint load per step. Treatment guidelines make strong recommendations

for weight loss but fail to designate any preferred weight loss method or specific eating approach.<sup>1</sup>

## Calorie-Restricted Diet

An individualized, low-calorie diet is the basic approach recommended for weight loss. A 500- to 1000-kcal/d calorie deficit, which achieves a gradual weight loss of 1 to 2 lb per week, is suggested and results in improvements of both symptomatic and serum biomarkers of OA.<sup>2,6</sup> However, adherence is difficult and may have detrimental impacts on lean body mass (LBM) if the diet is not nutritionally adequate.<sup>3,9</sup> Adequate protein intake is important to promote the maintenance of LBM, and there is evidence that a higher protein intake may be associated with added functional improvements in patients with OA.<sup>18</sup>

## Meal Replacements

Meal replacements (MRs) refer to any food or drink product eaten in place of a meal, usually with the goal of managing total daily caloric intake, and the Academy lists them as an option for individuals who need extra support with weight loss.<sup>20,21</sup> The evidence also suggests that some dieters using an MR may achieve both significant and faster weight loss compared with other diet approaches.<sup>20</sup> In 1 RCT, older adults on a low-calorie diet including up to 2 MR/d achieved significant weight loss and improvements in joint load, inflammatory biomarkers, pain, and function.<sup>6</sup> Meal replacements are well-accepted, convenient products that can be easily incorporated into various lifestyles and may be an effective weight management strategy for some patients. Some researchers report that some dieters choose to continue using MRs to aid in weight maintenance even after the completion of a weight loss program.<sup>22</sup>

## High-Quality Diet

Advancing age is a strong risk factor for OA,<sup>2,4,5</sup> with its prevalence significantly increasing with each decade of life.<sup>12</sup> Diet quality, or the nutritional adequacy and interaction of whole foods within a diet, is important in the prevention of chronic disease, the preservation of LBM, and the maintenance of QOL in older adults.<sup>9</sup> The DASH and Mediterranean eating approaches are 2 of the most well-studied eating patterns, and both emphasize high intakes of fruits, vegetables, whole grains, legumes, olive oil, fish, and seafood and limit the intake of saturated fats, sodium, and added sugars. Each has been associated with decreased morbidity, improved cognitive health, increased longevity, and lower rates of overweight and obesity.<sup>11–13</sup> Overweight and obese individuals starting a high-quality diet may also achieve weight loss comparable with other diet strategies, and high-quality diets may be associated with better weight loss at 1 year.<sup>23</sup> This weight loss, if maintained, can continue to impact body weight, which in turn, may improve symptomatic OA in a dose-response manner.

## Physical Activity

Diet strategies are necessary for significant and sustainable weight loss, and these results can be achieved without the addition of physical activity. Research further suggests that calorie-restricted diets are more effective than physical activity alone on reducing body weight, joint load, and inflammatory biomarkers.<sup>2,6</sup> However, physical activity is recommended for the management of OA<sup>1</sup> and is mentioned here because a large RCT among overweight and obese older adults with OA found that the efficacy of weight loss on pain and QOL was significantly greater when a diet and exercise program was combined.<sup>6</sup> Patients with OA face unique barriers that may make getting adequate physical activity difficult, including pain, physical limitations, fear of disease acceleration, and a lack of motivation or professional support.<sup>2</sup> However, once some weight loss and subsequent symptomatic improvements are achieved, patients may be less fearful of adding physical activity into their routines.

## Diet for Improved OA Management

The progression and severity of OA may be influenced by joint load, inflammation, and oxidative stress.<sup>2,5,6,10,11,14</sup> Nutrients from whole foods, eaten in the context of a high-quality diet, may have a greater benefit on OA than individual nutrients within supplements, which, in general, have failed to demonstrate strong evidence to support their use in OA management.<sup>1,2</sup> In contrast, research has shown that higher adherence to a high-quality diet is associated with a lower prevalence of OA and significant improvements in QOL, pain, and disability.<sup>3,4,9,11,12,16</sup> One study demonstrated that each 1-unit increase in DASH-diet adherence score was associated with 3% lower odds of having OA.<sup>12</sup> A few observational studies have additionally found that the protective relationship between OA and a high-quality diet remains significant, independent of body weight.<sup>3,14,16</sup>

A high-quality diet is theorized to be effective in OA management due to its inclusion of foods high in anti-inflammatory factors and antioxidants. These mechanisms have been demonstrated to positively impact metabolic syndrome, DM, and obesity, which suggests their potential role in attenuating the systemic inflammation and oxidative stress contributing to the progression of OA.<sup>11,12</sup> Most of the research on diet and OA is limited and observational, so we cannot state causality between the two. However, the following discussion will describe what emerging research is finding about the relationship between dietary characteristics and OA.

## Total Dietary Fat

A high-fat diet has been associated with worsened symptoms and structural characteristics of OA, although the research has been, thus far, limited to *in vitro*, animal, and observational studies.<sup>10,14</sup> There is also a significant positive relationship between total fat intake and both total

caloric intake and body mass index, suggesting its potential to modify OA through its impact on body weight. However, 1 study found that the association remained significant after weight was controlled for, suggesting its possible influence on the metabolic and inflammatory factors impacting OA. Fatty acids may contribute to OA through their role as precursors for inflammatory factors; thus, both the quantity and type of fatty acid consumed may impact levels of systemic inflammation and, subsequently, OA characteristics.<sup>14</sup>

## Saturated and Unsaturated Fats

Diets high in saturated fat are positively associated with worsened symptomatic and clinical characteristics of OA.<sup>9,10,14</sup> The inverse has also been demonstrated.<sup>3,9</sup> On the other hand, 1 study among overweight and obese older adults with knee OA demonstrated a protective relationship between unsaturated fat intake and knee OA structural damage, causing researchers to conclude that unsaturated fatty acids may potentially reduce the radiographic progression of the disease.<sup>14</sup> Both monounsaturated and polyunsaturated fatty acids have independently been associated with clinical and symptomatic OA improvements in laboratory, animal, and observational studies. The 2 polyunsaturated fatty acids, omega-3s and omega-6s, impact OA in different ways. Omega-3s help to decrease inflammatory biomarkers and may reduce both cartilage degradation and oxidative stress, whereas omega-6s have proinflammatory actions, may increase joint inflammation and some inflammatory markers, and accelerate the progression of OA. Thus, a lower ratio of omega-6 to omega-3 fatty acid may be more favorable in OA management.<sup>10,14</sup>

## Olives/Olive Oil

Olives and its derivatives are a large component of the Mediterranean diet and are high in monounsaturated fatty acids. Human studies have demonstrated a significant benefit when patients with OA were given either a topical or oral olive oil.<sup>11,15</sup> However, the effective dose and whether dietary intake levels are effective remain to be determined.

## Fish/Fish Oil

The consumption of fatty fish is a part of both the Mediterranean and DASH diets, and fish oil is widely used for its provision of 2 types of anti-inflammatory omega-3s, docosahexaenoic acid, and eicosapentaenoic acid. Although preliminary research suggests a protective relationship, human studies have not been able to demonstrate a significant benefit from fish oil supplements on OA symptom improvements.<sup>1,2</sup> However, an observational study of older adults demonstrated that individuals who consumed less fish had an increased odds of reporting right knee pain than individuals with higher fish consumption.<sup>13</sup>

Fruits and Vegetables

Fruits and vegetables are nutrient-dense foods high in antioxidants and polyphenols, both of which may be associated with improved OA outcomes, potentially through their ability to reduce inflammation and oxidative stress.<sup>11,13,15,16,24,25</sup> One observational study found an inverse association between total fruit and vegetable intake and both pain and radiographic prevalence of knee OA, demonstrating that participants who consumed at least 9 servings (of fruits and vegetables) per day had a 46% reduced odds of severe knee pain. Those consuming between 5 and 9 servings (of fruits and vegetables) per day had a 33% reduced odds.<sup>16</sup> Fruit intake may be inversely associated with OA prevalence and both symptom and structural severity.<sup>7,16,25</sup> One study, for example, found that consuming at least 2 servings of fruit each day was associated with fewer reports of severe knee pain in normal-weight adults.<sup>16</sup> Small RCTs have also demonstrated the specific benefit of strawberries (50-g freeze-dried strawberry powder per day, equivalent to 500-g fresh strawberries)<sup>24</sup> and pomegranate juice (200 mL of 100% juice per day)<sup>26</sup> on OA symptoms.

The quality of evidence to support vegetable intake for OA management is not as strong. Whereas some research has demonstrated a protective relationship, specifically on pain, depression, and QOL,<sup>13,16</sup> others have not found a significant association.<sup>7,25</sup> It is important to note, however, that the method of preparation of vegetables can impact its efficacy. For example, 1 study, which found no significant association, classified french fries as vegetables.<sup>7</sup>

Dietary Fiber

High-quality diets are generally associated with higher dietary fiber intake given the inclusion of whole grains, fruits, vegetables, nuts, seeds, and legumes. Fiber intake has

been associated with fewer OA symptoms and pain in a dose-response manner.<sup>2-4,8,12</sup> In 1 large prospective cohort study among US adults with or at risk of OA, participants with the highest fiber intake had a 61% lower risk of symptomatic OA.<sup>8</sup> In addition, fiber from cereal grains has been independently shown to have a significant benefit on OA symptoms in observational studies.<sup>8,11</sup>

CASE REVISITED

Ms M.C. decided to begin the Intensive Behavioral Therapy for Obesity (IBTO) program, involving a year of regularly scheduled appointments focused on weight management.<sup>27</sup> During her initial encounter, she reported that she had struggled with her weight for years and had tried Weight Watchers and Slim Fast diets without success. She was very discouraged, stated that she did not think she could lose weight, did not anticipate changing her current eating habits, and did not expect to gain any significant benefit from the meetings.

Ms M.C. came to her appointment with her daughter-in-law and reported that she lives alone, uses a walker to get around, and relies on others to help her get groceries. She stated that she does not cook and has no interest in cooking, because she does not want to stand for extended periods because of her OA symptoms. She further noted that she dislikes all vegetables and most fruits.

The Plan

Ms M.C.'s resting energy expenditure was measured using indirect calorimetry and determined to be 1454 kcal/d. She provided a 24-hour recall (Table 1) and noted that this was typical of her usual diet. A nutrient analysis revealed excessive calorie, total fat, and saturated fat intake, and inadequate protein, fiber, fruit, and vegetable intake. We felt

TABLE 1 Preintervention 24-Hour Recall and Nutrition Analysis							
	Food	Calories	Carbohydrate	Protein	Total Fat	Saturated Fat	Fiber
Meal 1	1 - Bojangles' sausage, egg, cheese biscuit	625 kcal	41 g	16 g	41.5 g	16 g	3 g
Meal 2	1 - Pack of peanut butter-filled cheese crackers	210 kcal	25 g	5 g	10 g	2 g	2 g
Snack 1	4 - Snickers "fun-size" candies	320 kcal	44 g	4 g	14 g	6 g	0 g
Meal 3	1 - Sandwich with salami, full-fat cheese, and mayonnaise on white bread	400 kcal	24 g	13 g	27.5 g	9 g	0 g
Snack 2	1 - Fudgesicle	70 kcal	13.5 g	2 g	1 g	0.5 g	0 g
Beverages	½ - 20-oz bottle of Dr. Pepper	125 kcal	33 g	0 g	0 g	0 g	0 g
Total (% of total calories)		1750 kcal	180.5 g (41.26)	40 g (9.14)	93.8 g (48.24)	33.5 g (17.23)	5 g



comfortable recommending weight loss along with a high-quality, anti-inflammatory diet, based on its potential association with improved OA symptoms, and demonstrated association with overall health and longevity, as well as its consistency with the US Dietary Guidelines.

Restrict Calories

To optimize weight loss, a daily calorie goal of 1100 kcal/d was negotiated with Ms M.C. To ensure adequate protein intake to preserve LBM, while also avoiding excess to limit exacerbation of CKD3, a protein goal was set at 54 to 62 g/d (0.7–0.8 g/kg of adjusted body weight; 20% of calorie goal). Because Ms M.C. had previously worked as an accountant, she was interested in tracking her daily caloric intake with a food log. Although it is well established that tracking intake improves outcomes, many are not willing to do so. Ms M.C. brought these to each meeting for review by the RDN. Ms M.C. was not willing to make other significant changes to her diet habits at first but was willing to make small adjustments within her current eating pattern. Together with the RDN, she identified swaps in food choices for calorie control, such as choosing a low-calorie beverage instead of soda. A review of her postintervention diet (Table 2) reflects a daily caloric intake near the calorie goal. She also agreed to make other changes that would ultimately reduce total- and saturated-fat intake, increase dietary fiber intake, and ensure adequate, but not excessive, protein intake. These small changes were made gradually during her first year with the RDN.

Reduce Fat

Total and saturated fats, respectively, made up more than 48% and 17% of Ms M.C.'s total caloric intake, respectively,

and primarily came from fast foods and sandwiches. Over time, Ms M.C. was able to reduce her total- and saturated-fat intake by more than half. Changes she made included exchanging her daily Bojangles' biscuit for a homemade breakfast sandwich, switching to a reduced-fat cheese, substituting sliced turkey for salami, and limiting mayonnaise on her sandwiches. She was able to increase her unsaturated fat intake by snacking on nuts more often than prepackaged snacks.

Increase Dietary Fiber

The RDN encouraged Ms M.C. to increase her fiber intake to assist with both weight loss and OA symptom management. Small changes that she made included switching from white bread to 100% whole wheat bread and shifting some of her snacks to higher-fiber foods. Despite these changes, however, her daily fiber intake remained inadequate. Thus, the RDN recommended Ms M.C. try a high-fiber MR bar to replace her midday meal. She chose a bar that also provided additional protein, and its inclusion in her diet significantly improved both her daily protein and fiber intake to amounts that would meet her needs and help to support the management of her OA.

Fruits and Vegetables

Despite frequent encouragement from the RDN to consume more fruits and vegetables, Ms M.C. was not ready to make this change but was beginning to contemplate how this could fit into her eating pattern. In the meantime, she took a daily multivitamin-mineral supplement.

Physical Activity

Ms M.C. initially expressed no intent to exercise, noting pain, stiffness, and limited mobility. Toward the end of

TABLE 2 Postintervention 24-Hour Recall and Nutrition Analysis							
	Food	Calories	Carbohydrate	Protein	Total Fat	Saturated Fat	Fiber
Meal 1	1 - Fried egg sandwich, with 2 eggs, low-fat cheese, 100% whole wheat bread, and cooking spray	264 kcal	25.6 g	19.2 g	10.1 g	4.1 g	4 g
Meal 2	1 - Quest oatmeal chocolate chip protein bar	190 kcal	23 g	20 g	7 g	1.5 g	16 g
Snack 1	¼ cup - Cashews, roasted without salt	196 kcal	11.2 g	5.2 g	15.9 g	3.1 g	1 g
Meal 3	1 - Sandwich with roasted turkey slices, low-fat cheese, and 100% whole wheat bread	237 kcal	27 g	21.9 g	5.9 g	3 g	4 g
Snack 2	1 - Fruit juice popsicle, with no added sugar	45 kcal	11 g	0 g	0 g	0 g	1 g
Beverages	Water	0 kcal	0 g	0 g	0 g	0 g	0 g
Total (% of total calories)		932 kcal	97.8 g (41.97)	66.3 g (28.45)	39 g (37.66)	11.7 g (11.30)	26 g

her IBTO program, however, Ms M.C. expressed an increased interest in adding chair exercises to her routine.

## Results

Each of the changes listed previously supported Ms M.C.'s weight loss goals and was consistent with an anti-inflammatory diet approach, which may support OA management. After 3 months of IBTO, Ms M.C. achieved a 15-lb weight reduction, equivalent to a 5.6% loss of body weight. At this appointment, she noted significant improvements in pain and stated that her "knees no longer hurt," which is consistent with research findings.<sup>1</sup> Ms M.C. continued to experience gradual weight loss during the course of her meetings with the RDN, achieving a 61.5-lb and 23% reduction in body weight. At each appointment, she noted dramatic decreases in joint pain and increases in functional mobility. The RDN encouraged her by explaining that each pound of weight lost significantly decreases the load on her joints, translating to improved OA symptoms. In the latter half of her IBTO meetings, Ms M.C. slowly began incorporating more cooking into her routine, which she attributed to her improved mobility and knee pain.

Although Ms M.C. was able to achieve significant improvements in her OA symptoms through diet changes that supported both healthy and sustainable weight loss, which were consistent with an anti-inflammatory diet, she did not make all of the changes recommended by the RDN—a reminder of the importance to recognize the autonomy of the individual and to work together to find strategies that are both realistic and achievable for them.

## SUMMARY

Despite the scarcity of nutrition-related recommendations in current treatment guidelines, this review and case demonstrates that nutrition can play a significant role in supporting patients who are experiencing OA achieve symptom relief. Osteoarthritis is a condition influenced by both mechanical and systemic factors, and there are few effective therapies available to patients. Nutrition has the unique ability to target both the mechanical and metabolic factors that impact pain and function. Improving pain is important both to reduce the amount of pain medications some individuals require and to support patients with comorbidities for whom pain medications are contraindicated.

The quality of evidence to support weight loss for OA management is strong, but the evidence supporting the role of diet quality on OA is less conclusive, as few large RCTs have been performed. However, the preliminary observational studies are promising, and high-quality diets have been strongly associated with overall health and weight management and are consistent with US Dietary Guidelines. Therefore, a high-quality, anti-inflammatory diet may support an appropriate weight loss intervention in the successful management of OA. These efforts are best

made with the guidance of an RDN who can tailor a plan that supports weight loss goals, ensures nutritional adequacy, and promotes long-term maintenance. These plans could use strategies such as restricting calories, using MRS, and encouraging a high-quality, anti-inflammatory diet. Encouraging physical activity, as appropriate, can further increase the efficacy of dietary interventions.

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