Scientific Research Publishing

Open Journal of Gastroenterology, 2025, 15(7), 335-344
https://www.scirp.org/journal/ojgas
ISSN Online: 2163-9469
ISSN Print: 2163-9450

Exploring the Role of Omega Fatty Acids in Colorectal Cancer—A Systematic Review

Jahnavi Ethakota[1*], Bipneet Singh[1], Haseeb Tareen[1], Niroshan Ranjan[1], Sakshi Bai[1], Oboseh John Ogedegbe[2], Chidamber Bharath Alamelumangapuram[1]

[1]Internal Medicine, Henry Ford Jackson Hospital, Jackson, MI, USA
[2]Internal Medicine, Trinity Health Ann Arbor Hospital, Ann Arbor, MI, USA
Email: *jethako1@hfhs.org, Bsingh5@hfhs.org, Htareen1@hfhs.org, Nranjan1@hfhs.org, Sbai2@hfhs.org, Ogedegbejohn2013@gmail.com, CAlamel1@hfhs.org, jethako1@hfhs.org

How to cite this paper: Ethakota, J., Singh, B., Tareen, H., Ranjan, N., Bai, S., Ogedegbe, O.J. and Alamelumangapuram, C.B. (2025) Exploring the Role of Omega Fatty Acids in Colorectal Cancer—A Systematic Review. *Open Journal of Gastroenterology*, **15**, 335-344.
https://doi.org/10.4236/ojgas.2025.157031

Received: June 14, 2025
Accepted: June 29, 2025
Published: July 2, 2025

Abstract

Introduction: Colorectal cancer (CRC) is the third leading cause of cancer deaths in the United States. There has been literature suggesting that omega-3 polyunsaturated fatty acids (omega-3 PUFAs) might be protective against colorectal cancer by promoting cell death and reducing inflammation via downregulating the inflammatory cascade through inhibition of prostaglandin-endoperoxide synthase 2. Laboratory research shows benefit, whereas observational studies in humans show no overall association. **Materials and Methods:** PRISMA guidelines were followed. MeSH terms including (Omega fatty acids or omega-3 or omega-6 Polyunsaturated fatty acids) AND (Colorectal cancer or colorectal carcinoma or colon cancer) were used. Cochrane, PubMed, and Google Scholar were used as search engines. 19 studies resulted, 2 were duplicates, 6 were case reports, and 4 were literature reviews, leaving 7 studies for review, which includes randomized control trials and prospective cohort studies. **Discussion and Results:** We evaluated the association between omega fatty acid intake and colorectal cancer (CRC) risk. Consistent with findings from the VITAL trial, the Alliance trial, the study by Kanto *et al.*, and several large prospective cohort studies, our results showed no significant association between omega-3 fatty acid consumption and CRC incidence. These findings suggest that, despite their proposed anti-inflammatory properties, omega fatty acids do not provide measurable protection against colorectal cancer. The prospective cohort study revealed no association between fish, omega-3 or omega-6 PUFA intake and CRC risk. Results suggest that associations between PUFA intake and CRC may vary by gender, subsite, and genetic risk. **Conclusion:** Based on the available data, there is no significant association

between omega fatty acid supplementation and colorectal cancer risk. Further research is warranted to clarify the role of dietary factors in CRC prevention.

Keywords

Omega Fatty Acids, PUFA, Colon Cancer, Prostaglandin, Carcinoma

1. Introduction

Colorectal cancer (CRC) ranks as the third most prevalent cancer and the third leading cause of cancer-related deaths in the United States. Over 1.4 million Americans are currently living with this disease. Research suggests that marine omega-3 polyunsaturated fatty acids (MO3PUFAs), such as eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and docosapentaenoic acid (DPA), may offer protective effects against cancer. These fatty acids could potentially enhance CRC survival by influencing both local and systemic immune responses [1] [2].

Growing research suggests that many cancers, including sporadic colorectal cancer, are fueled by self-renewing, treatment-resistant cancer stem cells (CSCs). This highlights the urgent need for better strategies to prevent and treat these cells. Omega-3 polyunsaturated fatty acids (Omega-3 PUFAs) are known to slow the growth of initial tumors, but their role in preventing cancer recurrence remains largely unstudied [3].

A 2007 meta-analysis by the World Cancer Research Fund and the American Institute for Cancer Research found limited but suggestive evidence that consuming fish, a primary source of omega-3 PUFAs, may reduce the risk of colorectal cancer in humans [4]. A commonly recognized mechanism for the potential health benefits of omega-3 PUFAs is their ability to compete with arachidonic acid (ARA), a key omega-6 PUFA, for metabolism by enzymes such as cyclooxygenase (COX), lipoxygenase (LOX), and cytochrome P450 (CYP). This competition may decrease the production of proinflammatory and tumor-promoting omega-6-derived eicosanoids while increasing omega-3-derived metabolites, which are generally less harmful or may even offer protective effects [5] [6].

Laboratory research indicates that omega-3 PUFAs may help prevent colorectal cancer by reducing inflammation, promoting cell death, and slowing cell growth [7] [8]. Several epidemiological studies, especially prospective cohort studies, suggest that a higher intake of omega-3 fatty acids may be linked to a lower risk of developing colorectal cancer, with the strongest effects seen in the distal part of the colon [9]. While some clinical trials have found that omega-3 supplementation can help lower inflammation and make chemotherapy easier to tolerate for colorectal cancer patients, others haven't shown any clear benefit in terms of slowing the disease's progression, leading to mixed overall results [10] [11]. This paper explores how omega-3 fatty acids may help prevent colorectal cancer by bringing together findings from both lab-based studies and clinical research, with the goal

of assessing their potential benefits and guiding future investigations.

2. Materials and Methods

PRISMA guidelines were followed.

The systematic search was conducted from June 1, 2013 to June 1, 2023, limited to articles published in English; inclusion criteria were randomized controlled trials and prospective cohort studies, and exclusion criteria were case reports, literature reviews, and retrospective cohort studies. MeSH terms including (Omega fatty acids or omega-3 or omega-6 Polyunsaturated fatty acids) AND (Colorectal cancer or colorectal carcinoma or colon cancer) were used. Cochrane, PubMed, and Google Scholar were used as search engines. 19 studies resulted, 2 were duplicates, 6 were case reports, and 4 were literature reviews, leaving 7 studies for review (Figure 1).

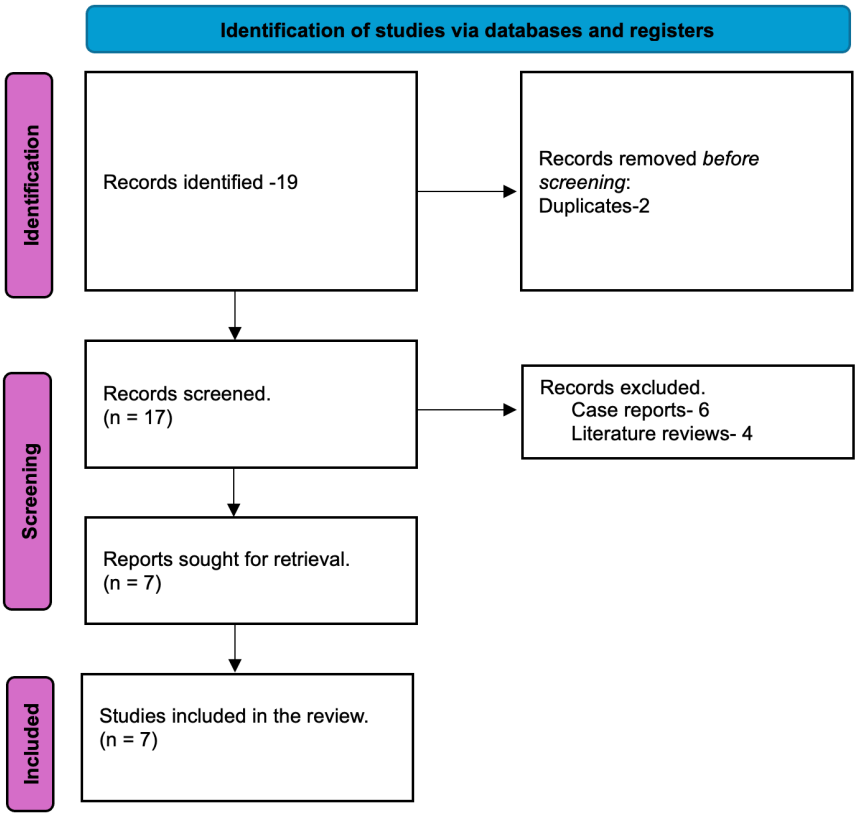

Figure 1. PRISMA diagram showing identification, screening and inclusion of studies.

Inclusion criteria: Randomized controlled trials and prospective cohort studies published in the last 10 years (June 2013-June 2023), English language.

Exclusion criteria: Case reports, literature reviews, retrospective cohort studies.

3. Quality Assessment

Using the Cochrane risk of bias tools, each study was systematically evaluated for potential sources of bias across multiple domains. See Figure 2.

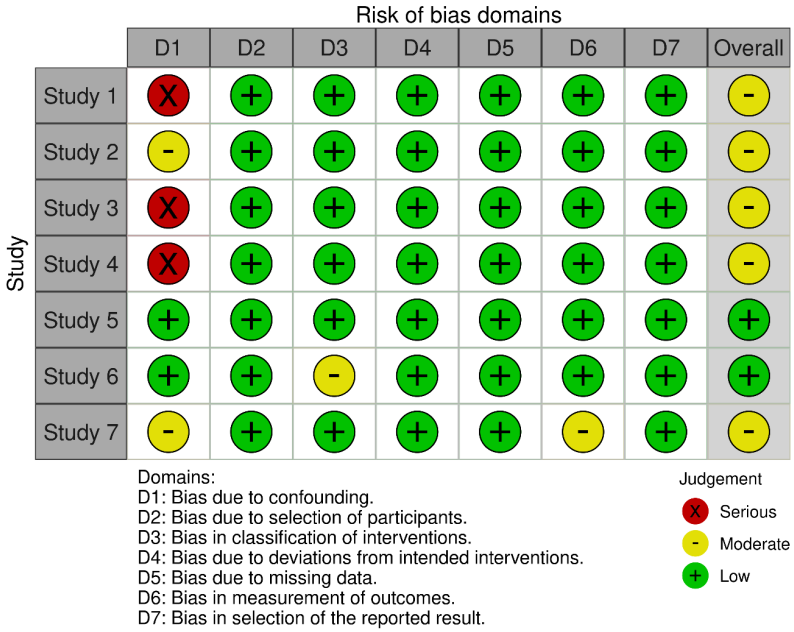

Figure 2. Risk of bias using Robvis I tool.

4. Results

Table 1. Study baseline characteristics.

Study name	Publishing year	Type of study	Duration of study	Country of the study	Number of participants
Tokudome *et al.* [12]	2014	RCT	24 months	Japan	205
White *et al.* [13]	2018	RCT	6 months	USA	141
Alliance Trial [14]	2019	RCT	6.9 years	USA	1735
Kantor *et al.* [15]	2014	Prospective COHORT	6 - 8 years	USA	68,109
Song *et al.* [16]	2014	COHORT	24 - 26 years	USA	123,529
Kato *et al.* [9]	2023	COHORT	13.8 years	Japan	42,536
Camargo *et al.* [17]	2015	RCT	9 weeks	Brazil	30

Table 2. Overview of study type, Intervention, comparison group and outcomes.

Study	**Intervention group**	Control group	Primary outcome	Secondary outcome
Tokudome *et al.* [12]	104-Increased intake	101	Increased Decrease	HR 0.805
White *et al.* [13]	2.5 g fish oil per day	Olive oil		Urinary PGE-M – REDUCED RECTAL PGE-M – NO EFFECT REDUCED PGE-M, IN A SUBGROUP
Alliance Trial [14]	MO3PUFA Intake: Higher intake groups: Participants in the higher quartiles (Q2 - Q4) or above the sex-specific median (≥0.05 g/day for women, ≥0.06 g/day for men) of MO3PUFA intake (EPA, DHA, DPA). Median intake in the highest quartile (Q4): 0.12 g/day (IQR: 0.10 - 0.14).	**MO3PUFA Intake Category**: Lowest quartile (Q1) or below the sex-specific median (<0.05 g/day for women, <0.06 g/day for men). Median intake in Q1: 0.03 g/day (IQR: 0.02 - 0.03).	{disease-free survival (DFS)} Higher marine omega-3 polyunsaturated fatty acid (MO3PUFA) intake was suggestively associated with improved DFS in stage III colon cancer patients with KRAS wild-type tumors (HR: 0.84) and deficient MMR (dMMR) tumors (HR: 0.69), but not in KRAS-mutant or proficient MMR (pMMR) tumors, with a significant interaction by KRAS status (p-interaction = 0.02).	{overall survival (OS)} Similar trends were observed for OS, with higher MO3PUFA intake linked to better survival in patients with KRAS wild-type and dMMR tumors.

Continued

Kantor *et al.* [15]	1) Fish Oil Supplement Use: -**High Use**: ≥4 days/week for ≥3 years (not explicitly stated but part of 68,109). -**Low Use**: <4 days/week or <3 years. **-Non-Users** (Reference/Control): No fish oil supplement use. 2) Dark Fish Consumption 3) **Total EPA+DHA Intake**:		High use: 49% reduced CRC risk compared to non-users (HR: 0.51, 95% CI: 0.26 - 1.00, p-trend = 0.06). -Stronger association in men (HR: 0.22, 95% CI: 0.06 - 0.90, p-trend = 0.02) than women (p-interaction = 0.02). Associated with reduced colon cancer risk (HR: 0.37, 95% CI: 0.15 - 0.91, p-trend = 0.03) but not rectal cancer (p-difference = 0.05). -**Dark Fish Consumption**: No overall association with CRC risk (HR for highest vs. lowest quartile: 0.77, 95% CI: 0.55 - 1.07). -**Total EPA+DHA Intake**: No overall association with CRC risk, but significant interaction with genetic risk (p-interaction = 0.02):	
Song *et al.* [16]	**Marine *ω*-3 PUFA Intake Categories**: Higher intake groups: Participants in higher quartiles (e.g., ≥0.15 g/day for women, ≥0.16 g/day for men) or at specific thresholds (e.g., ≥0.30 g/day for women, ≥0.41 g/day for men). Median fish intake: 21.5 g/day (IQR: 14.7 - 37.2 g/day) for women, 29.3 g/day (IQR: 14.7 - 49.9 g/day) for men.	**Marine *ω*-3 PUFA Intake Category**: Lowest quartile (e.g., <0.15 g/day for women, <0.16 g/day for men). Fish intake: <15 g/day for women, <16 g/day for men.	**Colorectal Cancer (CRC) Incidence**: Confirmed CRC cases during follow-up (1469 in NHS: 713 proximal, 416 distal, 310 rectal; 987 in HPFS: 342 proximal, 302 distal, 215 rectal), identified via self-reports, medical records, and National Death Index.	**Subsite-Specific CRC Risk**: Risk of CRC by subsite (proximal colon, distal colon, rectal cancer). Higher marine *ω*-3 PUFA intake was associated with increased distal colon cancer risk in women (HR: 1.36, 95% CI: 1.03 - 1.80 for ≥0.30 g/day) and men (HR: 1.43, 95% CI: 0.97 - 2.11 for ≥0.41 g/day, nonsignificant), but reduced rectal cancer risk in men (HR: 0.60, 95% CI: 0.39 - 0.93 for fish ≥46 g/day).
Kato *et al.* [9]	**Intake Levels** (highest quartile, Q4): -Total n-3 PUFA: Mean 2143 mg/day. -Marine n-3 PUFA (EPA + DPA + DHA): Mean 1031 mg/day. -ALA: Mean 1113 mg/day (men: 1175 mg/day, women: 1086 mg/day).	**Intake Levels** (lowest quartile, Q1): -Total n-3 PUFA: Mean 927 mg/day. -Marine n-3 PUFA: Mean 280 mg/day. -ALA: Mean 480 mg/day (men: 525 mg/day, women: 429 mg/day).	**Colorectal Cancer (CRC) Incidence**: Confirmed CRC cases (699 total: 462 colon, 237 rectal) over 585,644 person-years (median follow-up: 13.8 years), identified via ICD-10 codes C18 - C20 from cancer registries or hospital records.	**Subsite-Specific CRC Risk**: Risk by subsite (proximal colon [204 cases], distal colon [187 cases], rectal [237 cases]). Higher ALA intake was inversely associated with distal colon cancer risk (HR for Q4 vs. Q1: 0.41, 95% CI: 0.21 - 0.81, p for trend = 0.01). No significant associations were found for total n-3 PUFA or marine n-3 PUFA with CRC or subsite-specific risks.
Camargo *et al.* [17]	-Dosage: 2 g/day of fish oil (4 capsules of 500 mg each, providing ~360 mg/day EPA and ~240 mg/day DHA). -Duration: 9 weeks, starting on the day of the first chemotherapy cycle. -Source: Gelatin capsules (Omega-3, Phytomare®) extracted from salmon, mackerel, and sardines.	Participants received no fish oil supplementation or placebo during chemotherapy.	-Time to Disease Progression: The supplemented group showed a significantly longer median time to progression (593 days, SD: 211.5) compared to the control group (330 days, SD: 135.1; p = 0.04).	-Clinical Outcomes: no significant differences between the fish oil supplemented group (SG) and control group (CG) in death within 3 years, time to death, chemotherapy cycles, days in chemotherapy, delays, interruptions, hospitalizations, or CEA levels. In Stage IV, SG had a non-significant CEA decrease, while CG showed a CEA increase.

Additional Analysis and Theoretical Explanation for Discrepancies

While lab studies have shown that omega-3 fatty acids can reduce inflammation and possibly slow the growth of cancer cells, results from human studies haven't always lined up. This could be because lab experiments use higher, controlled doses of these fatty acids, while human studies rely on food surveys or supplement use, which aren't always accurate. Also, because colorectal cancer develops slowly over time, short-term studies may not capture the full picture. People's diets and lifestyles also vary widely, and that can influence results too.

Another reason for the mixed findings could be that some people respond differently to omega-3s based on their genes. For example, a study by Kantor *et al.* found that individuals with different genetic risk levels showed different results when it came to omega-3 intake and cancer risk. Some studies also suggest that

where in the colon the cancer develops—whether in the distal or proximal part—might affect how omega-3s work and lumping all colon cancers together might hide those differences.

Finally, things like how well someone's body absorbs and processes omega-3s can make a difference, too. Factors like metabolism, genetic makeup, and even the types of bacteria in the gut can affect how beneficial omega-3s are. Moving forward, research should focus more on these individual differences—especially genetic factors—to figure out who might benefit most from omega-3s. Tailored nutrition advice based on genetics could one day help reduce the risk of colorectal cancer more effectively. Refer to Table 1 and Table 2 to look at the individual studies, their characteristics and results.

5. Discussion

Tokudame *et al.* [12]—This study is a randomized controlled trial, with polypectomized participants. The intervention group had 104 participants, and the control group had 101 participants. The participants in the intervention group were advised to increase the intake of fish/shellfish oil supplements, Kerala oil, and to decrease the consumption of N6 PUFA and fat/oils for 24 months, whereas in the control groups, the participants were only asked to reduce the conception of fat/oils as a whole. The ratio of n-6 PUFA/n-3 PUFA and AA/LC n-3 PUFAs decreased. At the end of the study at 24 months after the intervention, the Hazard ratio was estimated to be 0.805, which represents reduced colorectal tumor incidence.

White *et al.* [13]—The study is a randomized double blind controlled trial with 141 participants. The intervention group was given 2.5 g of fish oil per day, whereas the control group was given olive oil supplementation over a six-month period. The participants in the study had a history of colorectal adenomas. The study is based on evaluating the effects of fish oil on the levels of urinary and rectal eicosanoids. Urinary prostaglandin E2 metabolite (PGE-M) was measured at baseline, three and six months, and the rectal prostaglandin E2 (PGE2) was measured at baseline and six months. The result revealed that the fish supplementation reduces the urinary PGE-M compared with olive oil, but did not reduce the rectal PGE2. However, it did significantly reduce the prostaglandins in the sub group of patients not using aspirin or NSAIDS. The study was statistically significant with a P value of 0.03. Due to small number of participants and shorter duration of the study, the results are limited. Limiting the external validity of the study and clinical significance.

Alliance Trial [14]—This study is a phase III randomized trial with 1735 colon cancer patients undergoing chemotherapy with either folfox or folfox + cetuximab. A dietary questionnaire was filled at enrollment and the study revealed that higher MO3PUFA intake was associated with improved 3-year DFS for KRAS wild-type tumors (77% vs. 73%; HR: 0.84; 95% CI: 0.67 - 1.05) but not KRAS-mutant tumors (64% vs. 70%; HR: 1.30; 95% CI: 0.97 - 1.73; p-interaction = 0.02).

Higher MO3PUFA was associated with better 3-year DFS for tumors with deficient mismatch repair status (MMR) (72% vs. 67%) but not proficient MMR (72% vs. 72%). Similar findings were obtained for overall survival. So it showed an association between higher MO3PUFA intake and improved survival among stage III colon cancer patients with wild-type KRAS and deficient MMR. Given the relatively small number of cases with tumor molecular assessments, further studies are required.

Kantor *et al.* [15]—This is a cohort study, utilizing the Vitamins and Lifestyle (VITAL) cohort, evaluating eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) intake, and their relation to CRC risk. It had 68,109 Washington residents aged 50 - 76, answered a questionnaire between 2000-2002 and were followed for CRC through 2008 (n = 488). People with fish oil supplementation on 4+ days/week for 3+ years experienced 49% lower CRC risk than non-users (HR: 0.51; 95% CI: 0.26 - 1.00; p-trend = 0.06). This association was primarily observed in men. The results revealed that dark fish and total EPA+DHA intake were not associated with CRC risk overall, these associations varied by genetic risk (p-interaction = 0.009 and 0.02, respectively), with inverse associations observed among low-moderate genetic risk groups and positive associations observed among high-risk groups. Results suggest that associations between LC-PUFA intake and CRC may vary by gender, subsite, and genetic risk, providing additional insight into the potential role of LC-PUFAs in cancer prevention.

Song *et al.* [16]—This is a prospective cohort study involving 123,529 US adults without a history of cancer at baseline. They were followed for 24 to 26 years, and the fish and PUFA intake was assessed at baseline and updated every 4 years by a food frequency questionnaire. No overall association was found between fish, omega-3 or omega-6 PUFA intake and CRC risk. Marine omega-3 PUFA may be differentially associated with distal CRC and a long latency may be required for its protection against CRC in men.

Kato *et al.* [9]—This is a collaborative cohort study, where the participants completed a self-food frequency questionnaire regarding the intake of n-3 PUFA, including marine-derived n-3 PUFA and alpha-linolenic acid (ALA), plant-derived n-3 PUFA. The median follow-up period was 13.8 years; 699 of 42,356 participants aged 40 - 79 years developed CRC. There was an inverse association between ALA intake and the distal colon cancer risk. Whereas no association was noted in between CRC risk and marine n-3 PUFA. According to this study, higher ALA intake might be beneficial in lowering the risk of distal colon cancer.

Camargo *et al.* [17]—This is a randomized controlled trial with 30 participants with colon cancer who never had chemotherapy. The intervention group received 2 g per day of fish oil for nine weeks, and the control group did not receive any fish oil or placebo. The time to tumor progression was significantly longer in the intervention group 593 days versus the control group, it was 330 days, P value 0.04, statistically significant. In patients with advanced cancer, they did show a longer time to tumor progression and lower CA values with fish oil supplementa-

tion, but it was not statically significant. The three-year survival was not significant between the two groups.

Understanding how omega-3 intake influences colorectal cancer (CRC) risk requires a more detailed look at the dose-response relationship. While many prospective studies categorize omega-3 intake into quartiles, the actual differences in intake between groups are often minimal, making it hard to detect meaningful effects. Lab studies tend to use higher, more controlled doses, which may not reflect real-world consumption. Some evidence suggests that small dietary increases in omega-3s might not achieve effective levels in the body, whereas large supplemental doses, though potentially more impactful, may be unrealistic or unsafe on a large scale. Meta-analyses in other cancers hint at U-shaped or threshold effects, but such patterns haven't been clearly defined for CRC.

To better understand these dynamics, future research should incorporate more accurate biomarkers of omega-3 exposure, like red blood cell EPA/DHA levels, and include a wider range of intake levels to explore both linear and nonlinear trends. It's also important to consider factors like the timing and duration of intake, background dietary fat composition, and individual differences in metabolism. Including mechanistic studies that assess tissue-level changes or inflammation markers can help clarify whether there's a minimum beneficial dose, or if too much omega-3 could offer no extra advantage or even introduce risk.

6. Limitations and Future Directions

While these studies were mostly randomized controlled trials and prospective cohort studies, they do have limitations. The major limitation would be considering the population with preexisting risk factors like polyps and adenomas. Few studies considered the population with colon cancer, so they limit the assessment of omega fatty acids in preventing colon cancer. The patient population was variable, including the normal population, polypectomized population, and colon cancer population, which can result in variable results. The small size of the RCT studies limits the power of the study. The external validity of most studies is limited. Future studies would be needed to assess the role of omega fatty acids in preventing colon cancer in populations with no risk factors versus risk factors. Pooled analyses of multiple cohorts are needed to validate the association.

7. Conclusion

As most of the above studies were conducted in populations with colon polyps, adenomas, or cancer, there is no significant supporting data for prevention of colon cancer with increased omega fatty acid intake in the general population. Given potential gene-diet interactions and subsite-specific effects, targeted research may identify subgroups that benefit. However, based on current data, routine omega-3 supplementation solely for CRC prevention is not warranted. Future high-quality studies with rigorous dose-response designs, biomarker-based assessments, and genetic stratification are needed. There is a need for further research to ex-

plore other dietary and lifestyle factors that may more effectively contribute to CRC prevention.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Siegel, R.L., Miller, K.D., Fuchs, H.E. and Jemal, A. (2022) Cancer Statistics, 2022. *CA*: *A Cancer Journal for Clinicians*, **72**, 7-33. https://doi.org/10.3322/caac.21708

[2] Song, M. and Chan, A.T. (2018) The Potential Role of Exercise and Nutrition in Harnessing the Immune System to Improve Colorectal Cancer Survival. *Gastroenterology*, **155**, 596-600. https://doi.org/10.1053/j.gastro.2018.07.038

[3] Vasudevan, A., Yu, Y., Banerjee, S., Woods, J., Farhana, L., Rajendra, S.G., *et al.* (2014) ω-3 Fatty Acid Is a Potential Preventive Agent for Recurrent Colon Cancer. *Cancer Prevention Research*, **7**, 1138-1148. https://doi.org/10.1158/1940-6207.capr-14-0177

[4] World Cancer Research Fund/American Institute for Cancer Research (2007) Food, Nutrition, Physical Activity, and the Prevention of Cancer: A Global Perspective. AICR.

[5] Sapieha, P., Stahl, A., Chen, J., Seaward, M.R., Willett, K.L., Krah, N.M., *et al.* (2011) 5-Lipoxygenase Metabolite 4-HDHA Is a Mediator of the Antiangiogenic Effect of ω-3 Polyunsaturated Fatty Acids. *Science Translational Medicine*, **3**, 69ra12. https://doi.org/10.1126/scitranslmed.3001571

[6] Bagga, D., Wang, L., Farias-Eisner, R., Glaspy, J.A. and Reddy, S.T. (2003) Differential Effects of Prostaglandin Derived from ω-6 and ω-3 Polyunsaturated Fatty Acids on COX-2 Expression and IL-6 Secretion. *Proceedings of the National Academy of Sciences of the United States of America*, **100**, 1751-1756. https://doi.org/10.1073/pnas.0334211100

[7] Berquin, I.M., Edwards, I.J. and Chen, Y.Q. (2008) Multi-Targeted Therapy of Cancer by ω-3 Fatty Acids. *Cancer Letters*, **269**, 363-377. https://doi.org/10.1016/j.canlet.2008.03.044

[8] Calviello, G., Serini, S., Piccioni, E. and Pessina, G. (2009) Antineoplastic Effects of N-3 Polyunsaturated Fatty Acids in Combination with Drugs and Radiotherapy: Preventive and Therapeutic Strategies. *Nutrition and Cancer*, **61**, 287-301. https://doi.org/10.1080/01635580802582777

[9] Kato, A., Okada, C., Eshak, E.S., Iso, H. and Tamakoshi, A. (2022) Association between Dietary Intake of N-3 Polyunsaturated Fatty Acids and Risk of Colorectal Cancer in the Japanese Population: The Japan Collaborative Cohort Study. *Cancer Medicine*, **12**, 4690-4700. https://doi.org/10.1002/cam4.5098

[10] de Luis, D.A., Aller, R., Izaola, O., Gonzalez Sagrado, M. and Conde, R. (2010) Effect of Two Different Hypocaloric Diets in Transaminases and Insulin Resistance in Nonalcoholic Fatty Liver Disease and Obese Patients. *Nutrición Hospitalaria*, **25**, 730-735.

[11] Silva, J.D.A.P., Trindade, E.B.S.D.M., Fabre, M.E.D.S., Menegotto, V.M., Gevaerd, S., Buss, Z.D.S., *et al.* (2012) Fish Oil Supplement Alters Markers of Inflammatory and Nutritional Status in Colorectal Cancer Patients. *Nutrition and Cancer*, **64**, 267-273. https://doi.org/10.1080/01635581.2012.643133

[12] Tokudome, S., Kuriki, K., Yokoyama, Y., Sasaki, M., Joh, T., Kamiya, T., *et al.* (2015) Dietary N-3/Long-Chain N-3 Polyunsaturated Fatty Acids for Prevention of Sporadic

Colorectal Tumors: A Randomized Controlled Trial in Polypectomized Participants. *Prostaglandins, Leukotrienes and Essential Fatty Acids*, **94**, 1-11. https://doi.org/10.1016/j.plefa.2014.09.001

[13] White, M.N., Shrubsole, M.J., Cai, Q., Su, T., Hardee, J., Coppola, J., *et al.* (2019) Effects of Fish Oil Supplementation on Eicosanoid Production in Patients at Higher Risk for Colorectal Cancer. *European Journal of Cancer Prevention*, **28**, 188-195. https://doi.org/10.1097/cej.0000000000000455

[14] Song, M., Ou, F., Zemla, T.J., Hull, M.A., Shi, Q., Limburg, P.J., *et al.* (2019) Marine ω-3 Fatty Acid Intake and Survival of Stage III Colon Cancer According to Tumor Molecular Markers in NCCTG Phase III Trial N0147 (Alliance). *International Journal of Cancer*, **145**, 380-389. https://doi.org/10.1002/ijc.32113

[15] Kantor, E.D., Lampe, J.W., Peters, U., Vaughan, T.L. and White, E. (2013) Long-Chain ω-3 Polyunsaturated Fatty Acid Intake and Risk of Colorectal Cancer. *Nutrition and Cancer*, **66**, 716-727. https://doi.org/10.1080/01635581.2013.804101

[16] Song, M., Chan, A.T., Fuchs, C.S., Ogino, S., Hu, F.B., Mozaffarian, D., *et al.* (2014) Dietary Intake of Fish, ω-3 and ω-6 Fatty Acids and Risk of Colorectal Cancer: A Prospective Study in U.S. Men and Women. *International Journal of Cancer*, **135**, 2413-2423. https://doi.org/10.1002/ijc.28878

[17] Camargo, C.D.Q., Mocellin, M.C., Pastore Silva, J.D.A., Fabre, M.E.D.S., Nunes, E.A. and Trindade, E.B.S.D.M. (2015) Fish Oil Supplementation during Chemotherapy Increases Posterior Time to Tumor Progression in Colorectal Cancer. *Nutrition and Cancer*, **68**, 70-76. https://doi.org/10.1080/01635581.2016.1115097