Narrative Review

Diet Composition's Effect on Chronic Musculoskeletal Pain: A Narrative Review

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Background: In the medical setting, clinicians frequently attend to patients with chronic musculoskeletal pain. Recent literature demonstrates diet may play a role in inflammation and musculoskeletal pain.

Objectives: The purpose of this narrative review is to present the most current literature on the effect of common diet regimes, additions, and eliminations on chronic musculoskeletal pain.

Study Design: This is a narrative review of the literature on the effect of 1) Mediterranean diets; 2) vegetarian and vegan diets; 3) oils, seafood, and omega-3 fatty acids; 4) fruits; 5) spices and herbal teas; and 6) elimination diets on patient-reported musculoskeletal pain scores.

Methods: In January 2023, the Google Scholar and PubMed databases were reviewed to identify research on the effect of common diet regimes and additions on self-reported pain outcomes in patients with chronic musculoskeletal pain.

Results: A total of 32 original research articles and a systematic review were included and used to develop grades of recommendation. There is fair evidence that diverse, plant-based Mediterranean, vegetarian, and vegan diets may reduce musculoskeletal pain. Other dietary considerations, including adding marine oils, seafood, omega-3 fatty acids, antioxidant-rich fruits, and turmeric may also benefit patients with chronic musculoskeletal pain. There is poor-quality or insufficient evidence to support adding olive oil, ginger, or herbal teas to reduce pain. While eliminating aspartame and monosodium glutamate may reduce inflammation, there is poor-quality evidence that it reduces musculoskeletal pain.

Limitations: This narrative review is not systematic in nature; instead, it aims to provide a current update on the effect of various diet regimes, additions, and eliminations on chronic musculoskeletal pain. The studies in this review are limited in sample size, study period, and robust comparisons to controls. This review is limited to studies on patients with either rheumatoid arthritis, osteoarthritis, or fibromyalgia due to the lack of relevant literature on other musculoskeletal pain conditions.

Conclusions: Clinicians can play a role in the well-being of patients with chronic musculoskeletal pain through holistic interventions such as a dietary emphasis on plant-based regimes. Further research is necessary to elucidate the relationship between diet, inflammatory markers, and disease states, as well as the safety and contraindications of these dietary changes.

Key words: Pain, musculoskeletal, diet, fibromyalgia, rheumatoid arthritis, osteoarthritis, mediterranean, vegetarian, vegan

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There is increasing interest in the role lifestyle plays in chronic musculoskeletal pain. Chronic musculoskeletal pain is defined as persistent pain of the bones (ostalgia), joints (arthralgia), muscles (myalgia), ligaments, and/or tendons. In the past decade, several studies have demonstrated an association between diet and musculoskeletal pain through inflammation, obesity, homeostatic balance, and/or nociceptive effects (1-5).

According to the World Health Organization, a

diet high in omega-3 fatty acids, fruits, vegetables, and whole grains has demonstrated anti-inflammatory and lifelong health effects (6). On the other hand, a diet high in red meats, saturated fats, trans fats, refined starches, sugar, and salt may trigger gut dysbiosis and consequently increase intestinal permeability, resulting in an immune imbalance toward inflammation (7,8). Furthermore, antinociceptive and analgesic effects are noted with naturally occurring anti-inflammatory compounds such as flavonoids, ginger root, curcuminoids, omega-3 polyunsaturated fatty acids, and taurine (9).

Given the high prevalence of patients with musculoskeletal pain in the medical setting and the association between diet, inflammation, and pain, a comprehensive understanding of how diet relates to musculoskeletal pain may serve clinicians when counseling patients. To date, reviews are scarce and generalized to various types of nonmusculoskeletal pain, including radicular and neuropathic pain.

Objectives

This review aims to present current literature on diet composition's effect on patient-reported musculoskeletal pain outcomes.

Study Design

The contents of this narrative review focus on patients with osteoarthritis, rheumatoid arthritis, or fibromyalgia, given the prevalence of musculoskeletal pain in these patients and the focus of prior literature on these medical conditions. Inflammation will be discussed as a potential mediating factor, but inflammatory marker outcomes are outside the scope of this review. We will examine the effect on patient-reported musculoskeletal pain scores of

- Mediterranean diets.
- Vegetarian and vegan diets.
- Adding oils, seafood, and omega-3 fatty acids.
- Adding fruits.
- Adding spices and herbal teas.
- Elimination diets.

Methods

In January 2023, the Google Scholar and PubMed databases were reviewed to identify research on diet's effect on self-reported pain outcomes in patients with chronic musculoskeletal pain. The search strategy used "Mediterranean diet," "vegetarian diet," "vegan diet," "oil," "seafood," "fruit," "spice," "herbal tea," or "elimination diet" combined with "musculoskeletal pain" or "chronic pain." Original research and systematic reviews from 1990 through 2023 were included. Original research on animals and cadavers was excluded. Included peer-reviewed original research papers and systematic reviews were used to develop grades of recommendation.

Results

Using the search criteria, 17,949 studies were identified. Of these, 32 relevant original research studies (2 studies on the Mediterranean diet, 4 studies on vegetarian/vegan diet, 12 studies on dietary oils, 4 studies on fruits, one study on turmeric, 5 studies on ginger, 2 studies on herbal teas, and 2 studies on elimination diets) were included and reviewed. Further, a meta-analysis of 8 randomized controlled trials on turmeric was reviewed. An assessment of empirically supported diets for musculoskeletal pain management using grades of recommendation (10) is presented in Table 1.

Discussion

Mediterranean Diet

The Mediterranean diet has garnered increasing attention by nutritionists and medical professionals over the past decade (2). This plant-based diet is characterized by regular consumption of whole grain, olive oil, fruits, vegetables, beans, legumes, nuts, herbs, and spices (11). Meat is consumed in smaller quantities. The typical meat of choice is fish and other seafoods. The high ratio of monounsaturated to saturated fats, high ratio of omega-3 to omega-6 polyunsaturated fatty acid and many fruits, vegetables, legumes, and whole grains, has well-demonstrated anti-inflammatory effects (2,12-14). For example, a 2014 population-based cohort study of 14,586 Italian citizens determined adherence to a Mediterranean diet was associated with lower platelet and leukocyte counts (14).

Several studies have demonstrated the benefit of a Mediterranean diet on decreasing inflammation in the human body (2,12-14). To our knowledge, however, regarding musculoskeletal pain specifically, only 2 studies have been published.

Sköldstam et al (15) investigated the efficacy of a Mediterranean vs Western diet in Swedish patients experiencing musculoskeletal pain from rheumatoid arthritis (RA). All patients had active RA for at least 2 years and were randomly assigned to a Mediterranean diet or control diet for 12 weeks (15). To promote compliance, all patients were provided a prescribed lunch and dinner for the first 3 weeks. A pain Visual Analog

Scale (VAS, 0-100 mm) was used to assess pain levels at the end of weeks one, 3, 6, and 12. The Mediterranean diet group's average VAS score decreased from 32 (standard deviation [SD] = 20) at week one to 20 (SD = 13) at week 12. The control group average VAS scores were 31 (SD = 20) at week one and 34 (SD = 21) at week 12. The reduction in pain was significantly greater for the Mediterranean diet group (n = 26) relative to the control diet group (n = 25, *P* = 0.006). The Mediterranean diet group (n = 25) also had a significant decrease in joint swelling from week one to week 12 compared to the control diet group (n = 24, *P* = 0.001) (15).

McKellar et al (16) extended these results by assigning women patients (range = 30-70 years old, median = 55 years old) with RA to an intervention group (n = 75) or control group (n = 55). The intervention group attended weekly 2-hour sessions for 6 weeks of hands-on Mediterranean food cooking classes supplemented with written information. The control group patients only received written dietary information. All patients completed food frequency questionnaires. VAS scores were assessed at baseline, 3 months, and 6 months. While consumption of fruit, vegetables, and legumes were below the recommended daily minimum of 5 portions per day, this – along with the ratio of monounsaturated to saturated fats – had improved significantly in the intervention group by 3 months. At 6 months, the intervention group had a significantly lower median VAS pain score relative to the control group (50 mm vs 63 mm, *P* = 0.049). Of note, this study was not randomized, limiting its strength (16).

A Mediterranean diet plan may assist in musculoskeletal pain management. However, additional randomized controlled trials are necessary to establish a stronger recommendation.

Vegetarian and Vegan Diets

As vegetarian (excludes all meat products) and vegan (excludes all animal products) diets grow in popularity, several studies have reported on the effects of plant-based diets on musculoskeletal pain (17-20). Hänninen et al (17) conducted a clinical trial on 33 patients with fibromyalgia, 42 patients with RA, and 40 healthy volunteers. They reported significant decreases in VAS-measured pain in patients with fibromyalgia and RA who adopted an uncooked vegan diet (17). An additional controlled trial similarly found significant decreases in self-reported musculoskeletal pain scores in patients with fibromyalgia who adhere to a vegetarian or vegan diet (18). A 2015 randomized open-label

Table 1. *Grades of recommendation for diet on musculoskeletal pain management**.

Intervention	Grade of Recommendation	Rationale
Mediterranean Diet Sköldstam et al (15) McKellar et al (16)	B	Some Level I and II evidence
Vegetarian and Vegan Diets Hänninen et al (17) Kaartinen et al (18) Clinton et al (19) Martinez-Rodriguez et al (20)	B	Level I, II, and III evidence, although mixed findings
Olive Oil Bitler et al (22) Mauro-Martin et al (23) Rus et al (24)	C	Some Level I evidence, although mixed findings
Marine Oils and Seafood Gruenwald et al (25) Bjørkkjær et al (26) Brunborg et al (28) Hill et al (30) Peanpadungrat (31) Hansen et al (32) Lindqvist et al (33) Berbert et al (34) Essouiri et al (36)	B	Some Level I evidence, consistent findings
Antioxidant-rich Fruits Du et al (37) Farid et al (38) Schell et al (39) Ghoochani et al (40)	B	Some Level I evidence, consistent findings
Turmeric Rudrappa et al (41) Gaffey et al (43)	B	Some Level I evidence, consistent findings
Ginger Zakeri et al (45) Paramdeep (46) Bolognesi et al (47) Niempoog et al (48)	C	Some Level I evidence, although mixed findings
Herbal Tea Connelly et al (49) Pirouzpanah et al (50)	I	Very limited Level I evidence
Elimination of Aspartame and MSG† Holton et al (55) Vellisca Latorre (56)	C	Limited Level I evidence

*Grade A indicates good evidence (Level-I studies with consistent findings) for or against recommending intervention; grade B, fair evidence (Level-II or III studies with consistent findings) for or against recommending intervention; grade C, poor-quality evidence (Level-IV or V studies with consistent findings) for or against recommending intervention; and grade I, insufficient or conflicting evidence not allowing a recommendation for or against intervention. †MSG = monosodium glutamate.

study assigned patients with osteoarthritis (OA) ages 19 - 70 years old to a whole-foods (minimally refined and free of additives) and plant-based diet (WFPB, n = 19) or control (continue current diet, n = 19) (19). The WFPB group patients had significantly greater decreases ($P < 0.001$) in VAS pain scores from baseline relative to control measurements (-2.85 vs -1.18) at the end of the 6-week study period (19). However, when Martinez-Rodriguez, et al (20) compared a lacto-vegetarian diet with exercise vs a lacto-vegetarian diet without exercise vs a control group, the results only demonstrate that a vegetarian diet combined with exercise had a significant effect on pain scores (6.7 pre vs 2.0 post, $P < 0.01$), whereas diet alone did not (6.1 pre vs. 6.3 post, $P > 0.05$).

These studies collectively provide mixed support for the efficacy of plant-based diets in reducing musculoskeletal pain.

Addition of Oils and Seafood

Olive oil consumption has also been associated with inflammation control (21) and has thus been the focus of recent pain management studies (22-28, 30-35). Bitler et al (22) reported patients with OA (n = 43) who consumed an olive oil extract rich in polyphenols (freeze-dried olive vegetation water 100 mg capsule twice daily for 8 weeks) had significant higher self-reported improvement ($P < 0.05$) relative to placebo (n = 47). When an olive oil supplement is combined with a gluten-free Inflammatory Gut-Brain Axis Control Diet 8-week diet, similar decreases in pain scores ($P = 0.046$) in patients with fibromyalgia was observed (23). However, another randomized controlled trial (24) found no effect of extra virgin olive oil on the VAS pain scores of patients with fibromyalgia, although improvements in oxidative stress, functional capacity, and health-related psychological status were noted.

The effect of marine oils on musculoskeletal pain has also been studied (25-28). Gruenwald et al (25) conducted a pilot study in which cod liver oil (one g Neutrataste capsule [Seven Seas]) was administered to German patients with rheumatoid arthritis for 3 months. There was a significant decrease in the number of painful joints, self-reported pain intensity, and physician-evaluated pain intensity by month 3 relative to baseline ($P < 0.001$).

In the setting of inflammatory bowel disease-related joint pain, omega-3 fatty acid-rich seal oil significantly reduced pain intensity ($P = 0.025$) and the number of tender joints ($P = 0.035$) compared to omega-6-rich soybean oil (omega-6 is a precursor to inflammatory mediators and thus may contribute to increased inflammation and pain [26,27]). A follow-up randomized trial comparing the efficacy of seal oil vs cod liver oil on relieving joint pain in patients with Crohn disease or ulcerative colitis demonstrated there were no significant differences between the seal and cod liver oil intervention groups; both improved various joint pain parameters (28). In particular, the administration of cod liver oil significantly improved ($P = 0.02$) joint pain intensity (28). However, it should be noted that seal oil is illegal in the United States under the Marine Mammal Protection Act (29).

In patients with knee OA, 2 additional studies support the efficacy of fish oil on musculoskeletal pain relief (30,31). Notably, a 2-year randomized clinical trial by Hill, et al (30) determined low-dose fish oil (eicosatetraenoic acid + docosahexaenoic acid [EPA + DHA] intake 450 mg) significantly improves ($P = 0.001$) Western Ontario McMaster Osteoarthritis Index (WOMAC) pain scores. A quasi-experimental study replicated these results using fish oil 1,000-2,000 mg daily for 8 weeks (31).

In patients with RA, a Danish study (32) further demonstrated a "Graastener diet" with low fat, high fish-meal, and high antioxidants resulted in significant decreases in VAS pain scores compared to controls ($P = 0.01$). In addition to fish and seal oils, a randomized 11-week crossover study (33) demonstrated blue mussel (high in EPA and DHA) intake resulted in significant improvement in VAS pain ($P = 0.048$), global health ($P = 0.041$), and fatigue ($P = 0.021$) scores. Patients with RA their diets supplemented with dual-oil fish oil and olive oil for 12 weeks (34). There were significant within-group improvements in joint pain with dual-oil supplementation ($P < 0.05$); no such significant within-group differences were observed in the fish oil only group or control (soybean oil) group ($P > 0.05$ [34]).

While studies on olive oil are mixed, the results of these marine oil and seafood studies suggest they may contribute to musculoskeletal pain relief. Regarding omega-3 fatty acid alone, a meta-analysis by Lee et al (35) of 10 randomized controlled trials demonstrated daily omega-3 fatty acid intake in patients with RA patients (> 2.7 g/d for at least 3 months) resulted in a clear reduction in nonsteroidal anti-inflammatory drug consumption relative to placebo-treated controls ($P = 0.011$). However, no direct measure of musculoskeletal pain was reported, thus this meta-analysis was not included in our grades of recommendation.

Nonmarine oils low in omega-3 fatty acid may also

assist in musculoskeletal pain management. Essouiri et al (36) conducted a randomized controlled clinical trial on argan oil (high in omega-6 and omega-9) intake in patients with knee OA. Patients who received argan oil daily (30 mL for 8 weeks, n = 51) had a statistically significant decrease in WOMAC pain scores ($P < 0.0001$) compared to the control group (no treatment, n = 49 [36]). There was also a significant decrease in VAS pain scores ($P = 0.02$) relative to control (36).

In summary, fish oil, seal oil, and seafood can provide measurable musculoskeletal pain relief. It is unclear if omega-3 fatty acid capsule supplementation alone provides pain relief. Further research is necessary to fully understand the optimal omega-3 to omega-6 ratio and fatty acid intake profile for musculoskeletal pain management.

Addition of Fruits

The simple addition of fruits and fruit extracts may benefit patients with musculoskeletal pain. Four randomized controlled trials (37-40) each studied a specific fruit (blueberries, purple passionfruit peel extract, strawberries, and pomegranate juice). They all reported a significant decrease ($P < 0.05$) in osteoarthritic knee pain and inflammation (37-40). A recent 2019 study by Du et al (37) on adults with symptomatic knee OA found consuming 40 g of freeze-dried blueberry powder daily for 4 months significantly decreased ($P < 0.05$) WOMAC pain scores relative to placebo.

These randomized controlled trials provide evidence that antioxidant-rich fruits, such as blueberries, passionfruit, strawberries, and pomegranates, may provide musculoskeletal pain relief in patients with OA (37-40).

Addition of Spices and Herbal Teas

Numerous spices and herbs have been explored in relation to musculoskeletal inflammation and pain management. The present review is limited to the effect of cooking spices and herbal beverages on musculoskeletal pain as examined in the literature. Curcuminoids (e.g., turmeric) decrease inflammation and provide musculoskeletal pain relief (41,42). A recent randomized controlled trial (41) demonstrated that a high-dissolution turmeric-sesame formula provided acute pain relief comparable to acetaminophen; 66% of treatment patients reported pain relief in the first 6 hours compared to 73% acetaminophen control patients. A quantitative meta-analysis of 8 randomized controlled trials (42) similarly concluded about 1,000 mg turmeric daily was effective in treating joint arthritis symptoms as measured by VAS ($P < 0.00001$) and WOMAC ($P < 0.009$). Nevertheless, evidence on the effectiveness of turmeric to treat musculoskeletal pain is still limited due to small sample sizes and short study durations (43).

Another common spice, ginger, has been effectively used to treat rheumatism and musculoskeletal pain (44-47). A large randomized controlled trial (44) (n = 247) evaluating the effect of a ginger extract on patients with knee OA found a significant reduction in VAS knee pain while standing (24.5 mm vs 16.4 mm; $P = 0.005$) and VAS knee pain after walking 50 feet (15.1 mm vs 8.7 mm; $P = 0.016$) compared to controls. A 2011 randomized clinical trial on 204 patients with knee OA replicated these results (45). A third study (46) administered 750 mg of ginger with/without diclofenac 50 mg to patients with knee OA patients for 12 weeks. Ginger provided significant VAS and WOMAC pain relief compared to baseline ($P < 0.001$); the combination with diclofenac provided additional (but insignificant relative to ginger-only [$P > 0.05$]) modest improvement in pain scores (46). A 2016 6-month registry study (47) on patients with knee OA examined the effect of MovarDol® (Leonardo Medica), a combination of ginger with 2 other anti-inflammatory supplements: N-acetyl-D-glucosamine and Boswellia Serrata extract. This combination was well-tolerated in the intervention group (n = 54) and resulted in significant improvements ($P < 0.05$) in WOMAC pain, functional, and emotional outcomes at 6 months compared to controls (n = 26) (47).MovarDol® is a dietary supplement not approved for purchase by the US Federal Drug Administration.

On the contrary, a randomized controlled trial (48) utilizing ginger one g/d for 8 weeks found no difference in knee OA pain scores (as measured by the Knee Injury and Osteoarthritis Outcome Score [KOOS] scoring system); there were no prominent side effects reported.

Insufficient evidence exists on the role of herbal teas in patients with musculoskeletal pain (49,50). An herbal tea, high-rosmarinic (rosA) acid spearmint tea (130-150 mg rosA per cup, twice a day for 16 weeks), resulted in a significant decrease in knee OA WOMAC pain scores ($P < 0.05$) compared to control tea (~13 mg rosA per cup) (49). A randomized controlled study (50) demonstrated that 6 g/d chamomile tea (brewed from dry Chamomile flowers) consumed for 42 days resulted in no difference in VAS scores (3.35 mm to 2.65 mm chamomile vs 3.07 mm to 2.93 mm placebo, $P = 0.916$),

although there was a significant decrease in the number of tender joints (2.51 to 1.96 chamomile vs 4.27 to 4.47 placebo, $P < 0.0001$).

Elimination Diets

The avoidance of specific substances common in modern diets may also be beneficial for limiting musculoskeletal pain. For example, monosodium glutamate (MSG) and aspartame are ingredients used to enhance food flavor and sweetness, respectively. However, MSG and aspartame are excitotoxins associated with inflammation in some animal models and human studies (51-54).

Holton et al (55) randomly assigned 57 patients with fibromyalgia to a 4-week diet excluding MSG and aspartame. Of the 37 patients who completed the diet, 84% reported > 30% improvement in symptoms and were subject to a 2-week double-blind randomized placebo-controlled crossover challenge with MSG or placebo (55). The MSG challenge group (n = 31) reported an increase in VAS pain score ($P = 0.07$) and significant return of fibromyalgia symptoms ($P = 0.03$) compared to placebo (55). Another one-month randomized trial (56) eliminating MSG and aspartame from the diets of women patients with fibromyalgia found some reduction in pain scores between the elimination group (n = 36) and the control group (n = 36, $P = 0.054$. There were no significant differences by the third and fourth months of the study period ($P = 0.178$) (56).

Overall, there is some limited evidence that eliminating specific additives like MSG and aspartame, as distinguished from large-scale dietary changes, may help with musculoskeletal pain (55,56). Further research on the elimination of potentially pro-inflammatory foods and additives, including MSG (51,52), aspartame (53,54), sodium (57,58), and red meats (59) are necessary to establish statistical significance.

Limitations

Our study has several major limitations to consider. First, the studies we used are limited in sample size, study period, and robust comparisons to controls. No single study provides definitive evidence that a given dietary intervention has a causal effect on long-term musculoskeletal pain outcomes; multiple robust randomized controlled trials are necessary to make stronger recommendations.

While the present review focuses on the effect of diet, it must also be emphasized other factors can affect the experience of musculoskeletal pain, including genetics, psychological well-being, regional factors, and other predisposing factors.

Second, the present review focuses on pain outcomes in patients with either RA, OA, or fibromyalgia due to the lack of relevant literature on other musculoskeletal pain conditions. Since these 3 conditions are not fully measurable entities and the course of their progression may vary, the conclusions of our review may not be generalizable to other inflammatory and non-inflammatory musculoskeletal conditions.

Third, there is increasing interest in other diets, such as ketogenic and Paleolithic diets. However, these diets were excluded from our review because there have been no randomized controlled studies focusing on the effects of these diets (without caloric restriction, which is outside the scope of this diet composition review) on musculoskeletal pain outcomes.

Fourth, as with all reviews, there must be an acknowledgment of possible publication bias. This review is nonsystematic in nature; it focuses on the effect of various diet regimes on chronic musculoskeletal pain.

Finally, while none of the included studies found any significant adverse side effects, there remains the possibility of adverse side effects and contraindications. For example, an increase in fruit consumption may not be appropriate for patients with diabetes mellitus. Further, identified nutrients of concern in those who follow a vegetarian diet include vitamin B-12, vitamin D, calcium, iron, and zinc (60). As such, clinicians should proceed with caution in recommending plant-based diets to those with chronic vitamin deficiency or osteoporosis; vitamin supplementation with certain diets may be warranted.

Conclusion

Clinicians can play a role in the well-being of patients with musculoskeletal pain through holistic interventions, such as dietary modifications, given the potential effect of diet composition on chronic musculoskeletal pain. Our findings are:

- Mediterranean diets (whole grain, olive oil, fruits, vegetables, beans, legumes, nuts, herbs, and spices) and other diverse plant-based diets (vegetarian and vegan diets) may safely reduce musculoskeletal pain due to their anti-inflammatory, antioxidant, and analgesic properties
- The addition of marine oils, seafood, and antioxidant-rich fruits (such as blueberries, passionfruit, strawberries, and pomegranates) may assist in musculoskeletal pain management

- The addition of spices (notably turmeric) may also safely reduce inflammation and musculoskeletal pain, although evidence is limited
- The avoidance of pro-inflammatory foods (red meat, excess sodium, saturated fats, trans fats, refined grains, and starches) and artificial additives (e.g., MSG and aspartame) may decrease inflammation but there is no clear connection to decreased musculoskeletal pain; further study is needed.

Additional randomized controlled trials with larger sample sizes, longer study periods, and more robust controls are necessary to support all these findings and recommendations. Further studies are also warranted to clarify the relationship among diet, inflammatory markers, and disease states as well as the safety and contraindications of these dietary changes. Nevertheless, the present review of existing studies can serve as an updated tool for clinicians and patients on safe and holistic measures for musculoskeletal pain management.

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