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Physical activity and prostate cancer: a systematic review

Abstract

Numerous studies confirmed that planned exercise therapy is a possible adjunct strategy connected with significant improvements in symptom-related results including exercise tolerance as well as several cancer patients-reported progress such as improvement in quality of life, and physical functioning during conventional adjuvant therapy. The aim of this review was to evaluate the association between physical activity and prostate cancer. Apart from lung cancer, prostate cancer is highly prevalent among men. We searched for original articles, systematic reviews, and meta-analyses that reported on exercise-mediated changes in the prostatic tumour risk and progression from 1980 to 2018. The following electronic databases was used: PubMed, Science Direct, Medline, Sports Discus, Web of Science, Google Scholar and Cochrane database. 85 studies written in English were included in this review. Patient's cardio-metabolic profile, type of exercise, specific workloads, frequency, duration, intensity and safety precautions are factors to consider when scheduling an exercise program. Regular participation in physical activity is important in the prevention of prostate cancer and it is associated with positive treatment outcomes in patients undergoing Androgen deprivation therapy. Physical Activity may affect prostate cancer progression by reducing insulin resistance, decreasing bioavailable Insulin-like growth factor 1 (IGFI), increasing adiponectin levels and circulating levels of insulin. Interleukin 6 (IL-6) promotes cell proliferation and inhibits apoptosis of prostate cancer cells in vitro. Physical activity is associated with lower circulating IL-6. Based on the information examined in this study, physical activity may be an effective nonpharmacological means in the treatment of prostate cancer.

Keywords: physical activity, exercise, prostate tumor, cancer prevention

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Introduction

For the past 2 decades, improved research and clinical attention has focused on the effectiveness of exercise therapy as an adjunct approach for the treatment of cancer.[1] Randomized trials validate that lanned exercise therapy is a feasible adjunct tactic connected with significant improvements in symptom-related outcomes including exercise tolerance as well as multiple patient-reported treatment progress such as improvement in quality of life and physical functioning equally during conventional adjuvant therapy.[2] In this review, we outline relevant studies related to exercise-mediated changes in the prostatic tumour risk and progression from 1980 to 2018. Prostate cancer is the second most prevalent form of cancer diagnosed among men after lung cancer.[3] Androgen deprivation therapy (ADT) is applied in the treatment of patients in the advanced stage of prostate cancer. The side effects of ADT include erectile dysfunction,[4] increase fat mass,[5] and reduction in muscle strength.[6] Combined resistance and aerobic exercise training program was effective in reversing muscle loss in men undergoing ADT due to prostate cancer.[7] Pelvic floor/sphincter training is effective in plummeting incontinence in patients with prostate cancer.[8,9] The molecular mechanisms behind the positive effects of exercise training programs in addition to ADT has not been well understood, however there was a decrease in inflammation due to low nuclear factor-κB activation in LNCaP cells incubated with post-exercise serum[10] and suppressed growth and increased apoptosis of LNCaP cells incubated with post-exercise serum.[11] Exercise alters p53, p21 and caspase activities resulting in tumour growth inhibition, tumour apoptosis, tumour suppression and suppressed metastasis.[12,13] Physical activity was effective in reducing prostate carcinogenesis in transgenic model.[14] The demonstration of possible mechanisms whereby exercise alters the progression of carcinogenesis might strengthen the clinical outcome of cancer treatment.

Exercise could also result to reductions in obesity and oxidative stress and a modulation of immune responses in prostate cancer patients.[15] Exercise causes reductions in circulating levels of testosterone and insulin-like growth factors[16,17] therefore reducing the development and spread of neoplastic cells. Apart from exercise, testosterone levels are controlled by diet,[18] and this may contribute to variances in exercise response among various populations.[19] The aim of this review was to evaluate the association between physical activity and prostate cancer. In this review, we outlined relevant studies concerned about exercise-mediated changes in prostatic growth and progression from 1980 to 2018. These mediated changes are linked to the role of consistent physical activity in improving the quality of life, physical fitness and averting the progression of prostate cancer among individuals diagnosed of prostate cancer.

Methods

Search strategy

We searched for studies that reported on exercise-mediated changes in the prostatic tumour risk and progression from 1980 to 2018. The following electronic databases was used: PubMed, Science

Direct, Medline, Sports Discus, Web of Science, Google Scholar and Cochrane database. The following search strategy was modified for the various databases and search engines: Prostate cancer, exercise, physical activity, cancer, prostate tumour, cancer prevention, and cancer adjunct therapy. We assessed Full articles and extracted relevant data. We used the MeSH system to extract relevant research studies indexed in PubMed.

Types of studies

Original articles, systematic reviews, and meta-analyses.

Inclusion and exclusion criteria

We selected precise articles that described physical activity and prostate growth, exercise therapy in support of the clinical treatment of prostate cancer and exercise prescription for prostate cancer patients. The selected articles were all written in English. Articles that were not precise, uncertain and with doubtful experimental procedure were excluded. 85 studies were included in this review.

Data extraction and management

We designated all trials retrieved from the databases. We reviewed for relevance based on physical activity and prostate cancer progression, cancer prevention, exercise therapy for prostate cancer patients undergoing ADT and radiotherapy. We retrieved full-text copies of all the articles recognised as hypothetically relevant in this review. Data was reported in a narrative and concise manner. The selection process was elucidated in a Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram (Figure 1).

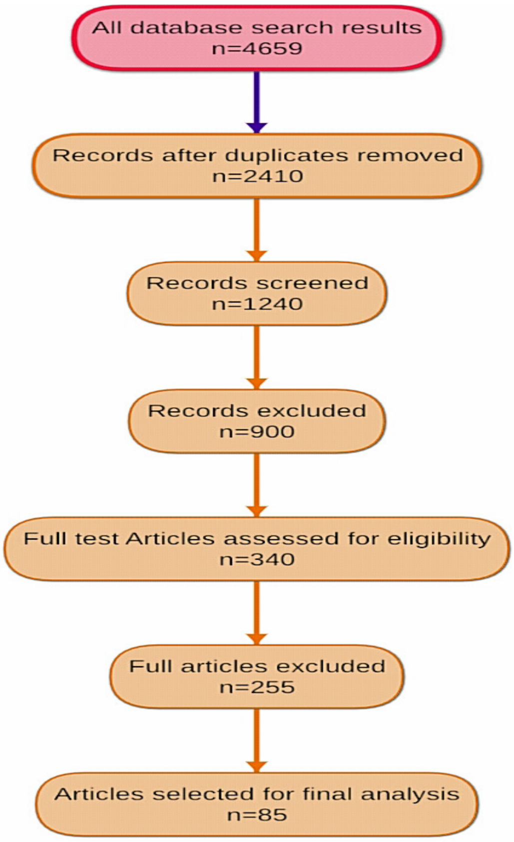

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram.

The effectiveness of exercise prescription and dosing for patients diagnosed with prostate cancer

Patient's cardio-metabolic profile, type of exercise, specific workloads, frequency, duration, intensity and safety precautions are factors to consider when planning an exercise program. Regular involvement in physical activity is vital in the prevention of prostate cancer and it is connected with positive treatment results in patients undergoing ADT.[20] Patients diagnosed with prostate cancer should accumulate at least; 150 min per week of moderate-intensity aerobic exercise or 75 min per week of vigorous aerobic exercise, or both, this is in accordance with the reference exercise strategies prescribed by the American College of Sports Medicine (ACSM) for cancer patients[21,22] Cardiovascular diseases are the leading cause of death in men with prostate cancer[23] and exercise performed according to the standard prescription improves cardiovascular fitness and averts cardiovascular deaths.[24] Galvao et al.[25] found a significant increase in muscle strength in prostate cancer patients allocated to the group that took part in chest press, a significant increase in muscle stamina was detected in the group that participated in chest press, there was significant increase in Muscle thickness at the quadriceps position. There was substantial development in general cardiovascular fitness,

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flexibility, muscle strength, quality of life, and drastic reduction in fatigue among prostate cancer patients undertaking radiotherapy after undergoing an 8-week cardiovascular exercise-training program[26] A randomised controlled trial conducted by Segal et al.[27] in which Prostate cancer patients completed resistance exercise training 3 times per week, demonstrated global progresses in quality of life, muscular strength, body fat ratio decrease and lessening in fatigue in the group that partook in resistance exercise and are undertaking radiotherapy, both aerobic and resistance training was found to lessen fatigue. A personalized exercise-training program planned and prescribed according to patients' cardio-metabolic and functional capacity might be more effective in the treatment of prostate cancer.[28] The ideal approach and dosage of exercise for patients diagnosed of prostate cancer has not been established.

Selected studies on physical activity and prostate cancer

According to the World Health Organization (WHO), physical activity is any physical movement produced by skeletal muscles that involves energy expenditure.[29] Based on experimental and clinical studies, physical activity averts the progression of prostate cancer by changing molecular mechanisms resulting to the suppression of tumour growth. In tabulating available epidemiological facts, we categorized them by type of study (cross-sectional, prospective cohort, or case–control) and by findings (an adverse effect, no clear response, a positive trend), and a statistically significant decrease of risk in the more active individuals. There have been many cross-sectional or cohort studies relating occupation to the risk of prostate cancer (Table 1). Leisure-time physical activity have also been linked with the risk of developing prostate cancer based on cohort studies (Table 2). Four retrospective and cohort studies of sport involvement and fitness realization was critically analysed (Table 3)., two of these information found no benefit from sport involvement,[70] but Wannamethee et al.[64] noted a considered outcome on the reported frequency of sport participation, However, the fourth report observed that a beneficial effect was connected with a high-attained level of aerobic fitness.[71]

Table 1 Occupational activity and the risk of developing prostate cancer

Author	Sample	Activity measure	Outcome	Comments
Cohort studies Negative findings				
Hartman et al.[30a]	29,133 male smokers, aged 50–69 years followed for an average of 6.1 years; 317 incident cases of PC	Self-report, sedentary job vs. occupational walkers vs. walkers/lifters vs. heavy laborers	RR 1.0, 0.6, 0.8, 1.2 (ns) of prostate cancer as stated by Finnish cancer registry	Attuned for age, urban living, smoking, benign prostate hyperplasia
Johnsen et al.[31a]	127,923 men, aged 20–97 years, followed for 8.5 years; 2458 cases of PC	Two classifications by interview or questionnaire: sitting, standing, or manual work; inactive, moderately inactive, moderately active, active	Occupational activity not significantly related to PC (OR manual 0.90 (0.77–1.04), p =0.15 for trend)	Attuned for leisure activity, height, weight, marital status, education
Nielsen et al.[32a]	22,895 Norwegian men aged 40 to >80 years followed for 9.3 years; 644 cases of PC	Modest binary classification (high vs. low level of occupational activity)	No effect of occupational activity ((high RR 1.04 (0.82–1.32); augmented risk in high vs. low education, RR 1.50 (1.11–2.19)	Age-adjusted relative risks
Putnam et al.[33a]	101 cases of PC were conveyed to State register office,1572 initially cancer-free men aged 40–86 years, followed for 4 years	Very energetic, ascetically active, or inactive at work, based on work-related codes	PC unrelated to occupational activity (RR for very active 1.0 (0.6–1.8))	Adjusted for age
Zeegers et al.[34a]	58,279 men aged 55–69 years, 1386 cases of PC over 9.3 years of follow-up	Work-related activities (estimated energy expenditure, sitting time for longest held and for most recent job)	RRs longest held: >12 vs. <8 kJ/min 0.91 (0.70–1.18) Sitting <2 vs. >6 h/day1.16 (0.91–1.47)	Attuned for age, alcohol drinking, BMI, energy intake, family history, education

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Table Continued

Author	Sample	Activity measure	Outcome	Comments
Positive trend				
Grotta et al.[35a]	13,109 Swedish men, initially aged 55 years, surveyed for 13 years; 904 cases of PC	Low vs medium vs. high level of work-related activity	HR for high activity 0.81 (0.61–1.07, ns), medium 0.96 (0.77–1.20)	Attuned for age, education, smoking, BMI, alcohol consumption, diabetes mellitus
Hrafnkelsdóttir et al.[36a]	24-year follow-up of 8221 Icelandic men initially aged 33–79 years; 1052 cases of PC	Work includes mostly sitting vs standing vs on the move	HR 1.0, 0.97 (0.80–1.17), 0.91 (0.79–1.06), ns	Attuned for age, height, BMI, diabetes, family history, education, medical check-ups
Significant positive findings				
Clarke et al.[37a]	5377 men firstly, aged 25–75 years surveyed for 17–21 years; 201 cases of PC	Very active vs. sedentary	RR for inactive 1.75 (1.12–2.67), p=0.05 for trend (outcome larger in African Americans)	Attuned for age, education, ethnicity, family history
Norman et al.[38]	3 cohorts containing 43,836, 28,702, and 19,670 cases of PC	Work-related designations (inactive, medium, to very high level of activity)	RR for sedentary vs. high/very high groups 1.11, 1.10, and 1.11 (p=0.0001 for all three groups)	Attuned for age, year of follow-up, area of residence
Orsini et al.[39a]	45,887 men aged 45–79 years, surveyed for 8 years; 2735 incident cases of PC	4 categories of occupation (mostly sitting vs. heavy manual)	RR=0.72 (0.57–0.90); p=0.007 for trend; effects smaller for advanced and fatal cancers	Attuned for leisure activity, age, smoking, alcohol consumption, education, diet, energy intake, waist/hip ratio, diabetes mellitus
Parent et al.[40a]	449 incident cases of PC; aged 59 years	High vs. medium vs. low lifetime occupational activity, metabolic equivalents (METs)	OR intermediate 0.64 (0.41–0.98), high 0.54 (0.31–0.95)	Data attuned for age, sex, education, ethnicity, smoking, BMI, outdoor activities
Vidarsdottir et al.[41]	60,194 men initially aged 20–64 years followed for 23 years	Educational level (basic, medium, high)	SIR basic =0.92 (0.84–0.99), academic =1.17 (1.05–1.30)	Greater diagnosis in highly educated group
Case–control studies **Adverse findings** **Negative findings**				
Doolan et al.[42]	1436 cases of PC aged 39–70 years, 1349 coordinated controls	Finnish occupation background, physical capacity classified by tertiles	OR highest tertile workload 1.15 (0.95–1.40), ns	Attuned for age, family history, economic resources
Hosseini et al.[43]	137 cases of PC, 137 locality controls, men <70 to >80 years	Walking to work (<10 vs. >10 h/week), intensity of work (sedentary/moderately active vs. highly active)	OR 0.7 (0.4–1.2) for longer walk (ns), OR=6.7 (1.3–35.1) for highly active work (p=0.02)	Multivariate adjusted
Lacey et al.[44a]	258 cases of PC, 471 age-matched controls, aged 50–94 years	Sedentary, moderate, or high work-related energy expenditures at ages 20–29 years, 40–49 years, or 12 years ago	RR 1.1 (0.7–1.7), 1.3 (0.8–1.9), 0.9 (0.5–1.8) of high vs. sedentary group	Attuned for age, marital status, education, BMI, energy intake, waist/hip ratio
Sass-Kortak et al.[45]	760 PC cases aged 50–84 years, 1632 telephone book controls	Quartiles of lifetime work-related activity	Active vs. least active workers OR 1.33 (1.02–1.74), p=0.18 for trend)	Attuned for age, family history, sunlight exposure

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Table Continued

Author	Sample	Activity measure	Outcome	Comments
No effect				
Friedenreich et al.[46a]	988 cases of PC, histologically confirmed, 1063 population controls	Energy expenditure <74.2 vs. >161.9 MET h/week	OR 0.90 (0.60–1.22), ns	Attuned for age, region, education, BMI, waist/hip ratio, energy intake, alcohol drinking, family and medical history
Positive trend				
Lagiou et al.[47]	320 histologically confirmed cases pf PC aged <60 to >80 years, 246 hospital controls	Low, medium, high level of job-related activity	OR low =1.0, medium =0.95 (0.49–1.84), high =0.69 (0.40–1.22), ns	Attuned for age and education
Wiklund et al.[48a]	1449 incident cases of PC in men aged 35–79 years, 1118 population controls	METs h/day of lifetime work-related activity, <11.8, <14.8, <19.8, >19.8	OR 1.0, 0.81 (0.65–1.08), 0.87 (0.66–1.15) 0.84 (0.61–1.15), ns	Attuned for age, region, education, BMI, alcohol consumption, family history, diabetes mellitus, energy intake
Significant positive findings				
Bairati et al.[49]	64 cases of PC, 5456 cases of benign prostate hyperplasia aged >45 years	(a) inactive job or light work; (b) 0, 1–49%, >50% of profession spent in inactive or light work	(a) OR 2.0 (1.1–3.6); 1.0, 1.7 (0.8–3.2), OR 2.8 (1.3–6.0) (p=0.007 for trend)	Attuned for age, education, total energy intake, smoking, use of vitamin supplements
Krishnadasan et al.[50]	362 cases of PC, 1805 matched controls; age not specified	Low vs. moderate vs. high work-related energy outflow	OR high 0.63 (0.40–1.00), moderate 0.96 (0.7–1.3), p=0.06 for trend)	Attuned for matching variables, pay, trichloroethylene exposure
Pierotti et al.[51a]	1294 incident cases of PC aged <75 years and 1451 hospital controls	3-level categorization of work-related activity at ages 12, 15–19, 30–39, and 50–59 years	OR age 12 years = 0.84 (0.67–1.06), age 15–19 years =0.94 (0.75–1.17), age 30–39 years =0.78 (0.63–0.97), age 50–59 years = 0.75 (0.61–0.93)	Attuned for age, test centre, education, Sex, BMI, total energy intake, smoking, alcohol consumption, family history
Strom et al.[52a]	176 cases of PC in Mexican Americans, 176 controls, age ~ 62 years	None/low vs. moderate/high energy demands of labour	Reduced risk in active (OR 0.46, 0.28–0.77), p=0.003)	Attuned for age, education, screening, exposure to agricultural chemicals
Villeneuve et al.[53a]	1623 histologically confirmed cases of PC, 1623 controls, aged 50–74 years	4-level classification of work (sitting to energetic)	Significant advantage from strenuous activity in teens or early 20 s, (OR light 0.8 (0.5–1.3), moderate 0.8 (0.5–1.2), strenuous 0.6, 0.4–0.9), ns for 30 s (0.7), 50 s, (0.8) or 2 years before interview (0.9)	Attuned for age, area of residence, smoking, alcohol consumption, BMI, diet, income, family history

HR, hazard ratio; MET, metabolic equivalent, ns not significant; OR, odds ratio; PC, prostate cancer; PMR, proportionate mortality ratio; RR, relative risk or rate ratio; SES, socioeconomic status; SIR, standardized incidence ratio

Table 2 Leisure-time physical activity and the risk of developing prostate cancer

Author	Sample	Activity measure	Findings	Comments
Cohort studies **Adverse trend** **Negative findings**				
Crespo et al.[54]	9824 men initially aged 35–79 years followed for death	Framingham index (quartiles)	No association between physical activity and prostate deaths	Adjusted for age, education, urban residence, smoking, BMI
Giovannucci et al.[55]	47,452 health experts initially aged 40–75 years, followed for 8 years; 1362 cases of PC	Leisure activity, 1 vs. 46.8 MET h/week	No significant association to PC except idea of less metastatic activity and lower Gleeson score with vigorous intensity exercise	Attuned for age, vasectomy, diabetes mellitus, smoking, energy intake, diet
Grotta et al.[35b]	13,109 Swedish men, initially aged 55 years, tracked for 13 years; 904 cases of PC	Low vs. high leisure activity	HR 0.93 (0.76–1.14, ns) for incident PC if high physical activity	Attuned for age, education, smoking, BMI, alcohol drinking, diabetes mellitus
Johnsen et al.[31a]	127,923 men, median initial age 61 years, followed for 8.5 years; 2458 cases of PC	Quartiles of leisure activity (<25 to >71 MET h/week)	Leisure activity unrelated to incident PC	Attuned for work-related activity, height, weight, marital status, education
Lee et al.[56]	8922 Harvard alumni, mean age 67 years; 439 developed PC during 5 years of follow-up	Physical activity questionnaire completed twice, weekly energy expenditure quartiles (<4.2 MJ to >12.6 MJ)	PC disparate to total volume of physical activity or weekly volume of vigorous physical activity	Accustomed for age, BMI, smoking, alcohol consumption, family history
Littman et al.[57]	34,757 men initially aged 50–76 years; 583 cases of PC	MET h/week, walking pace, stair climbing, high-intensity activity, activity at earlier ages	No association with PC except in sub-group aged >65 years with normal body mass	Attuned for family history, BMI, income
Liu et al.[58]	982 cases of PC in 22,071 physicians aged 40–84 years over 11 years of follow-up	Exercise sufficient to cause a sweat <1/week. vs. >5/weeks	No relationship of frequent activity to incidence of PC	Adjusted for smoking, alcohol drinking, height, diabetes mellitus, high cholesterol, hypertension, use of multi-vitamins
Parent et al.[40b]	449 incident cases of PC among 3730 cancer patients	participation in sports and outdoor activities (never or not often vs. often)	No significant consequence on risk of PC	Covariates age, SES, education, ethnicity, smoking, BMI
Platz et al.[59]	46,786 health professionals, initially aged 40–75 years; 2896 incident cases of PC over 14 years	Vigorous leisure activity <3, >3 MET h/week	No relationship to PC	Attuned for age, family history, BMI, diabetes mellitus, smoking, diet
Putnam et al.[33b]	101 cases of PC in 1572 initially cancer-free men, originally aged 40–64 years, followed for 4 years	Very active, moderately active, inactive	Risk of PC unrelated to leisure activity	Attuned for total energy intake

Table Continued

Author	Sample	Activity measure	Findings	Comments
Positive trends				
Clarke et al.[37b]	5377 men, aged <50 to >70 years, followed for 17–21 years; 201 cases of incident or fatal PC	Much vs. moderate vs. little or none	RR much 1.00, moderate 1.10 (0.75–1.61), inactive 1.17 (0.80–1.72), ns	Attuned for age, education, ethnicity, family history
Giovannucci et al.[60]	47,620 health specialists, initially aged 40–75 years, 14 years of follow-up; 2892 incident cases of PC (482 advanced, 280 fatal)	Vigorous physical activity, 0 vs. >29 MET h/week	No relationship for all subjects; if >65 years, OR for advanced cancer 0.33 (0.17–0.62)	Age, BMI, smoking, height, family history, diabetes mellitus, ethnicity, non-vigorous activity, energy intake and diet
Hrafnkelsdóttir et al.[36b]	24 years of follow-up of 822 Icelandic men initially aged 33–79 years; 1052 cases of PC	Regular physical activity from age of 20 years vs. sedentary	HR 0.93 (0.83–1.07) for all PC in active individuals, 0.82 (0.63–1.06) for advanced cancers	Accustomed for age, height, BMI, diabetes, family history, education, medical check-ups
Nielsen et al.[32b]	22,895 Norwegian men, initially aged 40 to >80 years, followed for 9.3 years; 644 cases of PC	High vs. low leisure activity	RR 0.80 (0.62–1.03)	Multivariate adjusted
Moore et al.[61]	293,902 men initially aged 50–71 years followed for up to 8.2 years; 17,872 cases of PC	Exercise at starting point and in adolescence (never/ rarely to >5 times/ week)	RR of total cases 0.97 (0.91–1.03), p=0.03 for inclination supporting frequent activity during adolescence, but no relationships to exercise habits at baseline	Accustomed for age, marital status, education, smoking, medical history, BMI, waist circumference, family history, diet and supplements
Nilsen et al.[62]	29,110 Norwegian men, initially mean age 52 years, followed for 7 years; 957 incident cases of PC	Activity score based on frequency, intensity and duration of activity (low vs. high)	Connected to total cancer cases (RR=0.86), but for advanced cancer RR=0.64 (0.43–0.95), p=0.02 for inverse trend	Attuned for age, marital status, education, BMI, smoking, alcohol consumption
Patel et al.[63]	72,174 men, initial mean age 64 years; 5503 incident cases of PC over 9 years	MET h/week (<0.7–35) at age 40 years	No significant effect (but active have fewer hostile tumours, RR 0.69 (0.52–0.92), p=0.06 for trend	Accustomed for age, ethnicity, BMI, weight change, energy intake, diet and vitamin use, diabetes mellitus, family and medical history
Zeegers et al.[34b]	58,279 men initially aged 55–69 years; 1386 cases of PC over 9.3 years	Cycling/walking (min/ day), gardening (h/week)	Gardening unrelated to PC; biking/walking <10 vs. >60 min/d, RR 0.85 (0.69–1.05), ns	Accustomed for age, alcohol drinking, BMI, energy intake, family history, gardening, sport participation
Significant positive findings				
Hartman et al.[30a]	29,133 male smokers, initially aged 50–69 years, followed for up to 9 years; 317 cases of PC	Inactive vs, moderate/ heavy leisure activity in working men	RR 0.7 (0.46–0.94) favoring active leisure	Attuned for age, urban living, smoking, benign hyperplasia
Orsini et al.[39b]	45,887 men, initially aged 45–79 years, followed for 8 years; 2735 incident cases of PC	Walking or cycling, 5 categories (hardly ever to >60 min/day)	RR=0.86 (0.76–0.98), p=0.028 for trend; effects greater for advanced (RR=0.74) and fatal (RR=0.72) cancers	Attuned for work-related activity, age, smoking, alcohol drinking, education, diet, energy intake, waist/hip ratio, diabetes mellitus
Wannamethee et al.[64a]	Potential study of 7588 men aged 40–59 years; 120 incident cases of PC	6-level classification of leisure activity from none to vigorous	Advantage from vigorous activity, OR 0.25 (0.06–0.99, p=0.06 for trend	Attuned for age, smoking, alcohol consumption, BMI, social class

Table Continued

Author	Sample	Activity measure	Findings	Comments
Case–control studies **Adverse findings**				
Chen et al.[65]	237 cases of PC, 481 controls aged >50 years	Mainly a dietary study: 4-level categorization of physical activity	Adverse effect of high vs. moderate exercise: OR 1.84 (1.01–3.34)	Multivariate analysis (age, BMI, income, marriage, dietary variables)
Wiklund et al.[48b]	1449 incident cases of PC, 1118 population controls, mean age 67–68 years	MET h/day lifetime recreational activity, <7.4 to >13.5	OR <7.4=1.0, <10.2=1.33 (1.00–1.78), <13.5=1.43 (1.07–1.91), >13.5=1.56 (1.16–2.10), p=0.006 for adverse effect of active leisure	Attuned for age, region, education, BMI, alcohol consumption, family history, diabetes mellitus, energy intake
No clear effect				
Lacey et al.[44b]	258 cases of PC, 471 age-matched controls, aged 50–94 years	Tertiles of moderate/ vigorous or all physical activity at age 20–29 years, age 40–49 years, and 12 years ago	No association to PC	Attuned for age, marital status, education, BMI, energy intake, waist/hip ratio
Pierotti et al.[51a]	1294 incident cases of PC aged <75 years and 1451 hospital controls	3-level classification of physical activity at ages 12, 15–19, 30–39, and 50–59 years	No effect on risk of PC at any age	Accustomed for age, test center, education, SES, BMI, total energy intake, smoking, alcohol drinking, family history
Sanderson et al.[66]	416 incident cases of PC, 429 Medicare beneficiary controls aged 65–79 years	Tertiles of strenuous and of moderate physical activity (h/ week)	No relationship to PC in either African American or Caucasian men	Adjusted for age, geographic region, family history
Strom et al.[52b]	176 cases of PC in Mexican Americans, 176 controls, age ~ 62 years	Leisure activity (<1/ week vs. >1/week)	No effect on risk of PC	Attuned for age, education, screening, work-related activity
Villeneuve et al.[53b]	1623 histologically confirmed cases of PC, 1623 controls, age 50–74 years	5-level classification (<1/ month to >5/week)	No clear relationship to PC	Accustomed for age, area of residence, smoking, alcohol consumption, BMI, diet, income, family history
Positive trends				
Friedenreich et al.[46b]	988 incident cases of PC, 1063 population controls, mean age 67 years	<78.5 vs. >25.1 MET h/ week	OR 1.00, 0.80 (0.61–1.04), p=0.06 for trend	Accustomed for age, region, education, BMI, waist/hip ratio, energy intake, alcohol drinking, family and medical history

Table Continued

Author	Sample	Activity measure	Findings	Comments
Significant positive findings				
Darlington et al.[67]	752 cases from Ontario cancer registry aged 50–84 years, telephone listing controls	Strenuous activity mid-teens, early 30 s, early 50 s (yes/no)	OR for strenuous activity in teens =1.0 (0.8–1.2), early 30 s=0.9 (0.7–1.0), early 50 s=0.8 (0.6–0.9).	Attuned for age, education, BMI, family history, occupation
Jian et al.[68]	130 histologically confirmed cases of PC, 274 controls, aged <65 to >75 years	Reported MET hours of moderate and total activity (<40 vs >120; <44 vs. >135)	OR moderate activity <40=1.0, <80=0.47 (0.22–1.02), <120=0.46 (0.21–0.99), >120=0.20 (0.07–0.62), p=0.015, Total activity <44=1.0, <90=0.42 (0.18–0.99), <135=0.36 (0.16–0.86), >135=0.39 (0.15–0.99), p=0.50 for trend)	Accustomed for age, area of residence, education, salary, marital status, number of children, years in labour force, family history, BMI, energy intake
Yu et al.[69]	1162 cases of PC; 3124 matched hospital controls, age <45 to >75 years	Leisure activity (active, moderate, or seldom)	Risk higher in sedentary (OR seldom = .3 (1.0–1.6), moderate = 1.1 (0.9–1.3) active = 1.0 (p=0.03)	Attuned for age

BMI, body mass index; HR hazard ratio; MET, metabolic equivalent; ns non-significant; NHANES, National Health and Nutrition Examination Survey; OR, odds ratio; PC, prostate cancer; RR, relative risk; SES, socioeconomic status

Table 3 Sports involvement, attained aerobic fitness, and risk of prostate cancer

Author	Sample	Activity measure	Findings	Comments
Cohort studies				
Merrill et al.[70]	PSA levels of 536 partakers in senior citizen games aged >50 years	Years active >3 times/week	Total physical activity unrelated to PSA levels	Attuned for age
Wannamethee et al.,[64b]	Potential study of 7588 men aged 40–59 years; 120 incident cases of PC	Sporting activity (none, >1/month, >1/week, >2/week)	RR none =1.00, <1/month =0.98, >1/month to 1/week =0.63, >2/week =0.53, p=0.05	Attuned Age, smoking, alcohol, BMI, SES
Zeegers et al.[34c]	58,279 men aged 55–69 years; 1386 cases of PC over 9.3 years	Sport involvement (never/ever; frequency; duration, year)	Sport involvement unrelated to PC	Attuned for age, alcohol consumption, BMI, energy intake, family history, education
Case-control studies				
Hållmarker et al.[72]	185,412 partakers in Vasaloppet ski contest and 184,617 non-participants	1827 vs. 1435 cases PC	HR 1.22 (1.13–1.30) backing non-participants	Non-participants matched for age, sex, county of residence
Galvão[73]	57 prostate cancer patients, aged 70.0±8.4 year	Randomized to multimodal supervised aerobic, resistance, and flexibility exercises undertaken thrice weekly (exercises (EX); n=28) or usual care (care controls (CON); n=29) for 3 months.	A significant difference between groups for self-reported physical functioning (3.2 points; 95% confidence interval, 0.4–6.0 points; P=0.028) and lower body muscle strength (6.6 kg; 95% confidence interval, 0.6–12.7; P=0.033) at 3 months favouring EX.	With bone metastases

BMI, body mass index; HR, hazard ratio; ns non-significant; PC, prostate cancer; PSA, prostate serum antigen; RR, relative risk; SES, socioeconomic status; EX, exercises

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Possible biological mechanisms linking exercise and prostate cancer

EL Richman et al.[74] Observed that walking pace was related to a lesser risk of prostate cancer independently of walking period, they stated that men who walked 3 or more hours/week at a brisk pace had a 57% lower risk of prostate cancer. Physical Activity may affect prostate cancer progression by reducing insulin resistance, decreasing bioavailable Insulin-like growth factor 1 (IGFI), increasing adiponectin levels and circulating levels of insulin[75] (Figure 2). Interleukin 6 **(**IL-6) promotes cell proliferation and inhibits apoptosis of prostate cancer cells in vitro;[76] however, physical activity is associated with lower circulating IL-6.[77] There is an increase in tumor blood flow in animal models, during intense endurance exercise, due to the change in vasculature, thus causing an upsurge in tumor perfusion and oxygenation and in turn decreases the propensity for metastasis.[78] Regulation of tumor vasculature might be a likely biological mechanism through which exercise prevents prostate cancer progression. Elevated serum levels of IGF-1, leptin and insulin are related to higher risk of prostate cancer progression.[79,80] LNCaP cells cultured with post exercise serum, expresses reduction in cell proliferation and increased apoptosis.[81]

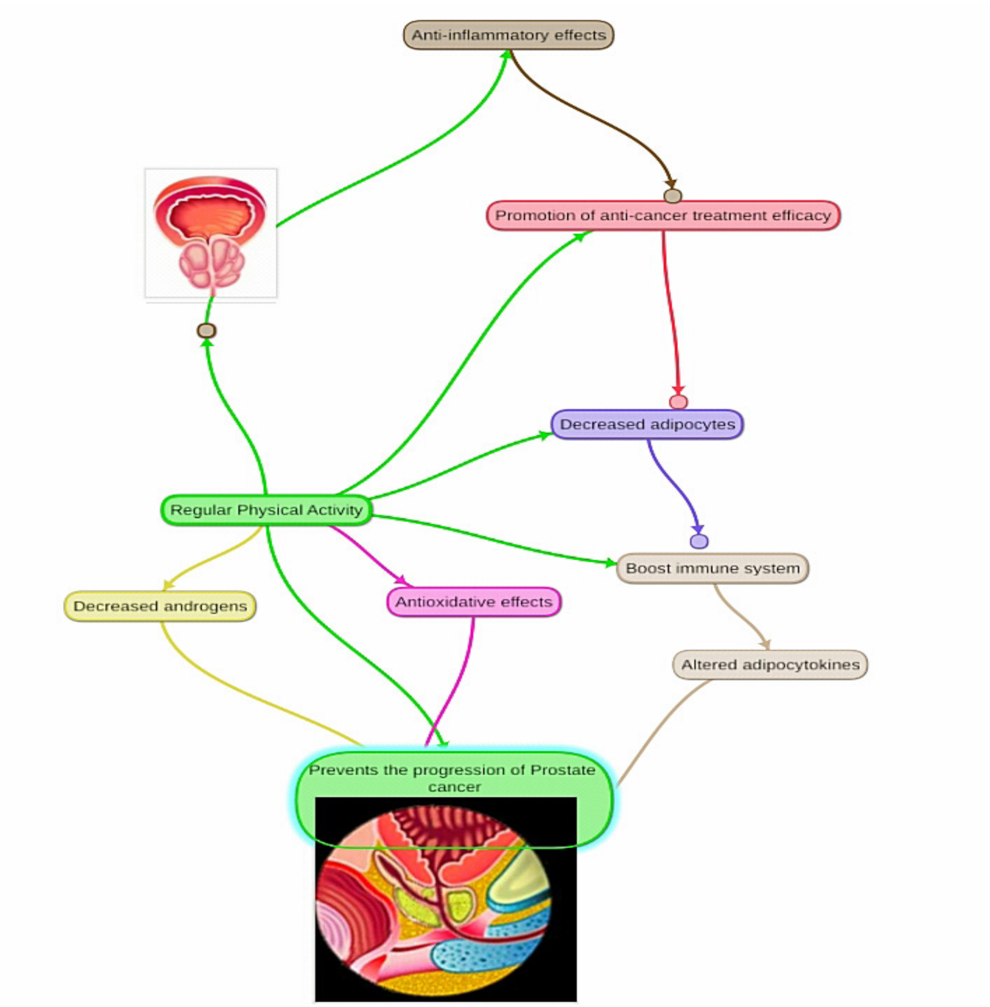

Figure 2 Possible Biological mechanisms linking Physical activity and Prostate Cancer.

Exercise lessens the side effects associated with androgen deprivation treatment for Prostate cancer.[82] Aerobic exercise exerts cardio-protective effects in animal-subjected to ADT.[83] Exercise results to an upsurge in the production of sex hormone–binding globulin (SHBG), dropping testosterone levels.[84] Exercise boost antioxidant-enzyme repair mechanisms and drops lipid peroxidation levels, in turn plummeting free radicals and minimizing oxidative stress.[85] Regular physical activity combined with lifestyle adjustment and exogenous natural supplements in addition to the pharmacological, surgical and radiotherapeutic treatment of prostate cancer may enable clinicians to attain the anticipated treatment goal.

Conclusion

Based on the information obtained and analysed in this study, a practical exercise and activity goal personalized for prostate cancer patients to increase their chances of survival would be a multidimensional tactic to decrease central adipose tissue deposition and to lessen circulating levels of inflammation, insulin, and unfavourable sex hormones. Further studies aimed to assess the most effective exercise therapy and actual dose, personalised according to patients' clinical status for averting prostate cancer progression are vital in order to develop a comprehensive prevention and treatment goal for prostate cancer. Physical activity levels, ranging from walking to more intense activities and exercise routines, offers unique benefits. data from Randomized trials continue to accumulate regarding the positive effects of exercise on treatment outcomes for men with prostate cancer and the implementation of exercise during and after treatment for prostate cancer ought to be part of the standard of care and treatment goal. The radiation oncologists are provided with exceptional chance to restate healthy lifestyle methods and modifications owing to the extensive time spent with patients on a weekly basis during treatment. Prostate cancer treatment is one of the lengthiest treatment regimens, and the oncologist is given several opportunities to recommend and aid to implement exercise and lifestyle changes.

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Conflicts of interest

The author declares there is no conflict of interest.

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