Title
Diet and lifestyle considerations for patients with prostate cancer

Journal
Urologic Oncology Seminars and Original Investigations, 38(3)

ISSN
1078-1439

Authors
Zuniga, Kyle B
Chan, June M
Ryan, Charles J
et al.

Publication Date
2020-03-01

DOI
10.1016/j.urolonc.2019.06.018

Peer reviewed

HHS Public Access

Author manuscript

Urol Oncol. Author manuscript; available in PMC 2021 March 01.

Published in final edited form as:

Urol Oncol. 2020 March ; 38(3): 105–117. doi:10.1016/j.urolonc.2019.06.018.

Diet and Lifestyle Considerations for Patients with Prostate Cancer

Kyle B. Zuniga, BS[a,b], **June M. Chan, ScD**[c,d], **Charles J. Ryan, MD**[e], **Stacey A. Kenfield, ScD**[c]

[a]Osher Center for Integrative Medicine, University of California San Francisco, San Francisco, CA

[b]College of Physicians and Surgeons, Columbia University Medical Center, New York, NY

[c]Department of Urology, University of California San Francisco, San Francisco, CA

[d]Department of Epidemiology & Biostatistics, University of California San Francisco, San Francisco, CA

[e]Department of Medicine, University of Minnesota, Minneapolis, MN

Abstract

Purpose—To review the literature and provide recommendations on diet and lifestyle considerations in patients with prostate cancer using evidence from randomized controlled trials (RCTs) with additional considerations based on observational evidence.

Materials and Methods—We initiated our search on ClinicalTrials.gov combining the term "prostate cancer" with a variety of diet and lifestyle factors. We then supplemented our summary of publications from registered trials by including other publications available on Pubmed.

Results—There is a well-established benefit of exercise for improving functional outcomes and pelvic floor muscle training for improving treatment-related adverse effects. Multimodality interventions that integrate several factors (e.g., low-saturated fat, plant-based, whole-food diets with exercise and stress reduction) appear to have the most clinically significant benefit for patients with prostate cancer. Ongoing multimodality interventions are including the efficacy of implementation strategies as observed outcomes. Limited RCT evidence suggests a clinically significant benefit for guided imagery/progressive muscle relaxation, Pilates, and lycopene-rich diets and a modest benefit for green tea, qigong, massage, and avoidance of non-prescribed vitamin and mineral supplements. Observational and single arm trial evidence indicates a need for further exploration of acupuncture, coffee, cruciferous vegetables, fish, *Larrea tridentata*, mushrooms, and vegetable-derived fats and avoidance of eggs, dairy, poultry with skin, processed red meat, and saturated fat. Published trials suggest no benefit from hypnosis, milk thistle, pomegranate, soy, or omega-3 fatty acid supplementation.

Corresponding author: Stacey Kenfield, 550 16th Street, San Francisco, CA 94143, Phone: 415 476 5392, Fax: 415 476 5366, Stacey.Kenfield@ucsf.edu.

Conclusions—Our search demonstrated that most diet and lifestyle factors identified from observational studies have limited data from RCTs. Few items have shown early evidence of benefit. The best recommendation for patients with prostate cancer is to form a habit of wellness through healthy eating, aerobic and resistance exercise, and psychological well-being. Future trial development should consider how interventions can be implemented into real world practice.

Keywords

Prostatic neoplasms; Diet; Life Style; Exercise; Dietary Supplements; Integrative Medicine

Introduction

Prostate cancer has the highest cancer incidence among men in the U.S., with an estimated 164,690 new cases diagnosed in 2018.[1] Improved understanding of how diet and lifestyle interventions alter prostate cancer progression and disease morbidity and treatment is essential to improve outcomes and quality of life (QOL). Multiple epidemiologic studies have sought to understand which diet and lifestyle factors contribute to prostate cancer outcomes. For example, metabolic syndrome may increase prostate cancer risk, result in higher grade tumors, and reduce survival.[2–4] Thus, lifestyle modifications targeting a healthy body mass index (BMI) may improve clinical and QOL outcomes.

Observational studies allow for inferences about the association between prostate cancer and diet and lifestyle factors that would not be possible with the use of randomized controlled trials (RCTs), either due to ethical reasons or feasibility. Still, the most reliable way to determine causal associations is through conducting RCTs. We saw a sobering example of this when vitamin E was shown to increase prostate cancer risk in the Selenium and Vitamin E Cancer Prevention Trial (SELECT) (HR 1.17, $p = 0.008$),[5] a finding not suggested by prior observational studies.[6] With this understanding, we sought to provide recommendations for patients with prostate cancer based on available RCT evidence, supplementing with observational data where appropriate.

Materials and Methods

We performed an extensive search of trials registered through ClinicalTrials.gov, combining the term “prostate cancer” with diet and lifestyle factors (see Appendix 1 for a full list of search terms). We included factors with full text publications reporting on participant outcomes. We supplemented our discussion with observational studies and other well-designed RCTs that provided historical context or conflicting results. A summary of single factor recommendations can be found in Table 1. A list of selected ongoing trials can be found in Table 2.

Dietary factors (alphabetical)

Green tea

Green tea catechins (GTCs) are highly bioactive and may affect molecular pathways implicated in tumorigenesis.[7] Observational data on green tea and prostate cancer risk is inconsistent. One meta-analysis found a potential benefit of tea consumption among case-

control studies, but this result was not corroborated when stratifying by green versus black tea nor when accounting for available cohort studies.[8]

Localized prostate cancer.[9–11]—One RCT of 48 patients scheduled for radical prostatectomy (RP) reported no statistically significant changes in markers of tumorigenesis or prostate-specific antigen (PSA) levels among those assigned to take green tea polyphenol extract; however, a post-hoc power analysis suggested that their sample size was inadequate.[9] Another study randomized 93 patients to 6 cups/day of green tea versus 6 cups/day of black tea versus water for three weeks prior to RP. Those in the green tea group had reduced tissue markers of inflammation and urinary markers of oxidative damage. The green tea group also had a modest average reduction in PSA from baseline (−1.2ng/ml) compared to the black tea (+0.4ng/ml) and control groups (+0.1ng/ml) ($p < 0.05$).[10]

Advanced prostate cancer.[12]—One single-arm trial treating patients with metastatic castrate resistant prostate cancer (mCRPC) with 6g of green tea extract reported a median increase in PSA by 43%, and 69% of participants experienced green tea toxicity (e.g., nausea, insomnia, diarrhea).[12]

Overall, green tea may confer modest benefit in localized disease. No RCT exists to support its use in advanced disease.

Lycopene/tomato products

Lycopene is a carotenoid molecule with antioxidant properties found primarily in tomato products. Observational studies suggest lycopene-rich diets may help prevent prostate cancer incidence and progression.[13–16]

Localized prostate cancer.[17–19]—One study comparing the prostate tissue of patients with localized prostate cancer given lycopene supplements versus placebo found that lycopene may modulate certain potentially carcinogenic oxidative stress response pathways.[17] Another RCT allocated 79 patients with localized prostate cancer scheduled for RP into one of three groups: a tomato-supplemented diet, a “tomato-plus” diet (tomato products plus selenium, omega-3 fatty acids, soy/isoflavones, grape/pomegranate juice, and green/black tea), or usual diet. During the brief three-week intervention, there was no statistically significant difference in change in median PSA between groups. However, in a subgroup analysis of participants with intermediate risk disease ($n = 41$), those in the tomato-product group saw a modest reduction in median PSA (−0.23ng/ml) compared to the control group (+0.45ng/ml, $p = 0.016$), while the tomato-plus group did not experience a similar significant benefit compared to the control group (+0.28ng/ml, $p = 0.094$).[18]

Advanced prostate cancer.[20, 21]—One study reported that patients with metastatic disease assigned to a lycopene and orchiectomy group versus orchiectomy alone had a lower average PSA at 24 months (3.0 versus 9.0ng/ml, $p < 0.001$), a higher proportion of responders (defined as PSA < 4ng/ml) (78% versus 40%, $p < 0.05$), and reduced all-cause mortality (13% versus 22%, $p < 0.001$).[20]

The benefit of lycopene needs to be explored further in longer-term studies, and trials on localized (NCT02144649) and advanced (NCT01949519) disease are ongoing.

Omega-3 fatty acids—Fish oil and flaxseed supplements, rich sources of omega-3 fatty acids, are popular for their perceived benefit in cardiovascular disease[22] and cancer.[23] For example, fish consumption was associated with reduced prostate cancer mortality in a prospective study of healthy individuals.[24] On the other hand, secondary case-control analyses from the Prostate Cancer Prevention Trial (PCPT) and SELECT suggest omega-3 fatty acids may increase prostate cancer risk.[25, 26] More recently, the Vitamin D and Omega-3 Trial (VITAL) demonstrated no statistically significant difference in prostate cancer-specific mortality between the omega-3 fatty acid supplement versus placebo groups among initially healthy participants.[27]

Localized prostate cancer.[17, 28–30]—A few RCTs have demonstrated these supplements, both alone and in combination with a low-fat diet, may improve molecular markers of progression in localized disease (e.g., proliferation index, oxidative stress response),[17, 28–30] but those studies examining markers of clinical progression (e.g., PSA) have demonstrated no benefit.[29–30]

Overall, evidence is conflicting, but substituting processed red meat and poultry with skin (foods high in saturated fat) for healthier lean proteins (e.g., fish, skinless poultry) is still recommended based on observational data. Ongoing trials in localized (NCT02176902) and advanced (NCT03753334) prostate cancer may clarify the association; however, the exposure tested in these trials is supplement intake rather than fish/flaxseed intake, with the latter potentially having additional unknown benefits.

Pomegranate

There is limited observational data on pomegranate in prostate cancer, though emerging research demonstrates that it may inhibit carcinogenesis on a molecular level. For example, the ellagitannins in pomegranate extract (POMx) may induce apoptosis through inhibition of Akt and mTOR phosphorylation in prostate cancer cells.[31]

Localized prostate cancer.[32]—An RCT (n = 68) on POMx given for four weeks prior to RP reported no difference in PSA change from placebo.[32]

Advanced prostate cancer.[33–35]—Available placebo-controlled RCTs on pomegranate suggest no benefit for preventing prostate cancer progression. One RCT reported no significant difference in PSA kinetics or pain scores in patients assigned to four weeks of a daily 500ml of pomegranate juice versus 500ml of placebo beverage.[33] Perhaps ongoing studies in localized (NCT02095145) and advanced (NCT00060086) prostate cancer will clarify these findings.

Soy

Soy products contain the isoflavones genistein and daidzein, which are types of phytoestrogens. Phytoestrogens are plant-based compounds with estrogen-like activity, and

it has been proposed that phytoestrogens may have anti-cancer properties through hormonal and non-hormonal activity.[36] A large body of observational research suggests that soy may reduce the risk of prostate cancer;[36] however, observational research in patients with prostate cancer is limited.

Localized prostate cancer.[19, 37–41]—In those with localized disease, soy may affect genes involved in the cell cycle, apoptosis, and metastatic potential.[37, 38] One three-week intervention in patients scheduled for RP reported that those assigned to take a daily 50g of soy grits had a reduced PSA compared to the control group (−12.7% versus 40%, p = 0.02).[39] However, subsequent studies have not replicated this benefit.[19, 37, 40, 41]

Advanced prostate cancer.[42–45]—A study investigating the effect of a soy protein isolate compared to placebo on biochemical recurrence (BCR) in post-RP patients was terminated after 2 years due to futility.[42] Another study explored the effects of soy alone and in combination with venlafaxine versus placebo on hot flash symptom severity scores in patients on androgen deprivation therapy (ADT). There was no statistically significant difference in these scores between groups, although those in the soy arm did report modestly improved emotional and functional scores on QOL assessment.[43]

Based on available evidence, it does not appear that soy alters prostate cancer prognosis or is beneficial in treating the adverse effects of ADT. Research on soy continues, however, focused on cancer progression (NCT02759380) and cardiometabolic dysfunction in patients on ADT (NCT02766478).

Vitamin and mineral supplements

Multiple U.S. cancer organizations do not recommend the usage of single supplements for prevention of cancer or cancer progression. Observational evidence suggests that some supplements may do more harm than good (e.g., selenium,[46] calcium[47]). Still, certain groups, such as individuals with vitamin D deficiency, may benefit from supplementation.[48] The Physicians' Health Study (PHS) II found no prostate cancer mortality benefit among healthy men with the use of multivitamins,[49] vitamin C, or vitamin E.[50]

Localized prostate cancer.[51, 52]—Selenium may downregulate genes involved in tumorigenesis.[51] However, one RCT did not report an improvement in PSA velocity in active surveillance patients assigned to take a daily selenium supplement. In fact, those taking the highest dose of selenium (800μg) and had the highest baseline selenium had a statistically significant increase in PSA velocity compared the placebo group (p = 0.018).[52]

Advanced prostate cancer.[53]—One non-randomized trial among men with mCRPC reported that after 12 weeks of weekly 60g intravenous ascorbic acid infusion, PSA actually increased by a median of 17ng/ml. There was also a high frequency of adverse events.[53]

A future direction for supplement studies includes exploring their interaction with conventional therapies. For example, one study is investigating PSA changes among mCRPC patients treated with docetaxel with or without vitamin C (NCT02516670).

Other plant-based supplements

Trials have been carried out on supplemental forms of *Larrea tridentata*,[54] milk thistle,[55] and white button mushroom[56] as well as on combination formulations[57–59] in patients with prostate cancer to observe their effect on serum biomarkers (e.g., PSA, IGF-I). Silibinin, a flavolignan derived from milk thistle, was not shown to be different from placebo in reducing IGF-I and IGFBP-3 levels in localized prostate cancer patients.[55]

Lifestyle factors (alphabetical)

Acupuncture

Acupuncture may ease the vasomotor symptoms associated with ADT. Although the mechanism of its efficacy is unclear, it has been proposed that acupuncture may affect the beta-endorphin and serotonin activity in the central nervous system that is responsible for symptoms.[60]

Advanced prostate cancer.[61–63]—A few small trials (n = 17–31) have demonstrated the efficacy of acupuncture on hot flashes in patients with prostate cancer treated with ADT; however, none have employed a control group (e.g., sham acupuncture / electrostimulation) for comparison. One study found that after four weeks of twice weekly acupuncture, participants reported an average 80.3% drop in hot flash score (as calculated from hot flash frequency and severity) at 8-month follow up ($p = 0.002$).[61] Larger, placebo-controlled RCTs are necessary to be certain of a causal association.

Pelvic floor muscle training

Localized prostate cancer.[64–71]: Pelvic floor muscle training (PFMT) has been utilized to ease symptoms of incontinence following RP and radiation therapy (RT), and multiple trials have demonstrated a reduction in incontinence frequency and severity in the immediate post-operative setting.[64, 65] More recent studies have explored how multidisciplinary interventions may improve the long-term efficacy of PFMT.[66–70] Another study reported that Pilates had a benefit similar to PFMT.[71] One study comparing PFMT alone versus PFMT with biofeedback (from surface or inserted electromyogram electrodes) found that both were effective in reducing incontinence over a 12 month period (50% and 59% reduction in incontinence episodes, respectively), and they were not statistically significantly different from each other.[66]

Exercise—In 2006, a small (n = 10) pilot study in patients with prostate cancer on ADT reported that an exercise intervention was feasible and may improve physical functioning and QOL.[72] Several observational studies demonstrate that exercise, from moderate activity (e.g., brisk walking) to vigorous activity (e.g., jogging, biking, swimming), improves prostate cancer prognosis and reduces prostate cancer-specific mortality.[73–75] RCTs have explored the effect of light-to-moderate,[76] moderate,[77–79] moderate-to-vigorous,[80–84] and vigorous[85–88] exercise using aerobic training,[77, 78, 80, 85–87] resistance training,[72, 81, 82, 89, 90] and a combination of these modalities[76, 79, 83, 84, 88] on a variety of clinical, functional, and psychosocial outcomes.

Localized prostate cancer.[76–78, 84, 87]: There are limited RCTs exploring the effect of exercise on QOL and clinical outcomes in localized prostate cancer alone. An aerobic intervention among post-RP patients did not demonstrate an improvement in sexual dysfunction.[77] The Active Surveillance Exercise Clinical Trial (ASX) is investigating the effects of a home-based walking intervention among patients with localized prostate cancer on tumor biomarkers and QOL (NCT02435472, open for enrollment in the San Francisco Bay Area).

Advanced prostate cancer.[72, 76, 78–90]: Exercise studies have been carried out in patients with[79, 81, 82, 86, 87, 90] and without[72, 78, 83, 88] bone metastases. The trial periods ranged from a brief 60-minute intervention to a short term 11-week intervention to one year, and were mostly supervised exercise[72, 76, 78, 79, 81–83, 86–90] while some were remote-based exercise.[80, 84] These interventions have consistently been shown to improve strength and physical functioning.[72, 79, 81, 82, 84, 86, 89, 90] Placebo-controlled trials have reported improvements in body composition (e.g, BMD[86]), cardiometabolic health (e.g., C-reactive protein[88]) and QOL (mental health,[87] sexual activity and interest[83]), while some studies did not report benefits in these outcomes. One study reported improved BMD after a 12-week soccer-based intervention in patients on ADT that was sustained at 32-week follow up.[86] No registered studies have investigated cardiovascular outcomes directly, and very few studies have reported small but not clinically meaningful benefits on body composition (lean mass[90]) and metabolic health (HDL cholesterol[78]). Exercise has also been explored as a tool for combating ADT-induced sexual dysfunction. One study randomized patients to a combined aerobic and resistance training program versus a usual care control group. At baseline, 20.6% of the intervention and 22.2% of the control participants had a major interest in sex (i.e., high libido). At the end of the intervention, 17.2% of the intervention versus 0% of the control reported a major interest in sex ($p = 0.024$).[83] Sexual activity was maintained in the intervention arm and decreased in the control group ($p = 0.045$).[83]

Multiple trials indicate that exercise may reduce disability in patients with prostate cancer on ADT. Multimodality studies exploring combined exercise and dietary interventions demonstrate more promising metabolic health outcomes, but more research is needed on prostate cancer-specific and cardiovascular outcomes. Inspired by an early pilot study demonstrating feasibility and safety of an exercise intervention among patients with advanced prostate cancer metastatic to multiple bone sites[90] as well as observational data reporting that post-diagnosis exercise (adjusted for pre-diagnosis exercise) may reduce risk of prostate cancer-specific and overall mortality, the INTense Exercise foR surVivAL Among Men With Metastatic Castrate-Resistant Prostate Cancer (INTERVAL) trial was launched in 2016. This international phase III RCT will examine the effect of a two-year supervised with transition to self-managed high-intensity aerobic and resistance training program versus self-directed exercise (provision of guidelines) on overall survival (primary endpoint) and progression (secondary endpoint) (NCT02730338).[91] Results from this and other ongoing trials will fill gaps in our understanding of the benefits of exercise in patients with prostate cancer.

Other lifestyle interventions for QOL improvement—The importance of managing mental health in patients with prostate cancer has become apparent as a result of observational studies demonstrating increased risk of psychological distress (e.g., anxiety, depression, insomnia) among patients with prostate cancer.[92] One study reported a 6.5 times increased risk of suicide among newly diagnosed patients compared to healthy age-matched controls.[93] Multiple interventions have been employed to encourage healthy behaviors and improve QOL in patients suffering from both the effects of their cancer and the adverse effects of treatment.

Localized prostate cancer.[94, 95]: Studies exploring the efficacy of hypnosis[94] and short-term in-person therapy groups[95] did not prove to be effective. An ongoing study is exploring the use of web-based modules to improve sexual intimacy among couples coping with the adverse effects of RP and RT. The goals of this study are to improve sexual functioning and QOL in patients and their partners.[96]

***Advanced prostate cancer*.[97–99]:** Guided imagery and progressive muscle relaxation (GI/PMR),[97] massage,[98] and qigong (may have included some localized patients)[99] may be effective tools for improving QOL in advanced cancer patients. GI/PMR was studied in patients with advanced breast (T3N1M0, n = 104) and prostate (T3a, Gleason score ≥ 8, n = 104) cancer receiving chemotherapy. Participants in the intervention group experienced clinically meaningful improvements pain, fatigue, nausea/vomiting, anxiety, and depression. They also reported improved body image and sexual function scores.[97]

Other select exposures showing benefit or harm from observational studies—Not all diet and lifestyle factors have been examined through RCTs, but the results of well-designed observational studies allow for some preliminary recommendations. For example, healthy BMI and smoking cessation are well-established ways of improving prostate cancer outcomes. One meta-analysis of observational studies examining the association between BMI and prostate cancer reported that, per 5kg/m^2 increase in BMI, there was a corresponding 21% increased risk of BCR and a 20% increased risk of prostate cancer-specific mortality.[100] Another study reported that smoking was associated with a 61% greater risk of BCR, but those who had quit smoking for at least 10 years had a prostate cancer-specific mortality risk similar to those who had never smoked.[101]

Other observational studies on dietary factors have reported preliminary evidence of a lower risk of prostate cancer progression in those with higher (versus lower) intakes of cruciferous vegetables (e.g., broccoli, cauliflower, kale),[102] coffee,[103] and vegetable-derived fats.[104] On the other hand, a higher (versus lower) intake of eggs/choline may increase the risk of prostate cancer recurrence,[105] and both recurrence and mortality risk may be elevated with greater intake of dairy,[106, 107] poultry with skin,[105] and saturated fat.[108, 109] There is also a suggestive positive association between processed red meat and risk of prostate cancer progression,[105, 110] and it is best avoided when possible due to its adverse effect on all-cause mortality.[111] Although these dietary factors have not been individually examined through RCTs, multimodality diet and lifestyle trials have incorporated this observational evidence into their design.

Multimodality lifestyle interventions—In 2006, a small pilot study employing a pre-post design taught patients with biochemically recurrent prostate cancer to increase intake of plants and whole grains and reduce intake of meat, dairy, and refined carbohydrates. The investigators reported a reduced rate of PSA rise, with median PSADT increasing from 11.9 months pre-study to 112.3 months after the 6-month intervention.[112] Since then, many multimodality interventions including dietary[113] and combined diet and lifestyle interventions[114–130] have been conducted in patients with localized prostate cancer, [58, 113–115, 117–119, 129] patients after RP,[119, 120] patients on ADT,[121–123, 128, 130] and post-treatment cancer survivors.[124–127] Given the impact of BMI on prostate health,[100] many multimodality interventions have targeted weight loss and other parameters of metabolic health by combining exercise with a low-saturated fat, plant-based, whole-food diet.[122] The Individualized Diet and Exercise Adherence Pilot Trial (IDEA-P) randomized 32 patients on ADT to 12 weeks of either twice weekly aerobic and resistance exercise, nutritional education encouraging a plant-based diet, and group counseling versus usual care. Comparing the intervention to the control group, the authors reported a statistically significant improvement in mobility performance ($p < 0.02$), muscular strength ($p < 0.01$), weight (−1.81 versus +0.90kg, $p = 0.02$), and fat mass (−1.05 versus +0.82%, $p = 0.04$) at 3-month follow up.[128]

Ongoing studies such as the Prostate Cancer: Evidence of Exercise and Nutrition Trial (PrEvENT) are continuing to examine the effects of diet and lifestyle modifications on prostate cancer-related and overall health.[131] The Men's Eating and Living (MEAL) study is a recently completed phase III RCT investigating the effect of a high-vegetable diet in preventing progression among patients on active surveillance, and preliminary results suggest feasible implementation.[132] Multimodality studies are important because they demonstrate that, although certain interventions may not have a significant effect alone, intensive interventions that combine multiple factors may result in improved prostate cancer outcomes.

Future directions—Few dietary and lifestyle factors have been rigorously investigated through RCTs, and in most cases, additional research is needed to draw firm conclusions of benefit. The use of large, high-quality observational cohorts with diverse socio-demographic and clinical characteristics are still needed to generate hypotheses, to inform exposures to be tested in RCTs, to provide evidence for exposures that cannot be evaluated in an RCT, and to provide further supportive evidence, for example, regarding dosage/quantity, timing, and relevant population (e.g., disease stage). Moreover, as observational data grow for multiple lifestyle factors, future RCTs may focus on more comprehensive diet and exercise interventions rather than single factors. To complement this, there is ongoing need for observational and pre-clinical studies examining each factor individually to identify new associations and understand biological mechanisms.

Investigating implementation and dissemination of information is an essential component of lifestyle research. Many ongoing studies are incorporating this concept into their study design.[84, 119, 124, 125] For example, Prostate 8, a web-based, personalized lifestyle RCT, [119] investigated the feasibility and efficacy of encouraging eight diet and lifestyle modifications in patients with localized prostate cancer either on active surveillance or

having undergone RP. Over the 12-week period, participants wore their Fitbit a median of 82 days (IQR 72–83, 98% of the intervention period), replied to a median 71% of text messages (IQR 57–89%), and visited the website a median of three times (IQR 2–5). There was also a statistically significantly higher proportion adopting the dietary recommendations and greater changes made in intake for these dietary behaviors compared to the control group. A subsequent study (Prostate 8 – II) includes lifestyle coaching and improved personalization, and it will include prostate cancer-specific and metabolic health outcomes. Finally, the True NTH Community of Wellness feasibility pilot trial is testing the feasibility and acceptability of enrolling U.S. patients nationwide with all stages of prostate cancer into an internet- and phone-based diet and exercise intervention.[133]

Adoption of these factors can be improved not only on the patient level but also on the physician and public health policy level. Physician provision of diet and lifestyle advice during office visits is essential. Physician education may improve information delivery, as barriers to advice-giving may include perceived lack of evidence to support behavioral modification and perceived lack of patient interest.[134] The addition of evidence-based behavioral factors to national organization guidelines may also improve dissemination of information and new implementation research. For example, the American Cancer Society recommends a plant-based, low saturated fat diet in their survivorship guidelines[135] and the Prostate Cancer Foundation has published health and wellness guides for patients living with prostate cancer (https://www.pcf.org/guide/). Integration of information into health system patient programs is needed, in concert with recommendations for cardiovascular health, and has great potential to improve health and well-being and reduce future health care utilization and costs.

Conclusions

A wide variety of lifestyle practices may be beneficial in slowing prostate cancer progression, mitigating the adverse effects of prostate cancer treatment, and improving QOL. There is evidence supporting the benefit of exercise and PFMT. Further studies are needed to confirm the benefit of GI/PMR, Pilates, lycopene-rich diets, green tea, qigong, and massage. Limited evidence on factors like pomegranate, soy, or omega-3 fatty acids does not currently suggest a clinical benefit. Observational evidence supports the benefit of a healthy BMI and smoking cessation to improve clinical outcomes and increase survival. Observational findings for new lifestyle factors may be confirmed in future RCTs combining exercise with specific dietary factors to increase or avoid, and with less focus on single supplements. A habit of healthy eating, regular exercise, and psychological well-being confers the best outcomes among patients with prostate cancer and strategies to disseminate the evidence and implement best practices will have great impact.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This project was supported by funding from R01CA207749, the National Center for Complementary and Integrative Health (T32AT003997), the Steven & Christine Burd-Safeway Distinguished Professorship, and the Helen Diller Family Chair in Population Science for Urologic Cancer.

References

1. Noone AM HN, Krapcho M, Miller D, Brest A, Yu M, Ruhl J, Tatalovich Z, Mariotto A, Lewis DR, Chen HS, Feuer EJ, Cronin KA (eds). SEER Cancer Statistics Review, 1975–2015, National Cancer Insitute based on November 2017 SEER data submission, posted to the SEER web site, April 2018 [cited 2019 1 14].
2. Cicione A, De Nunzio C, Tubaro A, et al., Metabolic syndrome diagnosis and widespread high grade prostatic intraepithelial neoplasia significantly increase prostate cancer risk: results from a multicenter biopsy study. BMC Cancer, 2016 16: p. 59 DOI: 10.1186/s12885-016-2085-8. [PubMed: 26846521]
3. Bhindi B, Xie WY, Kulkarni GS, et al., Influence of Metabolic Syndrome on Prostate Cancer Stage, Grade, and Overall Recurrence Risk in Men Undergoing Radical Prostatectomy. Urology, 2016 93: p. 77–85. DOI: 10.1016/j.urology.2016.01.041. [PubMed: 27015944]
4. Polesel J, Gini A, Dal Maso L, et al., The impact of diabetes and other metabolic disorders on prostate cancer prognosis. Journal of Diabetes and its Complications, 2016 30(4): p. 591–596. DOI: 10.1016/j.jdiacomp.2016.02.008. [PubMed: 26936307]
5. Klein EA, Thompson IM Jr., Tangen CM, et al., Vitamin E and the risk of prostate cancer: the Selenium and Vitamin E Cancer Prevention Trial (SELECT). Jama, 2011 306(14): p. 1549–56. DOI: 10.1001/jama.2011.1437. [PubMed: 21990298]
6. Chan JM, Stampfer MJ, Ma J, et al., Supplemental vitamin E intake and prostate cancer risk in a large cohort of men in the United States. Cancer Epidemiol Biomarkers Prev, 1999 8(10): p. 893–9. [PubMed: 10548318]
7. Miyata Y, Shida Y, Hakariya T, et al., Anti-Cancer Effects of Green Tea Polyphenols Against Prostate Cancer. Molecules, 2019 24(1). DOI: 10.3390/molecules24010193.
8. Lin Y.-w., Hu Z.-h., Wang X, et al., Tea consumption and prostate cancer: an updated meta-analysis. World journal of surgical oncology, 2014 12: p. 38–38. DOI: 10.1186/1477-7819-12-38. [PubMed: 24528523]
9. Nguyen MM, Ahmann FR, Nagle RB, et al., Randomized, double-blind, placebo-controlled trial of polyphenon E in prostate cancer patients before prostatectomy: evaluation of potential chemopreventive activities. Cancer prevention research (Philadelphia, Pa.), 2012 5(2): p. 290–298. DOI: 10.1158/1940-6207.CAPR-11-0306.
10. Henning SM, Wang P, Said JW, et al., Randomized clinical trial of brewed green and black tea in men with prostate cancer prior to prostatectomy. The Prostate, 2015 75(5): p. 550–559. DOI: 10.1002/pros.22943. [PubMed: 25545744]
11. McLarty J, Bigelow RL, Smith M, et al., Tea polyphenols decrease serum levels of prostate-specific antigen, hepatocyte growth factor, and vascular endothelial growth factor in prostate cancer patients and inhibit production of hepatocyte growth factor and vascular endothelial growth factor in vitro. Cancer Prev Res (Phila), 2009 2(7): p. 673–82. DOI: 10.1158/1940-6207.Capr-08-0167. [PubMed: 19542190]
12. Jatoi A, Ellison N, Burch PA, et al., A phase II trial of green tea in the treatment of patients with androgen independent metastatic prostate carcinoma. Cancer, 2003 97(6): p. 1442–6. DOI: 10.1002/cncr.11200. [PubMed: 12627508]
13. Chen P, Zhang W, Wang X, et al., Lycopene and Risk of Prostate Cancer: A Systematic Review and Meta-Analysis. Medicine (Baltimore), 2015 94(33): p. e1260 DOI: 10.1097/md.0000000000001260. [PubMed: 26287411]
14. Chan JM, Holick CN, Leitzmann MF, et al., Diet After Diagnosis and the Risk of Prostate Cancer Progression, Recurrence, and Death (United States). Cancer Causes & Control, 2006 17(2): p. 199–208. DOI: 10.1007/s10552-005-0413-4. [PubMed: 16425098]

15. Zu K, Mucci L, Rosner BA, et al., Dietary lycopene, angiogenesis, and prostate cancer: a prospective study in the prostate-specific antigen era. J Natl Cancer Inst, 2014 106(2): p. djt430 DOI: 10.1093/jnci/djt430. [PubMed: 24463248]

16. Graff RE, Pettersson A, Lis RT, et al., Dietary lycopene intake and risk of prostate cancer defined by ERG protein expression. The American journal of clinical nutrition, 2016 103(3): p. 851–860. DOI: 10.3945/ajcn.115.118703. [PubMed: 26817504]

17. Magbanua MJM, Roy R, Sosa EV, et al., Gene expression and biological pathways in tissue of men with prostate cancer in a randomized clinical trial of lycopene and fish oil supplementation. PloS one, 2011 6(9): p. e24004–e24004. DOI: 10.1371/journal.pone.0024004. [PubMed: 21912659]

18. Paur I, Lilleby W, Bøhn SK, et al., Tomato-based randomized controlled trial in prostate cancer patients: Effect on PSA. Clinical Nutrition, 2017 36(3): p. 672–679. DOI: 10.1016/j.clnu.2016.06.014. [PubMed: 27406859]

19. Grainger EM, Thomas-Ahner J, Wan L, et al., A Novel Tomato-Soy Juice Induces a Dose-Response Increase in Urinary and Plasma Phytochemical Biomarkers in Men with Prostate Cancer. The Journal of Nutrition, 2018 149(1): p. 26–35. DOI: 10.1093/jn/nxy232.

20. Ansari MS and Gupta NP, A comparison of lycopene and orchidectomy vs orchidectomy alone in the management of advanced prostate cancer. BJU International, 2003 92(4): p. 375–378. DOI: 10.1046/j.1464-410X.2003.04370.x. [PubMed: 12930422]

21. Jatoi A, Burch P, Hillman D, et al., A tomato-based, lycopene-containing intervention for androgen-independent prostate cancer: results of a Phase II study from the North Central Cancer Treatment Group. Urology, 2007 69(2): p. 289–94. DOI: 10.1016/j.urology.2006.10.019. [PubMed: 17320666]

22. Jia X, Kohli P, and Virani SS, Omega-3 Fatty Acid and Cardiovascular Outcomes: Insights From Recent Clinical Trials. Current Atherosclerosis Reports, 2019 21(1): p. 1 DOI: 10.1007/s11883-019-0763-0. [PubMed: 30631963]

23. Aguiar de Pastore Silva J, Emilia M Fabre de Souza, and Waitzberg DL, Omega-3 supplements for patients in chemotherapy and/or radiotherapy: A systematic review. Clinical Nutrition, 2015 34(3): p. 359–366. DOI: 10.1016/j.clnu.2014.11.005. [PubMed: 25907586]

24. Chavarro JE, Stampfer MJ, Hall MN, et al., A 22-y prospective study of fish intake in relation to prostate cancer incidence and mortality. Am J Clin Nutr, 2008 88(5): p. 1297–303. DOI: 10.3945/ajcn.2008.26419. [PubMed: 18996866]

25. Brasky TM, Till C, White E, et al., Serum phospholipid fatty acids and prostate cancer risk: results from the prostate cancer prevention trial. Am J Epidemiol, 2011 173(12): p. 1429–39. DOI: 10.1093/aje/kwr027. [PubMed: 21518693]

26. Brasky TM, Darke AK, Song X, et al., Plasma phospholipid fatty acids and prostate cancer risk in the SELECT trial. J Natl Cancer Inst, 2013 105(15): p. 1132–41. DOI: 10.1093/jnci/djt174. [PubMed: 23843441]

27. Manson JE, Cook NR, Lee IM, et al., Marine n-3 Fatty Acids and Prevention of Cardiovascular Disease and Cancer. N Engl J Med, 2019 380(1): p. 23–32. DOI: 10.1056/NEJMoa1811403. [PubMed: 30415637]

28. Azrad M, Vollmer RT, Madden J, et al., Flaxseed-derived enterolactone is inversely associated with tumor cell proliferation in men with localized prostate cancer. Journal of medicinal food, 2013 16(4): p. 357–360. DOI: 10.1089/jmf.2012.0159. [PubMed: 23566060]

29. Demark-Wahnefried W, Polascik TJ, George SL, et al., Flaxseed supplementation (not dietary fat restriction) reduces prostate cancer proliferation rates in men presurgery. Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology, 2008 17(12): p. 3577–3587. DOI: 10.1158/1055-9965.EPI-08-0008.

30. Aronson WJ, Kobayashi N, Barnard RJ, et al., Phase II prospective randomized trial of a low-fat diet with fish oil supplementation in men undergoing radical prostatectomy. Cancer prevention research (Philadelphia, Pa.), 2011 4(12): p. 2062–2071. DOI: 10.1158/1940-6207.CAPR-11-0298.

31. Koyama S, Cobb LJ, Mehta HH, et al., Pomegranate extract induces apoptosis in human prostate cancer cells by modulation of the IGF-IGFBP axis. Growth Horm IGF Res, 2010 20(1): p. 55–62. DOI: 10.1016/j.ghir.2009.09.003. [PubMed: 19853487]

32. Freedland SJ, Carducci M, Kroeger N, et al., A double-blind, randomized, neoadjuvant study of the tissue effects of POMx pills in men with prostate cancer before radical prostatectomy. Cancer prevention research (Philadelphia, Pa.), 2013 6(10): p. 1120–1127. DOI: 10.1158/1940-6207.CAPR-12-0423.
33. Stenner-Liewen F, Liewen H, Cathomas R, et al., Daily Pomegranate Intake Has No Impact on PSA Levels in Patients with Advanced Prostate Cancer - Results of a Phase IIb Randomized Controlled Trial. Journal of Cancer, 2013 4(7): p. 597–605. DOI: 10.7150/jca.7123. [PubMed: 24069070]
34. Pantuck AJ, Pettaway CA, Dreicer R, et al., A randomized, double-blind, placebo-controlled study of the effects of pomegranate extract on rising PSA levels in men following primary therapy for prostate cancer. Prostate Cancer Prostatic Dis, 2015 18(3): p. 242–8. DOI: 10.1038/pcan.2015.32. [PubMed: 26169045]
35. Paller CJ, Ye X, Wozniak PJ, et al., A randomized phase II study of pomegranate extract for men with rising PSA following initial therapy for localized prostate cancer. Prostate cancer and prostatic diseases, 2013 16(1): p. 50–55. DOI: 10.1038/pcan.2012.20. [PubMed: 22689129]
36. Applegate CC, Rowles JL, Ranard KM, et al., Soy Consumption and the Risk of Prostate Cancer: An Updated Systematic Review and Meta-Analysis. Nutrients, 2018 10(1): p. 40 DOI: 10.3390/nu10010040.
37. Hamilton-Reeves JM, Banerjee S, Banerjee SK, et al., Short-term soy isoflavone intervention in patients with localized prostate cancer: a randomized, double-blind, placebo-controlled trial. PloS one, 2013 8(7): p. e68331–e68331. DOI: 10.1371/journal.pone.0068331. [PubMed: 23874588]
38. Xu L, Ding Y, Catalona WJ, et al., MEK4 function, genistein treatment, and invasion of human prostate cancer cells. Journal of the National Cancer Institute, 2009 101(16): p. 1141–1155. DOI: 10.1093/jnci/djp227. [PubMed: 19638505]
39. Dalais FS, Meliala A, Wattanapenpaiboon N, et al., Effects of a diet rich in phytoestrogens on prostate-specific antigen and sex hormones in men diagnosed with prostate cancer. Urology, 2004 64(3): p. 510–515. DOI: 10.1016/j.urology.2004.04.009. [PubMed: 15351581]
40. deVere White RW, Tsodikov A, Stapp EC, et al., Effects of a high dose, aglycone-rich soy extract on prostate-specific antigen and serum isoflavone concentrations in men with localized prostate cancer. Nutr Cancer, 2010 62(8): p. 1036–43. DOI: 10.1080/01635581.2010.492085. [PubMed: 21058191]
41. Lazarevic B, Boezelijn G, Diep LM, et al., Efficacy and safety of short-term genistein intervention in patients with localized prostate cancer prior to radical prostatectomy: a randomized, placebo-controlled, double-blind Phase 2 clinical trial. Nutr Cancer, 2011 63(6): p. 889–98. DOI: 10.1080/01635581.2011.582221. [PubMed: 21714686]
42. Bosland MC, Kato I, Zeleniuch-Jacquotte A, et al., Effect of soy protein isolate supplementation on biochemical recurrence of prostate cancer after radical prostatectomy: a randomized trial. JAMA, 2013 310(2): p. 170–178. DOI: 10.1001/jama.2013.7842. [PubMed: 23839751]
43. Vitolins MZ, Griffin L, Tomlinson WV, et al., Randomized trial to assess the impact of venlafaxine and soy protein on hot flashes and quality of life in men with prostate cancer. J Clin Oncol, 2013 31(32): p. 4092–8. DOI: 10.1200/jco.2012.48.1432. [PubMed: 24081940]
44. Sharma P, Wisniewski A, Braga-Basaria M, et al., Lack of an effect of high dose isoflavones in men with prostate cancer undergoing androgen deprivation therapy. The Journal of urology, 2009 182(5): p. 2265–2272. DOI: 10.1016/j.juro.2009.07.030. [PubMed: 19758646]
45. Pendleton JM, Tan WW, Anai S, et al., Phase II trial of isoflavone in prostate-specific antigen recurrent prostate cancer after previous local therapy. BMC cancer, 2008 8: p. 132–132. DOI: 10.1186/1471-2407-8-132. [PubMed: 18471323]
46. Kenfield SA, Van Blarigan EL, DuPre N, et al., Selenium supplementation and prostate cancer mortality. J Natl Cancer Inst, 2015 107(1): p. 360 DOI: 10.1093/jnci/dju360. [PubMed: 25505227]
47. Aune D, Navarro Rosenblatt DA, Chan DS, et al., Dairy products, calcium, and prostate cancer risk: a systematic review and meta-analysis of cohort studies. Am J Clin Nutr, 2015 101(1): p. 87–117. DOI: 10.3945/ajcn.113.067157. [PubMed: 25527754]

48. Li H, Stampfer MJ, Hollis JB, et al., A prospective study of plasma vitamin D metabolites, vitamin D receptor polymorphisms, and prostate cancer. PLoS Med, 2007 4(3): p. e103 DOI: 10.1371/journal.pmed.0040103. [PubMed: 17388667]
49. Gaziano JM, Sesso HD, Christen WG, et al., Multivitamins in the prevention of cancer in men: the Physicians' Health Study II randomized controlled trial. JAMA, 2012 308(18): p. 1871–1880. DOI: 10.1001/jama.2012.14641. [PubMed: 23162860]
50. Wang L, Sesso HD, Glynn RJ, et al., Vitamin E and C supplementation and risk of cancer in men: posttrial follow-up in the Physicians' Health Study II randomized trial. The American journal of clinical nutrition, 2014 100(3): p. 915–923. DOI: 10.3945/ajcn.114.085480. [PubMed: 25008853]
51. Kok DEG, Kiemeney LALM, Verhaegh GW, et al., A short-term intervention with selenium affects expression of genes implicated in the epithelial-to-mesenchymal transition in the prostate. Oncotarget, 2017 8(6): p. 10565–10579. DOI: 10.18632/oncotarget.14551. [PubMed: 28076331]
52. Stratton MS, Algotar AM, Ranger-Moore J, et al., Oral selenium supplementation has no effect on prostate-specific antigen velocity in men undergoing active surveillance for localized prostate cancer. Cancer prevention research (Philadelphia, Pa.), 2010 3(8): p. 1035–1043. DOI: 10.1158/1940-6207.CAPR-09-0143.
53. Nielsen TK, Højgaard M, Andersen JT, et al., Weekly ascorbic acid infusion in castration-resistant prostate cancer patients: a single-arm phase II trial. Translational andrology and urology, 2017 6(3): p. 517–528. DOI: 10.21037/tau.2017.04.42. [PubMed: 28725594]
54. Friedlander TW, Weinberg VK, Huang Y, et al., A phase II study of insulin-like growth factor receptor inhibition with nordihydroguaiaretic acid in men with non-metastatic hormone-sensitive prostate cancer. Oncol Rep, 2012 27(1): p. 3–9. DOI: 10.3892/or.2011.1487. [PubMed: 21971890]
55. Flaig TW, Glodé M, Gustafson D, et al., A study of high-dose oral silybin-phytosome followed by prostatectomy in patients with localized prostate cancer. The Prostate, 2010 70(8): p. 848–855. DOI: 10.1002/pros.21118. [PubMed: 20127732]
56. Twardowski P, Kanaya N, Frankel P, et al., A phase I trial of mushroom powder in patients with biochemically recurrent prostate cancer: Roles of cytokines and myeloid-derived suppressor cells for Agaricus bisporus-induced prostate-specific antigen responses. Cancer, 2015 121(17): p. 2942–2950. DOI: 10.1002/cncr.29421. [PubMed: 25989179]
57. Dorff TB, Groshen S, Tsao-Wei DD, et al., A Phase II trial of a combination herbal supplement for men with biochemically recurrent prostate cancer. Prostate cancer and prostatic diseases, 2014 17(4): p. 359–365. DOI: 10.1038/pcan.2014.37. [PubMed: 25245366]
58. Thomas R, Williams M, Sharma H, et al., A double-blind, placebo-controlled randomised trial evaluating the effect of a polyphenol-rich whole food supplement on PSA progression in men with prostate cancer--the U.K. NCRN Pomi-T study. Prostate cancer and prostatic diseases, 2014 17(2): p. 180–186. DOI: 10.1038/pcan.2014.6. [PubMed: 24614693]
59. van Die MD, Williams SG, Emery J, et al., A Placebo-Controlled Double-Blinded Randomized Pilot Study of Combination Phytotherapy in Biochemically Recurrent Prostate Cancer. Prostate, 2017 77(7): p. 765–775. DOI: 10.1002/pros.23317. [PubMed: 28181675]
60. Yano T, Kato B, Fukuda F, et al., Alterations in the function of cerebral dopaminergic and serotonergic systems following electroacupuncture and moxibustion applications: possible correlates with their antistress and psychosomatic actions. Neurochem Res, 2004 29(1): p. 283–93. [PubMed: 14992288]
61. Ashamalla H, Jiang ML, Guirguis A, et al., Acupuncture for the Alleviation of Hot Flashes in Men Treated With Androgen Ablation Therapy. International Journal of Radiation Oncology*Biology*Physics, 2011 79(5): p. 1358–1363. DOI: 10.1016/j.ijrobp.2010.01.025.
62. Frisk J, Spetz A-C, Hjertberg H, et al., Two Modes of Acupuncture as a Treatment for Hot Flushes in Men with Prostate Cancer—A Prospective Multicenter Study with Long-Term Follow-Up. European Urology, 2009 55(1): p. 156–163. DOI: 10.1016/j.eururo.2008.02.002. [PubMed: 18294761]
63. Beer TM, Benavides M, Emmons SL, et al., Acupuncture for Hot Flashes in Patients With Prostate Cancer. Urology, 2010 76(5): p. 1182–1188. DOI: 10.1016/j.urology.2010.03.033. [PubMed: 20494414]

64. Van Kampen M, De Weerdt W, Van Poppel H, et al., Effect of pelvic-floor re-education on duration and degree of incontinence after radical prostatectomy: a randomised controlled trial. Lancet, 2000 355(9198): p. 98–102. DOI: 10.1016/s0140-6736(99)03473-x. [PubMed: 10675166]
65. Filocamo MT, Li Marzi V, Del Popolo G, et al., Effectiveness of early pelvic floor rehabilitation treatment for post-prostatectomy incontinence. Eur Urol, 2005 48(5): p. 734–8. DOI: 10.1016/j.eururo.2005.06.004. [PubMed: 16002204]
66. Goode PS, Burgio KL, Johnson TM 2nd, et al., Behavioral therapy with or without biofeedback and pelvic floor electrical stimulation for persistent postprostatectomy incontinence: a randomized controlled trial. JAMA, 2011 305(2): p. 151–159. DOI: 10.1001/jama.2010.1972. [PubMed: 21224456]
67. Zhang AY, Bodner DR, Fu AZ, et al., Effects of Patient Centered Interventions on Persistent Urinary Incontinence after Prostate Cancer Treatment: A Randomized, Controlled Trial. J Urol, 2015 194(6): p. 1675–81. DOI: 10.1016/j.juro.2015.07.090. [PubMed: 26231554]
68. Dieperink KB, Johansen C, Hansen S, et al., The effects of multidisciplinary rehabilitation: RePCa-a randomised study among primary prostate cancer patients. British journal of cancer, 2013 109(12): p. 3005–3013. DOI: 10.1038/bjc.2013.679. [PubMed: 24169342]
69. Tantawy SA, Elgohary HMI, Abdelbasset WK, et al., Effect of 4 weeks of whole-body vibration training in treating stress urinary incontinence after prostate cancer surgery: a randomised controlled trial. Physiotherapy, 2018 DOI: 10.1016/j.physio.2018.07.013.
70. Bidstrup E, Hvarness P,H, Bagi P, et al., Feasibility and acceptability of couple counselling and pelvic floor muscle training after operation for prostate cancer AU - Karlsen, Randi V. Acta Oncologica, 2017 56(2): p. 270–277. DOI: 10.1080/0284186X.2016.1267397. [PubMed: 28105866]
71. Pedriali FR, Gomes CS, Soares L, et al., Is pilates as effective as conventional pelvic floor muscle exercises in the conservative treatment of post-prostatectomy urinary incontinence? A randomised controlled trial. Neurourol Urodyn, 2016 35(5): p. 615–21. DOI: 10.1002/nau.22761. [PubMed: 25809925]
72. Galvao DA, Nosaka K, Taaffe DR, et al., Resistance training and reduction of treatment side effects in prostate cancer patients. Med Sci Sports Exerc, 2006 38(12): p. 2045–52. DOI: 10.1249/01.mss.0000233803.48691.8b. [PubMed: 17146309]
73. Bonn SE, Sjolander A, Lagerros YT, et al., Physical activity and survival among men diagnosed with prostate cancer. Cancer Epidemiol Biomarkers Prev, 2015 24(1): p. 57–64. DOI: 10.1158/1055-9965.Epi-14-0707. [PubMed: 25527697]
74. Richman EL, Kenfield SA, Stampfer MJ, et al., Physical activity after diagnosis and risk of prostate cancer progression: data from the cancer of the prostate strategic urologic research endeavor. Cancer research, 2011 71(11): p. 3889–3895. DOI: 10.1158/0008-5472.CAN-10-3932. [PubMed: 21610110]
75. Kenfield SA, Stampfer MJ, Giovannucci E, et al., Physical activity and survival after prostate cancer diagnosis in the health professionals follow-up study. J Clin Oncol, 2011 29(6): p. 726–32. DOI: 10.1200/jco.2010.31.5226. [PubMed: 21205749]
76. Santa Mina D, Guglietti CL, de Jesus DR, et al., The acute effects of exercise on cortical excitation and psychosocial outcomes in men treated for prostate cancer: a randomized controlled trial. Front Aging Neurosci, 2014 6: p. 332 DOI: 10.3389/fnagi.2014.00332. [PubMed: 25505413]
77. Jones LW, Hornsby WE, Freedland SJ, et al., Effects of nonlinear aerobic training on erectile dysfunction and cardiovascular function following radical prostatectomy for clinically localized prostate cancer. Eur Urol, 2014 65(5): p. 852–5. DOI: 10.1016/j.eururo.2013.11.009. [PubMed: 24315706]
78. Pernar CH, Fall K, Rider JR, et al., A Walking Intervention Among Men With Prostate Cancer: A Pilot Study. Clinical genitourinary cancer, 2017 15(6): p. e1021–e1028. DOI: 10.1016/j.clgc.2017.05.022. [PubMed: 28668276]
79. Galvão DA, Taaffe DR, Spry N, et al., Exercise Preserves Physical Function in Prostate Cancer Patients with Bone Metastases. Medicine and science in sports and exercise, 2018 50(3): p. 393–399. DOI: 10.1249/MSS.0000000000001454. [PubMed: 29036016]

80. Trinh L, Arbour-Nicitopoulos KP, Sabiston CM, et al., RiseTx: testing the feasibility of a web application for reducing sedentary behavior among prostate cancer survivors receiving androgen deprivation therapy. Int J Behav Nutr Phys Act, 2018 15(1): p. 49 DOI: 10.1186/s12966-018-0686-0. [PubMed: 29880049]
81. Winters-Stone KM, Dobek JC, Bennett JA, et al., Resistance training reduces disability in prostate cancer survivors on androgen deprivation therapy: evidence from a randomized controlled trial. Arch Phys Med Rehabil, 2015 96(1): p. 7–14. DOI: 10.1016/j.apmr.2014.08.010. [PubMed: 25194450]
82. Winters-Stone KM, Lyons KS, Dobek J, et al., Benefits of partnered strength training for prostate cancer survivors and spouses: results from a randomized controlled trial of the Exercising Together project. J Cancer Surviv, 2016 10(4): p. 633–44. DOI: 10.1007/s11764-015-0509-0. [PubMed: 26715587]
83. Cormie P, Newton RU, Taaffe DR, et al., Exercise maintains sexual activity in men undergoing androgen suppression for prostate cancer: a randomized controlled trial. Prostate Cancer And Prostatic Diseases, 2013 16: p. 170 DOI: 10.1038/pcan.2012.52. [PubMed: 23318529]
84. McGowan EL, North S, and Courneya KS, Randomized Controlled Trial of a Behavior Change Intervention to Increase Physical Activity and Quality of Life in Prostate Cancer Survivors. Annals of Behavioral Medicine, 2013 46(3): p. 382–393. DOI: 10.1007/s12160-013-9519-1. [PubMed: 23783829]
85. Uth J, Hornstrup T, Schmidt JF, et al., Football training improves lean body mass in men with prostate cancer undergoing androgen deprivation therapy. Scand J Med Sci Sports, 2014 24 Suppl 1: p. 105–12. DOI: 10.1111/sms.12260. [PubMed: 24944134]
86. Uth J, Hornstrup T, Christensen JF, et al., Efficacy of recreational football on bone health, body composition, and physical functioning in men with prostate cancer undergoing androgen deprivation therapy: 32-week follow-up of the FC prostate randomised controlled trial. Osteoporos Int, 2016 27(4): p. 1507–1518. DOI: 10.1007/s00198-015-3399-0. [PubMed: 26572756]
87. Bjerre ED, Brasso K, Jorgensen AB, et al., Football Compared with Usual Care in Men with Prostate Cancer (FC Prostate Community Trial): A Pragmatic Multicentre Randomized Controlled Trial. Sports Med, 2019 49(1): p. 145–158. DOI: 10.1007/s40279-018-1031-0. [PubMed: 30506427]
88. Galvao DA, Taaffe DR, Spry N, et al., Combined resistance and aerobic exercise program reverses muscle loss in men undergoing androgen suppression therapy for prostate cancer without bone metastases: a randomized controlled trial. J Clin Oncol, 2010 28(2): p. 340–7. DOI: 10.1200/jco.2009.23.2488. [PubMed: 19949016]
89. LaStayo PC, Marcus RL, Dibble LE, et al., Eccentric exercise versus usual-care with older cancer survivors: the impact on muscle and mobility--an exploratory pilot study. BMC Geriatr, 2011 11: p. 5 DOI: 10.1186/1471-2318-11-5. [PubMed: 21272338]
90. Cormie P, Newton RU, Spry N, et al., Safety and efficacy of resistance exercise in prostate cancer patients with bone metastases. Prostate Cancer Prostatic Dis, 2013 16(4): p. 328–35. DOI: 10.1038/pcan.2013.22. [PubMed: 23917308]
91. Newton RU, Kenfield SA, Hart NH, et al., Intense Exercise for Survival among Men with Metastatic Castrate-Resistant Prostate Cancer (INTERVAL-GAP4): a multicentre, randomised, controlled phase III study protocol. BMJ Open, 2018 8(5): p. e022899 DOI: 10.1136/bmjopen-2018-022899.
92. Bill-Axelson A, Garmo H, Holmberg L, et al., Long-term distress after radical prostatectomy versus watchful waiting in prostate cancer: a longitudinal study from the Scandinavian Prostate Cancer Group-4 randomized clinical trial. Eur Urol, 2013 64(6): p. 920–8. DOI: 10.1016/j.eururo.2013.02.025. [PubMed: 23465517]
93. Carlsson S, Sandin F, Fall K, et al., Risk of suicide in men with low-risk prostate cancer. Eur J Cancer, 2013 49(7): p. 1588–99. DOI: 10.1016/j.ejca.2012.12.018. [PubMed: 23337463]
94. Gregoire C, Nicolas H, Bragard I, et al., Efficacy of a hypnosis-based intervention to improve well-being during cancer: a comparison between prostate and breast cancer patients. BMC Cancer, 2018 18(1): p. 677 DOI: 10.1186/s12885-018-4607-z. [PubMed: 29929493]

95. Ibfelt E, Rottmann N, Kjaer T, et al., No change in health behavior, BMI or self-rated health after a psychosocial cancer rehabilitation: Results of a randomized trial. Acta Oncol, 2011 50(2): p. 289–98. DOI: 10.3109/0284186x.2010.531761. [PubMed: 21231790]

96. Wittmann D, Mehta A, Northouse L, et al., TrueNTH sexual recovery study protocol: a multi-institutional collaborative approach to developing and testing a web-based intervention for couples coping with the side-effects of prostate cancer treatment in a randomized controlled trial. BMC Cancer, 2017 17(1): p. 664 DOI: 10.1186/s12885-017-3652-3. [PubMed: 28969611]

97. Charalambous A, Giannakopoulou M, Bozas E, et al., Guided Imagery And Progressive Muscle Relaxation as a Cluster of Symptoms Management Intervention in Patients Receiving Chemotherapy: A Randomized Control Trial. PLoS One, 2016 11(6): p. e0156911 DOI: 10.1371/journal.pone.0156911. [PubMed: 27341675]

98. Toth M, Marcantonio ER, Davis RB, et al., Massage therapy for patients with metastatic cancer: a pilot randomized controlled trial. Journal of alternative and complementary medicine (New York, N.Y.), 2013 19(7): p. 650–656. DOI: 10.1089/acm.2012.0466.

99. Campo RA, Agarwal N, LaStayo PC, et al., Levels of fatigue and distress in senior prostate cancer survivors enrolled in a 12-week randomized controlled trial of Qigong. Journal of cancer survivorship : research and practice, 2014 8(1): p. 60–69. DOI: 10.1007/s11764-013-0315-5. [PubMed: 24170679]

100. Cao Y and Ma J, Body mass index, prostate cancer-specific mortality, and biochemical recurrence: a systematic review and meta-analysis. Cancer Prev Res (Phila), 2011 4(4): p. 486–501. DOI: 10.1158/1940-6207.Capr-10-0229. [PubMed: 21233290]

101. Kenfield SA, Stampfer MJ, Chan JM, et al., Smoking and prostate cancer survival and recurrence. JAMA, 2011 305(24): p. 2548–2555. DOI: 10.1001/jama.2011.879. [PubMed: 21693743]

102. Richman EL, Carroll PR, and Chan JM, Vegetable and fruit intake after diagnosis and risk of prostate cancer progression. Int J Cancer, 2012 131(1): p. 201–10. DOI: 10.1002/ijc.26348. [PubMed: 21823116]

103. Geybels MS, Neuhouser ML, Wright JL, et al., Coffee and tea consumption in relation to prostate cancer prognosis. Cancer Causes Control, 2013 24(11): p. 1947–54. DOI: 10.1007/s10552-013-0270-5. [PubMed: 23907772]

104. Richman EL, Kenfield SA, Chavarro JE, et al., Fat intake after diagnosis and risk of lethal prostate cancer and all-cause mortality. JAMA internal medicine, 2013 173(14): p. 1318–1326. DOI: 10.1001/jamainternmed.2013.6536. [PubMed: 23752662]

105. Richman EL, Stampfer MJ, Paciorek A, et al., Intakes of meat, fish, poultry, and eggs and risk of prostate cancer progression. Am J Clin Nutr, 2010 91(3): p. 712–21. DOI: 10.3945/ajcn.2009.28474. [PubMed: 20042525]

106. Pettersson A, Kasperzyk JL, Kenfield SA, et al., Milk and dairy consumption among men with prostate cancer and risk of metastases and prostate cancer death. Cancer Epidemiol Biomarkers Prev, 2012 21(3): p. 428–36. DOI: 10.1158/1055-9965.Epi-11-1004. [PubMed: 22315365]

107. Tat D, Kenfield SA, Cowan JE, et al., Milk and other dairy foods in relation to prostate cancer recurrence: Data from the cancer of the prostate strategic urologic research endeavor (CaPSURE). Prostate, 2018 78(1): p. 32–39. DOI: 10.1002/pros.23441. [PubMed: 29105845]

108. Epstein MM, Kasperzyk JL, Mucci LA, et al., Dietary fatty acid intake and prostate cancer survival in Orebro County, Sweden. Am J Epidemiol, 2012 176(3): p. 240–52. DOI: 10.1093/aje/kwr520. [PubMed: 22781428]

109. Strom SS, Yamamura Y, Forman MR, et al., Saturated fat intake predicts biochemical failure after prostatectomy. Int J Cancer, 2008 122(11): p. 2581–5. DOI: 10.1002/ijc.23414. [PubMed: 18324626]

110. Richman EL, Kenfield SA, Stampfer MJ, et al., Egg, red meat, and poultry intake and risk of lethal prostate cancer in the prostate-specific antigen-era: incidence and survival. Cancer Prev Res (Phila), 2011 4(12): p. 2110–21. DOI: 10.1158/1940-6207.Capr-11-0354. [PubMed: 21930800]

111. Schwingshackl L, Schwedhelm C, Hoffmann G, et al., Food groups and risk of all-cause mortality: a systematic review and meta-analysis of prospective studies. Am J Clin Nutr, 2017 105(6): p. 1462–1473. DOI: 10.3945/ajcn.117.153148. [PubMed: 28446499]

112. Saxe GA, Major JM, Nguyen JY, et al., Potential attenuation of disease progression in recurrent prostate cancer with plant-based diet and stress reduction. Integr Cancer Ther, 2006 5(3): p. 206–13. DOI: 10.1177/1534735406292042. [PubMed: 16880425]
113. Aronson WJ, Barnard RJ, Freedland SJ, et al., Growth inhibitory effect of low fat diet on prostate cancer cells: results of a prospective, randomized dietary intervention trial in men with prostate cancer. The Journal of urology, 2010 183(1): p. 345–350. DOI: 10.1016/j.juro.2009.08.104. [PubMed: 19914662]
114. Eriksen AK, Hansen RD, Borre M, et al., A lifestyle intervention among elderly men on active surveillance for non-aggressive prostate cancer: a randomised feasibility study with whole-grain rye and exercise. Trials, 2017 18(1): p. 20 DOI: 10.1186/s13063-016-1734-1. [PubMed: 28086943]
115. Ornish D, Weidner G, Fair WR, et al., Intensive lifestyle changes may affect the progression of prostate cancer. J Urol, 2005 174(3): p. 1065–9; discussion 1069–70 DOI: 10.1097/01.ju.0000169487.49018.73. [PubMed: 16094059]
116. Fruge AD, Dasher JA, Bryan D, et al., Physiological Effort in Submaximal Fitness Tests Predicts Weight Loss in Overweight and Obese Men with Prostate Cancer in a Weight Loss Trial. Int J Cancer Clin Res, 2017 4(2). DOI: 10.23937/2378-3419/1410083.
117. Demark-Wahnefried W, Nix JW, Hunter GR, et al., Feasibility outcomes of a presurgical randomized controlled trial exploring the impact of caloric restriction and increased physical activity versus a wait-list control on tumor characteristics and circulating biomarkers in men electing prostatectomy for prostate cancer. BMC Cancer, 2016 16: p. 61 DOI: 10.1186/s12885-016-2075-x. [PubMed: 26850040]
118. Henning SM, Galet C, Gollapudi K, et al., Phase II prospective randomized trial of weight loss prior to radical prostatectomy. Prostate Cancer Prostatic Dis, 2018 21(2): p. 212–220. DOI: 10.1038/s41391-017-0001-1. [PubMed: 29203893]
119. Kenfield SA, Van Blarigan EL, Ameli N, et al., Feasibility, Acceptability, and Behavioral Outcomes from a Technology-enhanced Behavioral Change Intervention (Prostate 8): A Pilot Randomized Controlled Trial in Men with Prostate Cancer. European Urology, 2019 DOI: 10.1016/j.eururo.2018.12.040.
120. Cox M, Basen-Engquist K, Carmack CL, et al., Comparison of Internet and Telephone Interventions for Weight Loss Among Cancer Survivors: Randomized Controlled Trial and Feasibility Study. JMIR Cancer, 2017 3(2): p. e16 DOI: 10.2196/cancer.7166. [PubMed: 28954716]
121. Bourke L, Gilbert S, Hooper R, et al., Lifestyle Changes for Improving Disease-specific Quality of Life in Sedentary Men on Long-term Androgen-Deprivation Therapy for Advanced Prostate Cancer: A Randomised Controlled Trial. European Urology, 2014 65(5): p. 865–872. DOI: 10.1016/j.eururo.2013.09.040. [PubMed: 24119318]
122. Freedland SJ, Howard L, Allen J, et al., A lifestyle intervention of weight loss via a low-carbohydrate diet plus walking to reduce metabolic disturbances caused by androgen deprivation therapy among prostate cancer patients: carbohydrate and prostate study 1 (CAPS1) randomized controlled trial. Prostate Cancer Prostatic Dis, 2019 DOI: 10.1038/s41391-019-0126-5.
123. Dawson JK, Dorff TB, Todd Schroeder E, et al., Impact of resistance training on body composition and metabolic syndrome variables during androgen deprivation therapy for prostate cancer: a pilot randomized controlled trial. BMC Cancer, 2018 18(1): p. 368 DOI: 10.1186/s12885-018-4306-9. [PubMed: 29614993]
124. Ottenbacher AJ, Day RS, Taylor WC, et al., Long-term physical activity outcomes of home-based lifestyle interventions among breast and prostate cancer survivors. Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer, 2012 20(10): p. 2483–2489. DOI: 10.1007/s00520-011-1370-y. [PubMed: 22249915]
125. Christy SM, Mosher CE, Sloane R, et al., Long-term dietary outcomes of the FRESH START intervention for breast and prostate cancer survivors. J Am Diet Assoc, 2011 111(12): p. 1844–51. DOI: 10.1016/j.jada.2011.09.013. [PubMed: 22117660]
126. Winger JG, Mosher CE, Rand KL, et al., Diet and exercise intervention adherence and health-related outcomes among older long-term breast, prostate, and colorectal cancer survivors. Ann Behav Med, 2014 48(2): p. 235–45. DOI: 10.1007/s12160-014-9598-7. [PubMed: 24648018]

127. Morey MC, Snyder DC, Sloane R, et al., Effects of home-based diet and exercise on functional outcomes among older, overweight long-term cancer survivors: RENEW: a randomized controlled trial. Jama, 2009 301(18): p. 1883–91. DOI: 10.1001/jama.2009.643. [PubMed: 19436015]

128. Focht BC, Lucas AR, Grainger E, et al., Effects of a Group-Mediated Exercise and Dietary Intervention in the Treatment of Prostate Cancer Patients Undergoing Androgen Deprivation Therapy: Results From the IDEA-P Trial. Ann Behav Med, 2018 52(5): p. 412–428. DOI: 10.1093/abm/kax002. [PubMed: 29684136]

129. Demark-Wahnefried W, Clipp EC, Morey MC, et al., Lifestyle intervention development study to improve physical function in older adults with cancer: outcomes from Project LEAD. Journal of clinical oncology : official journal of the American Society of Clinical Oncology, 2006 24(21): p. 3465–3473. DOI: 10.1200/JCO.2006.05.7224. [PubMed: 16849763]

130. Tsang DS, Jones JM, Samadi O, et al., Healthy Bones Study: can a prescription coupled with education improve bone health for patients receiving androgen deprivation therapy?-a before/after study. Support Care Cancer, 2018 26(8): p. 2861–2869. DOI: 10.1007/s00520-018-4150-0. [PubMed: 29532243]

131. Hackshaw-McGeagh L, Lane JA, Persad R, et al., Prostate cancer - evidence of exercise and nutrition trial (PrEvENT): study protocol for a randomised controlled feasibility trial. Trials, 2016 17(1): p. 123 DOI: 10.1186/s13063-016-1248-x. [PubMed: 26948468]

132. Parsons JK, Pierce JP, Mohler J, et al., Men's Eating and Living (MEAL) study (CALGB 70807 [Alliance]): recruitment feasibility and baseline demographics of a randomized trial of diet in men on active surveillance for prostate cancer. BJU international, 2018 121(4): p. 534–539. DOI: 10.1111/bju.13890. [PubMed: 28437029]

133. Winters-Stone KM, Kenfield SA, Van Blarigan EL, et al., Effect of Increasing Levels of Web-Based Behavioral Support on Changes in Physical Activity, Diet, and Symptoms in Men With Prostate Cancer: Protocol for a Randomized Controlled Trial. JMIR Res Protoc, 2018 7(11): p. e11257 DOI: 10.2196/11257. [PubMed: 30442638]

134. Sutton E, Hackshaw-McGeagh LE, Aning J, et al., The provision of dietary and physical activity advice for men diagnosed with prostate cancer: a qualitative study of the experiences and views of health care professionals, patients and partners. Cancer causes & control : CCC, 2017 28(4): p. 319–329. DOI: 10.1007/s10552-017-0861-7. [PubMed: 28220328]

135. Skolarus TA, Wolf AM, Erb NL, et al., American Cancer Society prostate cancer survivorship care guidelines. CA Cancer J Clin, 2014 64(4): p. 225–49. DOI: 10.3322/caac.21234 [PubMed: 24916760]

Highlights

- Diets high in lycopene/tomatoes may improve prostate cancer outcomes.
- Physical activity (e.g., exercise, PFMT) may improve prostate cancer QOL.
- Multimodal behavioral change may provide the greatest prostate cancer benefit.
- Implementation research is needed to integrate interventions in different settings.

Table 1.

Recommendations on individual diet and lifestyle factors for patients with localized and advanced prostate cancer.[‡]

	Localized prostate cancer	Advanced prostate cancer
Dietary factors		
Lycopene/tomato products ***	[17–19]	[20]
Green tea **	[9, 10]	
Avoidance of non-prescribed vitamin and mineral supplements (e.g., selenium) **	[51,52]	
Coffee *		
Cruciferous vegetables *		
Fish *		
Larrea tridentata *		
Mushrooms *		
Vegetable-derived fats *		
Avoidance of dairy *		
Avoidance of eggs *		
Avoidance of poultry with skin *		
Avoidance of processed red meat *		
Avoidance of saturated fat *		
Milk thistle	[55]	
Pomegranate	[32]	[33, 34]
Soy	[19, 37–41]	[42–44]
Omega-3 fatty acids	[17, 28–30]	
Lifestyle factors		
Pelvic floor muscle training ****	[64–68, 71]	
Pilates ***	[71]	
Exercise ****	[76–78, 85, 86, 88]	[76, 78, 79, 81–89]
Healthy body mass index †		
Smoking cessation †		
Guided imagery/progressive muscle relaxation ***		[97]
Qigong **		[99]
Massage **		[98]
Acupuncture *		
Hypnosis	[94]	

‡ = Citations are provided for factors with RCTs with a placebo/usual care control group in patients with localized (including post-radical prostatectomy/radiation therapy) and advanced prostate cancer (including patients on androgen deprivation therapy).

Absence of * = Equivocal benefit based on available evidence

* = Evidence leans toward potential benefit based on at least one observational study or RCT without a placebo control arm

** = Evidence leans toward potential benefit based on at least one placebo-controlled RCT, but clinical significance is modest

*** = Evidence leans toward potential benefit based on at least one placebo-controlled RCT with clinically significant effect

**** = Well-established benefit based on two or more placebo-controlled RCTs with clinically significant effect

† = Overwhelming observational evidence suggests benefit despite lack of RCTs focused on this factor alone.

Table 2:

Selected ongoing randomized controlled trials on diet and lifestyle factors in patients with prostate cancer.

Name of Trial (NCT No.)	Start	Participants	Inclusion Criteria	Intervention	Outcomes (Primary, Secondary)
Tangerine or Red Tomato Juice in Treating Patients with Prostate Cancer Undergoing Surgery (NCT02144649)	June 2015	45	Biopsy-proven prostate cancer scheduled for RP	Daily tangerine or red tomato juice (2 5.5oz. cans)	**Feasibility, safety, carotenoid levels in blood and prostate tissue**, change in histopathologic and immunohistochemical markers of tumorigenesis
Effects of EPA in Men With Biochemical Recurrence or Progression of Prostate Cancer. (RCT-EPAII-BCR) (NCT03753334)	July 2017	Estimated 30	Biopsy-proven prostate cancer, biochemical recurrence following RP or RT	Daily MAG-EPA supplement (5g fish oil including 4g purified monoglycerides EPA)	**PSADT**, red blood cell fatty acid profiles
A Study to Examine the Effectiveness of Aspirin and/or Vitamin D3 to Prevent Prostate Cancer Progression (PROVENT) (NCT03103152)	December 2016	104	Biopsy-confirmed prostate cancer, clinical stage <T3, Gleason 6 or 7, serum PSA ≤15ng/mL, <10mm of cancer in single core	Daily Vitamin D (4000IU) alone or with high (300mg) or low (100mg) dose aspirin	**Feasibility**; progression as measured by changes in lesions on multi-parametric MRI, rising PSA, and/or increased Gleason score or maximum cancer core length; toxicity
Trial of Curcumin to Prevent Progression of Low-risk Prostate Cancer Under Active Surveillance (NCT03769766)	January 2019	Estimated 291	Biopsy-proven prostate cancer, Clinical stage T1c-T2a/b, Gleason ≤6 with no pattern 4, serum PSA ≤10ng/mL, <4 cores with cancer	Twice daily curcumin supplement (500mg BCM-95)	**Rate of progression as defined by receipt of primary therapy (RP, RT, hormonal therapy) or pathologic progression (>4 cores involved, ≥50% of any core involved, Gleason ≥4)**
Cannabis Oil and Radiation Therapy for the Management of Pain (NCT03763851)	January 2019	Estimated 420	Metastatic carcinoma of the prostate, lung, or breast	High (2.5mg THC/ 2.5mg CBD) or low (1mg THC/1mg CBD) dose cannabis capsule with RT	**Cancer pain intensity and quality**, QOL, functional status, fatigue, cognitive status
Active Surveillance Exercise Clinical Trial (ASX) (NCT02435472)	May 2016	Estimated 150	Biopsy-proven prostate cancer on AS, clinical stage <T3, Gleason ≤6 or 3+4 in <34% of cores, serum PSA ≤10 ng/ml or PSAD <0.15	4 home-based walking sessions/week at 55–75% individual exercise capacity	**Cancer biomarker changes**, circulating & tumor biomarkers, general and prostate cancer-specific anxiety, adherence to active surveillance
CHAMP: A Randomized Controlled Trial of High-intensity Aerobic and Resistance Exercise for Metastatic Prostate Cancer (NCT02613273)	July 2016	Estimated 39	Biopsy-proven metastatic castrate resistant prostate cancer on ADT with GnRH agonist/ antagonist or prior bilateral orchiectomy	Three sessions per week of either aerobic exercise consisting of two high-intensity interval training workouts and one continuous vigorous intensity workout or resistance exercise for 12 weeks	**Feasibility, tolerance, safety**, general and prostate cancer-specific QOL, anxiety, depression, pain, physical function, strength
INTense Exercise foR surVivAL Among Men With Metastatic Castrate-Resistant Prostate Cancer (INTERVAL) (NCT02730338)	December 2015	Estimated 866	Biopsy-proven metastatic castrate resistant prostate cancer on ADT with GnRH agonist/ antagonist or prior bilateral orchiectomy	24 28-day cycles of high intensity aerobic and resistance training three times per week, psychosocial support	**Overall survival**; time to prostate cancer progression; symptomatic skeletal related events; biomarker analysis of inflammatory markers, insulin/ glucose metabolism, and androgen biosynthesis; QOL; physical function; pain; opiate/ analgesic use
Comprehensive Yoga Program (SKY) as	January 2016	44	RT for prostate cancer	Yoga instruction (Week 1: 3 hours daily for 5	**Change in QOL, depression, anxiety, psychological well-**

Name of Trial (NCT No.)	Start	Participants	Inclusion Criteria	Intervention	Outcomes (Primary, Secondary)
Adjunct Therapy for Prostate Cancer (NCT03220945)				days, Weeks 2–13: 2 hours weekly)	**being, fatigue, and pain**, change in serum antioxidants, serum oxidative stress, and hair/ salivary cortisol
A Randomized Controlled Trial of Diet and Exercise Interventions among Men with Prostate Cancer - II (Prostate 8 - II)	May 2018	Estimated 200	Biopsy-proven prostate cancer scheduled for RP	4-arm diet and exercise intervention for 2 years, with different combinations of tools that may include a web portal with lifestyle tracking, text messaging, heart rate monitor and resistance bands, and exercise and diet telephone coaching	**Change in Decipher score**, mRNA expression patterns, PSA, recurrence rate, body weight, waist and hip circumference, fasting glucose, hemoglobin A1C, lipids, antioxidant levels, CRP, physical activity, QOL, sleep quality, barriers, acceptability
Diet in Altering Disease Progression in Patients With Prostate Cancer on Active Surveillance (NCT01238172)	January 2011	464	Biopsy-proven prostate cancer, clinical stage ≤ T2a, <25% of tissue positive for cancer, ≤50% of any one biopsy tissue core positive for cancer	Dietary education and telephone counseling sessions	**Disease progression**, time to progression, time to treatment, QOL, dietary recall