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Exercise and Cancer: The Impact of Physical Activity

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Learning Objectives

-Examine the effect of exercise on cancer prevention.

-Examine the evidence of specific benefits of exercise in cancer patients.

-Learn the important relationship of body composition to cancer.

-Consider how to broaden the view of exercise.

-Make a plan to get started or increase exercise.

Historical recognition of exercise for health

- An Indian physician, Sushruta in 600 BC was the first to prescribe exercise for health.
  - -He referred patients to exercise because “it made the body stout, strong, firm, compact, and light, enhanced the growth of limbs and muscles, improved digestion and complexion, prevented laziness, and reduced senility”
- Hippocrates from 460 to 370 BCE said “eating alone will not keep a man well, he must also take exercise”

Historical observation of lifestyle and cancer

Energy Balance and the tumor microenvironment

- Ewing in 1911 noted that the poor did not develop cancer, which tended to victimize wealthy individuals.

- Siversten and Dahlstrom in 1921 noted: “Human carcinoma may be the reaction to and result of chronic irritation of adult epithelial tissue bathed in body fluids altered by certain metabolic products as a result of deficient muscular activity.”

Historical observation about energy balance

Energy Balance and Cancer

- FL Hoffman in 1937- retrospective study of 4000 people (2234 cancer patients, 1149 controls) given a lengthy questionnaire. The conclusion was that “excess nutrition demanded an outlet in physical activity which is rarely met with in modern life.” Hoffman felt that the latent power of growth and development likely found an outlet in cell proliferation.

Health benefits of regular physical activity

Lower risk of all-cause mortality
Lower risk of cardiovascular disease mortality
Lower risk of cardiovascular disease (including heart disease and stroke)
Lower risk of hypertension
Lower risk of type 2 diabetes
Lower risk of adverse blood lipid profile
Lower risk of cancers of the bladder, breast, colon, endometrium, esophagus, kidney, lung, and stomach
Improved cognition
Reduced risk of dementia (including Alzheimer disease)
Improved quality of life
Reduced anxiety
Reduced risk of depression
Improved sleep
Slowed or reduced weight gain
Weight loss, particularly when combined with reduced calorie intake
Prevention of weight regain following initial weight loss
Improved bone health
Improved physical function
Lower risk of falls (older adults)
Lower risk of fall-related injuries (older adults)
For pregnant women, reduced risk of excessive weight gain, gestational diabetes, and postpartum depression
For people with various chronic medical conditions, reduced risk of all-cause and disease-specific mortality, improved physical function, and improved quality of life

Reproduced from: US Department of Health and Human Services. Physical Activity Guidelines for Americans, 2nd edition, US Department of Health and Human Services, Washington, DC

Primary Cancer Prevention

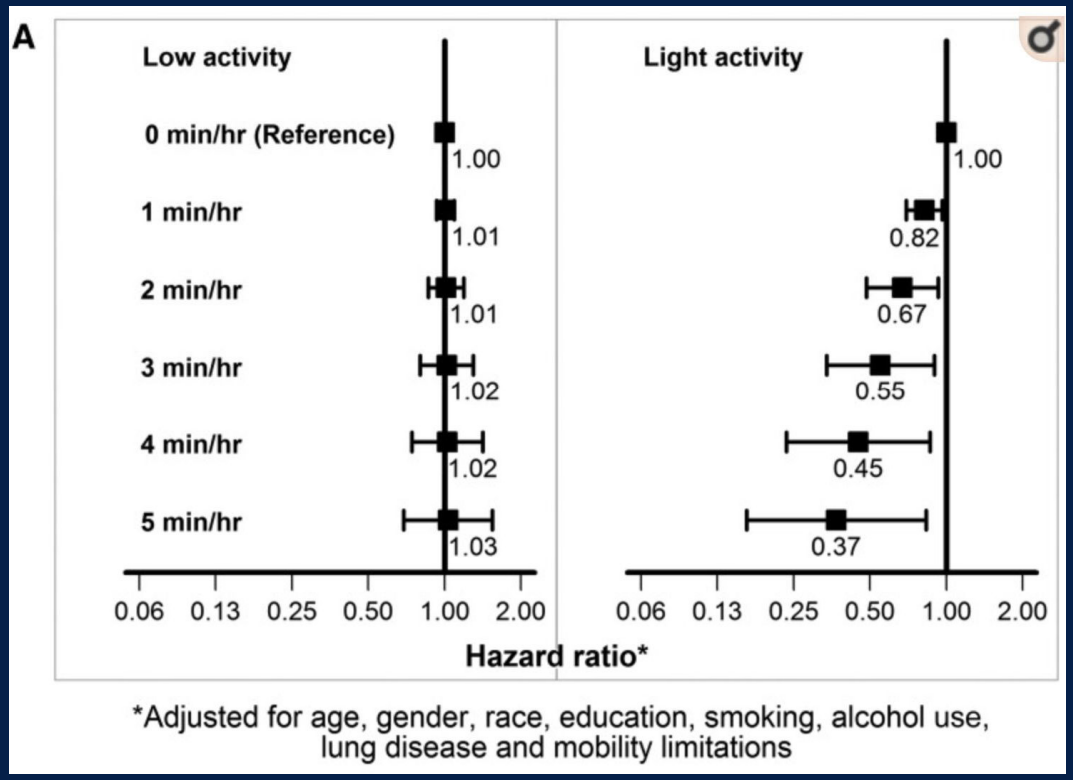
One in three patients in the United States will be diagnosed with cancer.

What are the way we can prevent cancer?

- Avoiding tobacco.
- Avoiding alcohol.
- Maintaining a healthy body weight.
- Eating a healthy diet.
- Getting vaccinated for HPV and hepatitis B.
- Wearing sunscreen.
- Engaging in Exercise.

Sedentary Living Research

Even as little as 2 minutes of activity per hour conferred a survival benefit



Beddhu et al, Clin J Am Soc Nephrol. 2015; UTD; Gordon et al, J Cardiopulm Rehabil. 1993

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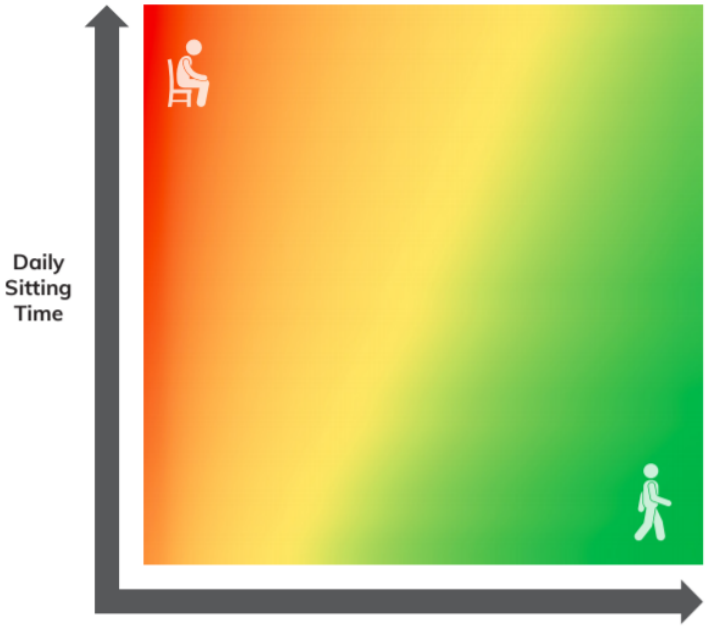
Sitting is the new smoking…

Sedentary behavior is second only to smoking as the leading preventable cause of cancer in the US.

Figure 1-3. Relationship Among Moderate-to-Vigorous Physical Activity, Sitting Time, and Risk of All-Cause Mortality in Adults



Risk of all-cause mortality decreases as one moves from red to green.

Sedentary behavior =

increased risk of cancer of the

-breast

-colon

-endometrium

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Figure 2-1. Relationship of Moderate-to-Vigorous Physical Activity to All-Cause Mortality

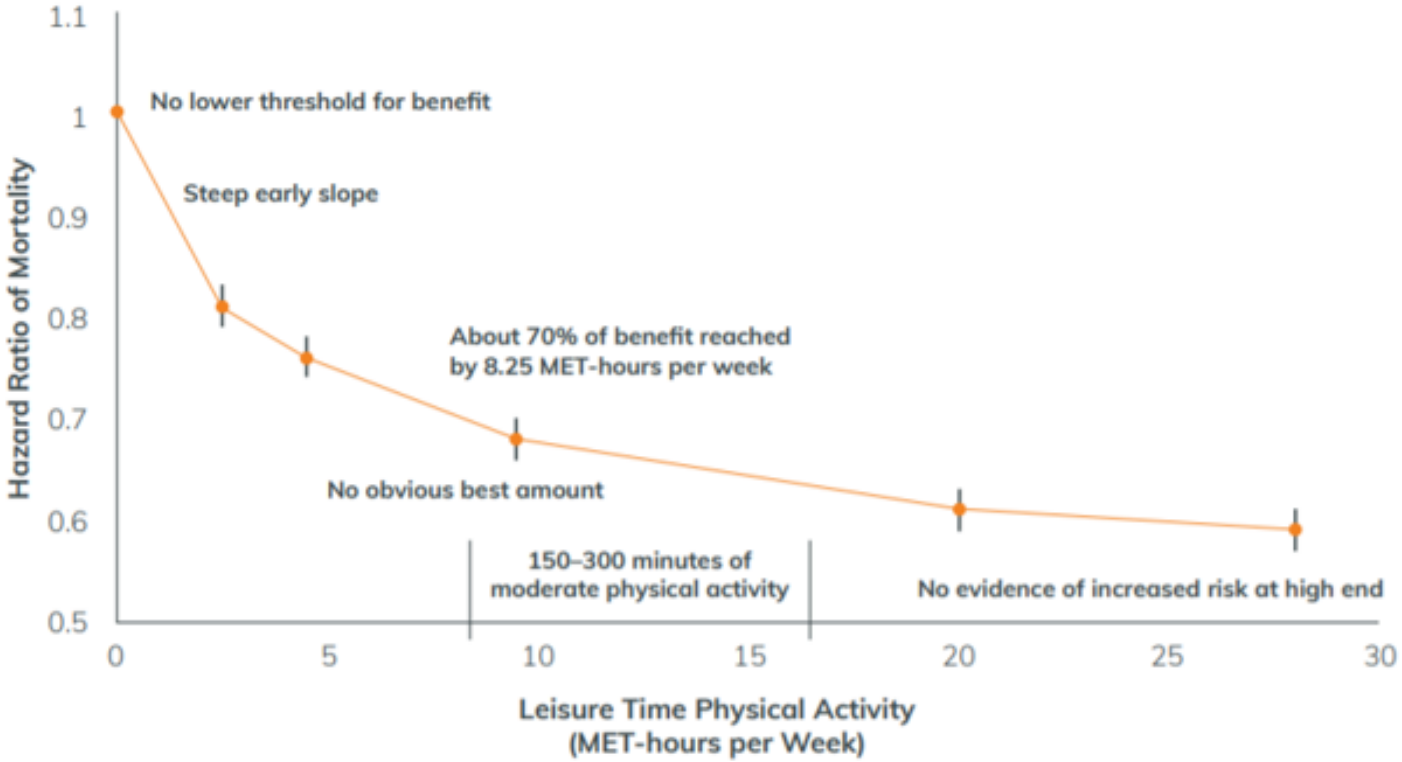
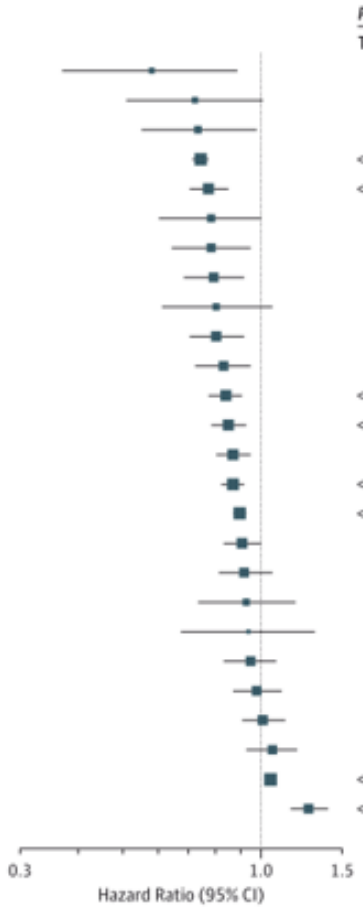


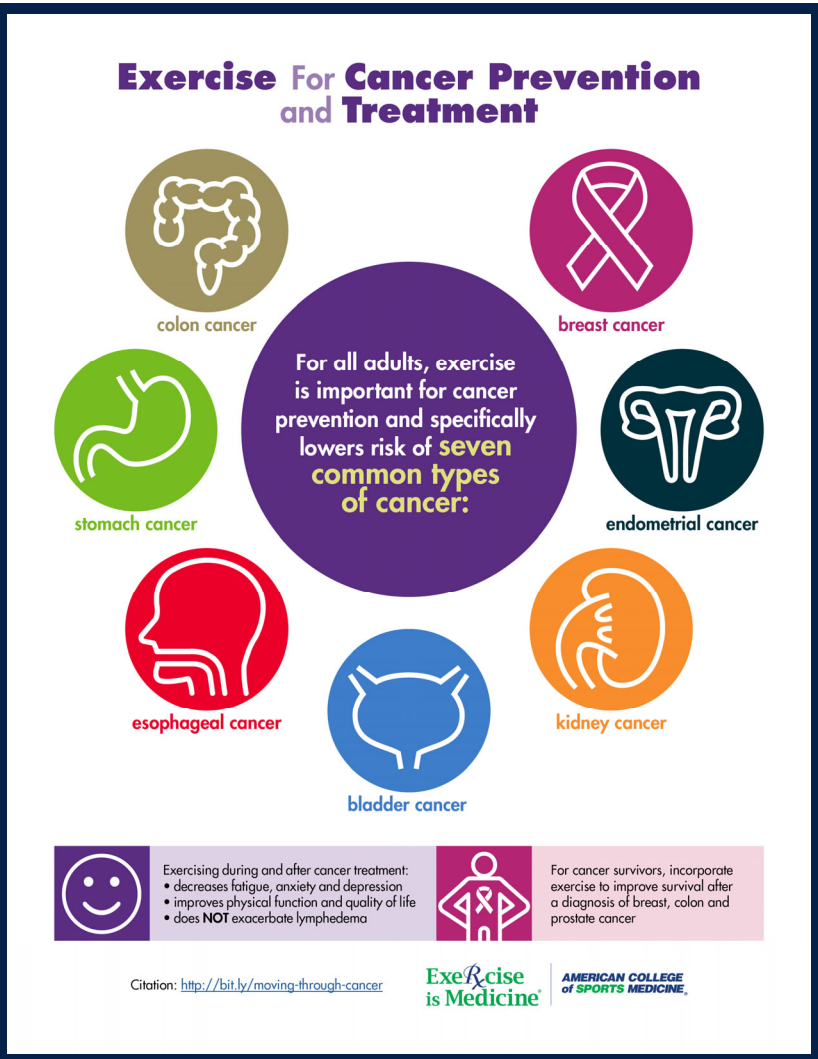
Figure 1. Summary Multivariable Hazard Ratios for a Higher (90th Percentile) vs Lower (10th Percentile) Level of Leisure-Time Physical Activity by Cancer Type

Cancer	Studies, No.	Cases, No.	HR (95% CI)	*P* Value Trend	*P* Value Heterogeneity[a]
Esophageal adenocarcinoma	5	899	0.58 (0.37-0.89)	.01	.01
Gallbladder	6	382	0.72 (0.51-1.01)	.06	.29
Liver	10	1384	0.73 (0.55-0.98)	.04	.02
Lung	12	19133	0.74 (0.71-0.77)	<.001	.47
Kidney	11	4548	0.77 (0.70-0.85)	<.001	.40
Small intestine	7	503	0.78 (0.60-1.00)	.05	.85
Gastric cardia	6	790	0.78 (0.64-0.95)	.02	.99
Endometrial	9	5346	0.79 (0.68-0.92)	.003	.001
Esophageal squamous	6	442	0.80 (0.61-1.06)	.12	.78
Myeloid leukemia	10	1692	0.80 (0.70-0.92)	.002	.78
Myeloma	9	2161	0.83 (0.72-0.95)	.008	.36
Colon	12	14160	0.84 (0.77-0.91)	<.001	.01
Head and neck	11	3985	0.85 (0.78-0.93)	<.001	.45
Rectum	12	5531	0.87 (0.80-0.95)	.001	.38
Bladder	12	9073	0.87 (0.82-0.92)	<.001	.84
Breast	10	35178	0.90 (0.87-0.93)	<.001	.30
Non-Hodgkin lymphoma	11	6953	0.91 (0.83-1.00)	.05	.18
Thyroid	11	1829	0.92 (0.81-1.06)	.26	.48
Gastric noncardia	7	1428	0.93 (0.73-1.19)	.56	.09
Soft tissue	10	851	0.94 (0.67-1.31)	.70	.03
Pancreas	10	4186	0.95 (0.83-1.08)	.40	.14
Lymphocytic leukemia	10	2160	0.98 (0.87-1.11)	.73	.99
Ovary	9	2880	1.01 (0.91-1.13)	.81	.98
Brain	10	2110	1.06 (0.93-1.20)	.41	.43
Prostate	7	46890	1.05 (1.03-1.08)	<.001	.90
Malignant melanoma	12	12438	1.27 (1.16-1.40)	<.001	.02



Exercise for Cancer Prevention: tumors with the strongest evidence.

- Colon
- Stomach
- Esophagus
- Bladder
- Kidney
- Uterine
- Breast



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Exercise for Prevention of Cancer

Specific recommendations for minimum exercise dose for cancer prevention

- Limit Sedentary Behavior
- Engage in at least 150 minutes a week of moderate exercise or 75 minutes a week of intense exercise.
- Engage in strength training exercise for all major muscle groups at least twice a week.

How Does Exercise Help Cancer Patients?

- Enhances the immune system.
- Lowers Systemic Inflammation
- Lowers Stress Hormones
- Changes the Microbiome
- Lowers estrogen levels by decreasing body fat.
- Improves body composition
- Improves heart and lung function
- Improves cognition –brain function.

Exercise and health related outcomes in cancer patients

Outcome	Aerobic Only	Resistance Only	Combination (Aerobic + Resistance)
Strong Evidence	Dose	Dose	Dose
Cancer-related fatigue	**3x**/week for **30** min per session of moderate intensity	**2x**/week of **2** sets of **12-15** reps for major muscle groups at moderate intensity	**3x**/week for **30** min per session of moderate aerobic exercise, plus **2x**/week of resistance training **2** sets of **12-15** reps for major muscle groups at moderate intensity
Health-related quality of life	**2-3x**/week for **30-60** min per session of moderate to vigorous	**2x**/week of **2** sets of **8-15** reps for major muscle groups at a moderate to vigorous intensity	**2-3x**/week for **20-30** min per session of moderate aerobic exercise plus **2x**/week of resistance training **2** sets of **8-15** reps for major muscle groups at moderate to vigorous intensity
Physical Function	**3x**/week for **30-60** min per session of moderate to vigorous	**2-3x**/week of **2** sets of **8-12** reps for major muscle groups at moderate to vigorous intensity	**3x**/week for **20-40** min per session of moderate to vigorous aerobic exercise, plus **2-3x**/week of resistance training **2** sets of **8-12** reps for major muscle group at moderate to vigorous intensity
Anxiety	**3x**/week for **30-60** min per session of moderate to vigorous	Insufficient evidence	**2-3x**/week for **20-40** min of moderate to vigorous aerobic exercise plus **2x**/week of resistance training of **2** sets, **8-12** reps for major muscle groups at moderate to vigorous intensity
Depression	**3x**/week for **30-60** min per session of moderate to vigorous	Insufficient evidence	**2-3x**/week for **20-40** min of moderate to vigorous aerobic exercise plus **2x**/week of resistance training of **2** sets, **8-12** reps for major muscle groups at moderate to vigorous intensity
Lymphedema	Insufficient evidence	**2-3x**/week of progressive, supervised, program for major muscle groups does not exacerbate lymphedema	Insufficient evidence

https://www.exerciseismedicine.org/assets/page_documents/exercise-guidelines-cancer-infographic.pdf

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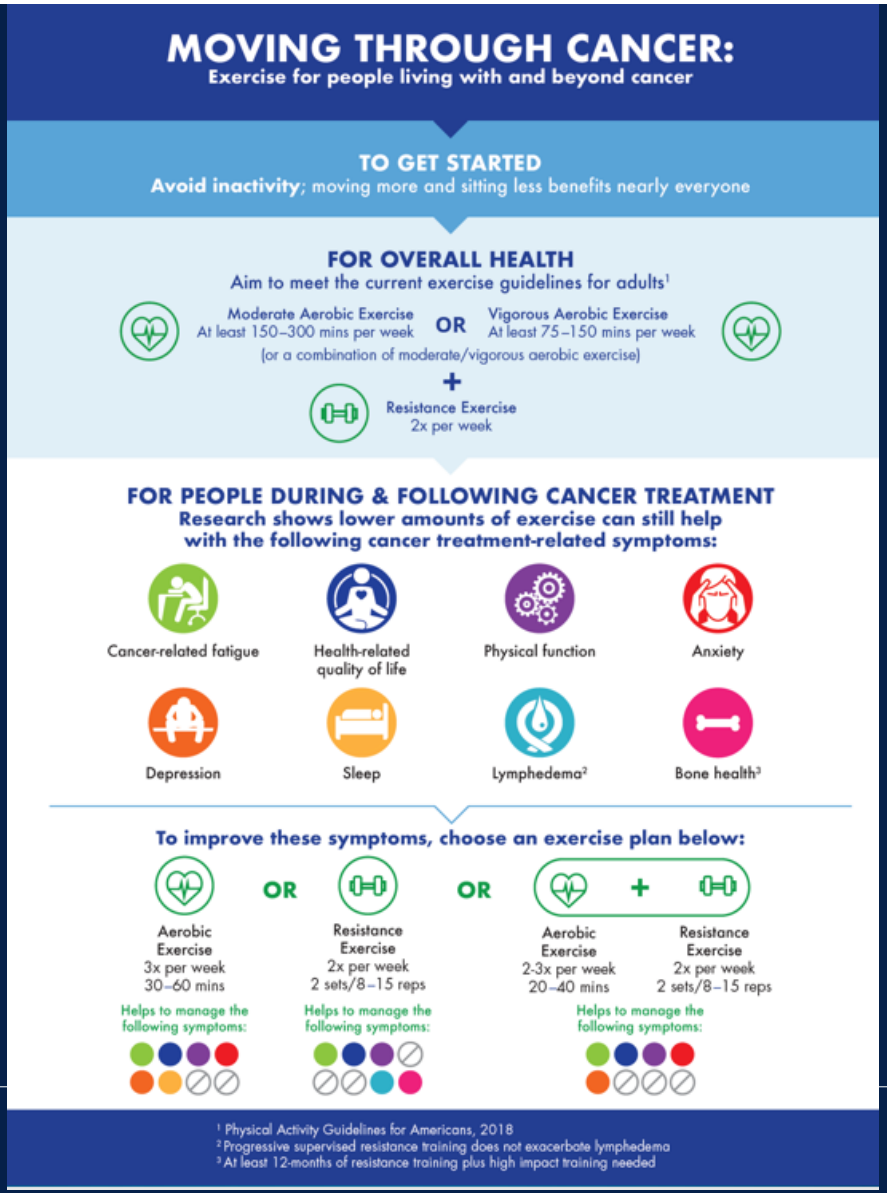
MOVING THROUGH CANCER:
Exercise for people living with and beyond cancer
TO GET STARTED
Avoid inactivity; moving more and sitting less benefits nearly everyone
FOR OVERALL HEALTH
Aim to meet the current exercise guidelines for adults[1]
Moderate Aerobic Exercise
At least 150–300 mins per week
OR
Vigorous Aerobic Exercise
At least 75–150 mins per week
(or a combination of moderate/vigorous aerobic exercise)
+
Resistance Exercise
2x per week
FOR PEOPLE DURING & FOLLOWING CANCER TREATMENT
Research shows lower amounts of exercise can still help with the following cancer treatment-related symptoms:
Cancer-related fatigue
Health-related quality of life
Physical function
Anxiety
Depression
Sleep
Lymphedema[2]
Bone health[3]
To improve these symptoms, choose an exercise plan below:
Aerobic Exercise
3x per week
30–60 mins
Helps to manage the following symptoms:
OR
Resistance Exercise
2x per week
2 sets/8–15 reps
Helps to manage the following symptoms:
OR
Aerobic Exercise
2-3x per week
20–40 mins
+
Resistance Exercise
2x per week
2 sets/8–15 reps
Helps to manage the following symptoms:
[1] Physical Activity Guidelines for Americans, 2018
[2] Progressive supervised resistance training does not exacerbate lymphedema
[3] At least 12-months of resistance training plus high impact training needed

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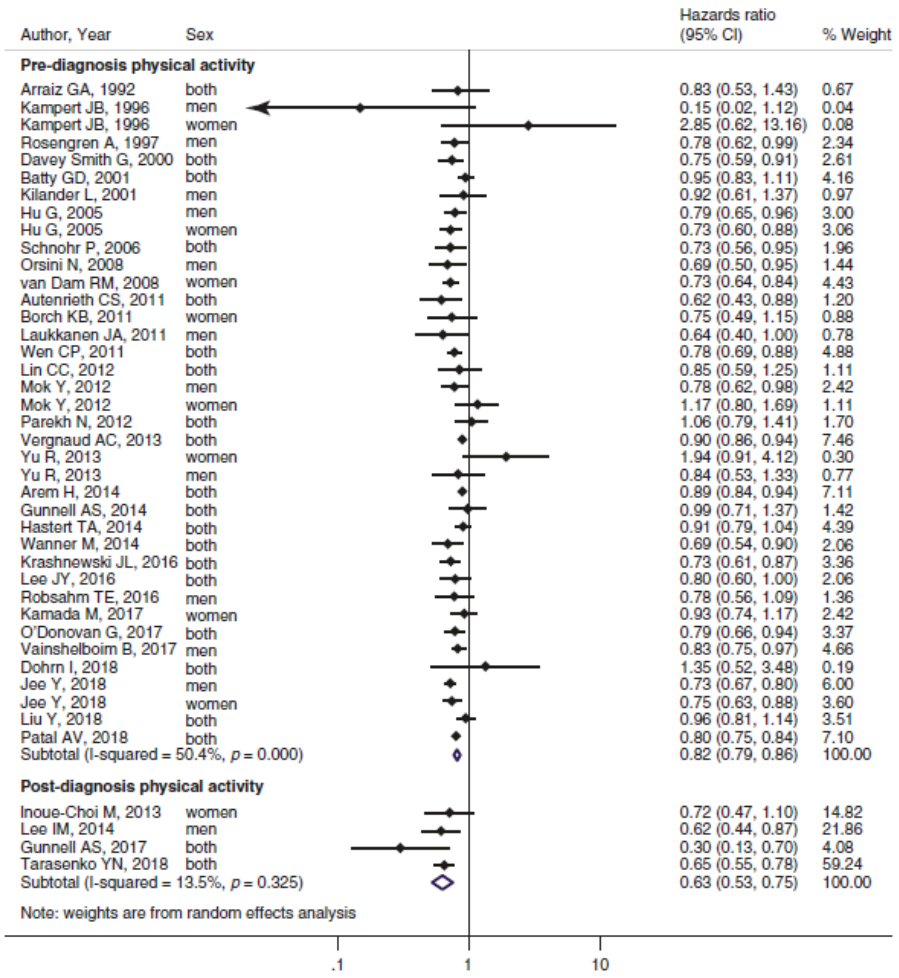

Fig. 3.1 Pre- and post-diagnosis physical activity and cancer-specific mortality for studies that combined all cancer sites

Survival and Physical Activity

- All sites pre diagnosis
- Post diagnosis:
  - Breast
  - Colon
  - Prostate

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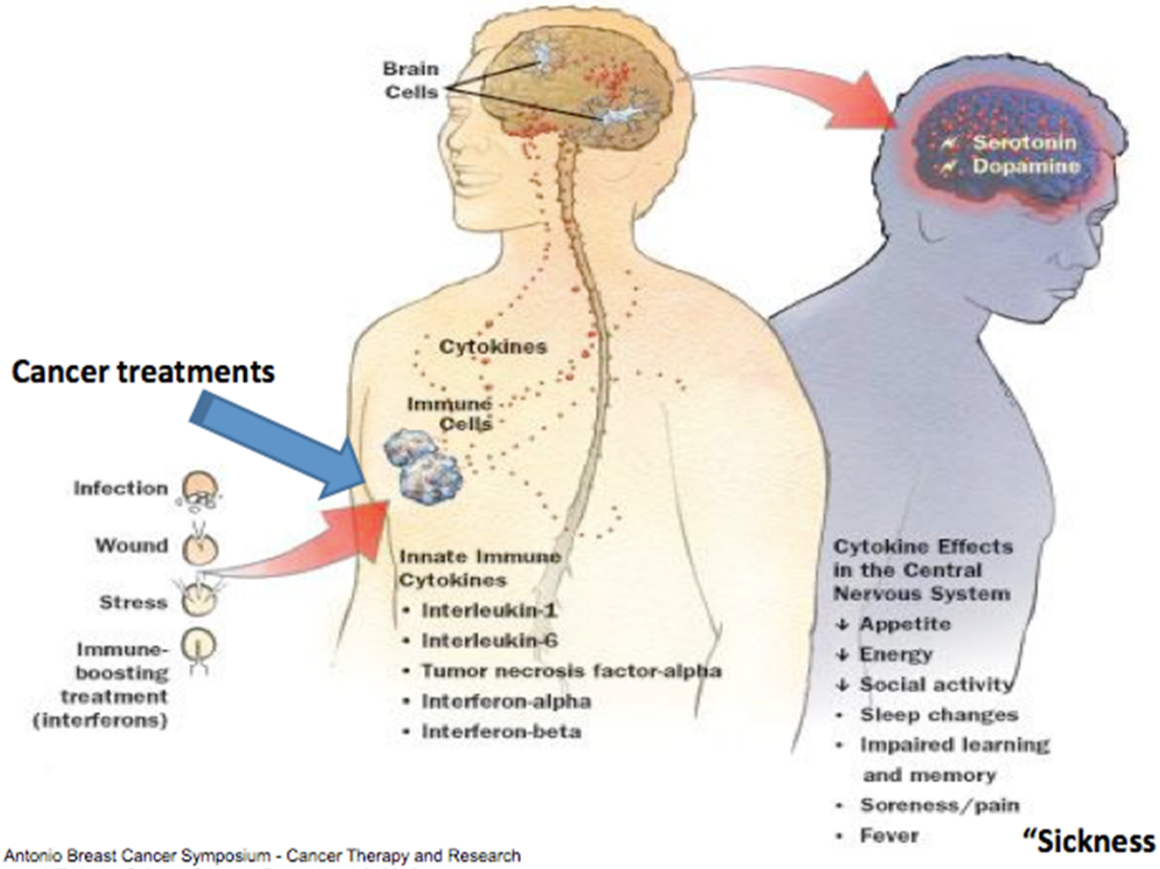
Cancer Related Fatigue (CRF)

- Distinguished from regular fatigue: a complex, multifactorial syndrome not fully helped by rest.
- Caused by systemic inflammation, dysregulation of the hypothalamic-pituitary- adrenal axis , depression, anemia and physical inactivity.
- Medications are not effective
- Exercise is the single most effective treatment.
- Those with the greatest fatigue at baseline get the greatest effects from exercise.

Tissue Trauma, Inflammation, CNS Response



San Antonio Breast Cancer Symposium - Cancer Therapy and Research Center at UT Health Science Center – December 4-8, 2012

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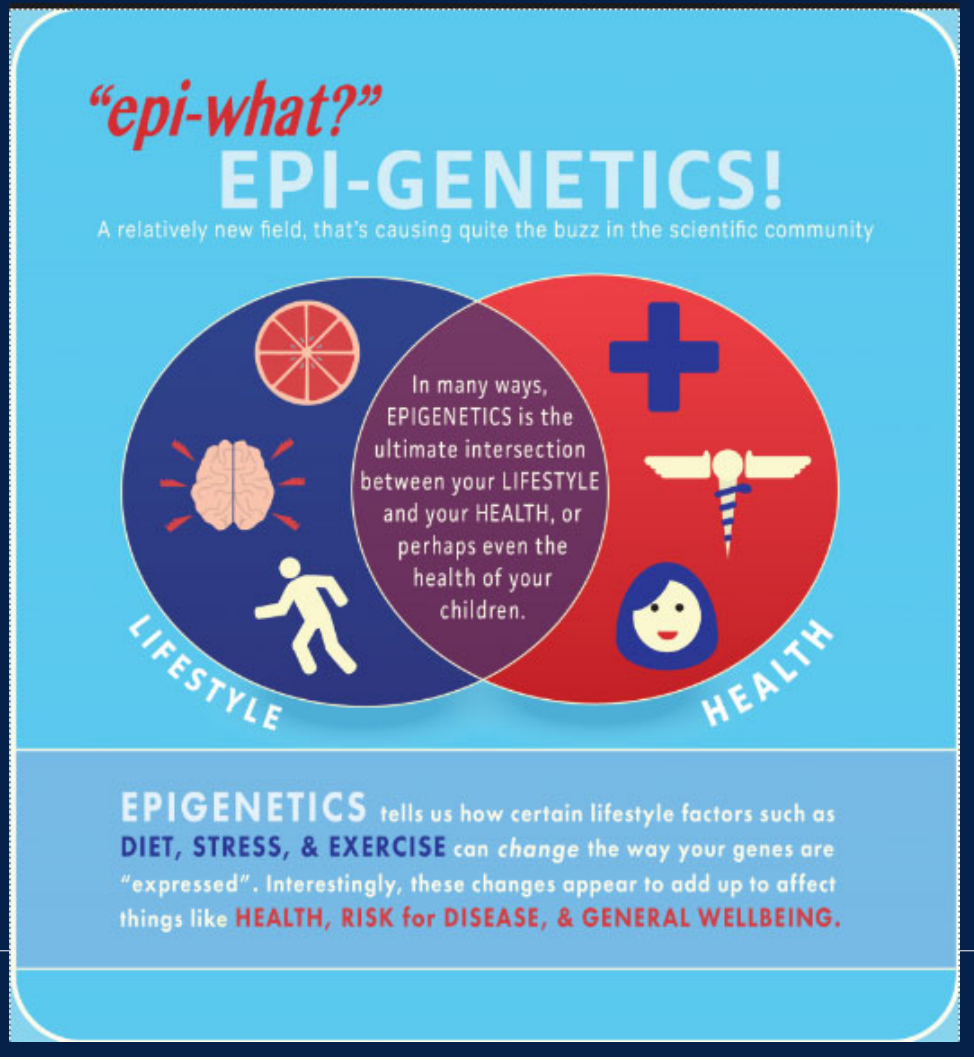
Epigenetics- the expression of genes due to environmental factors

We are not destined to be sick!!

- Food , exercise, sleep, stress, trauma, mental health, toxic exposure: all influence if a disease is manifested.
- “Genes load the gun but environment pulls the trigger.”



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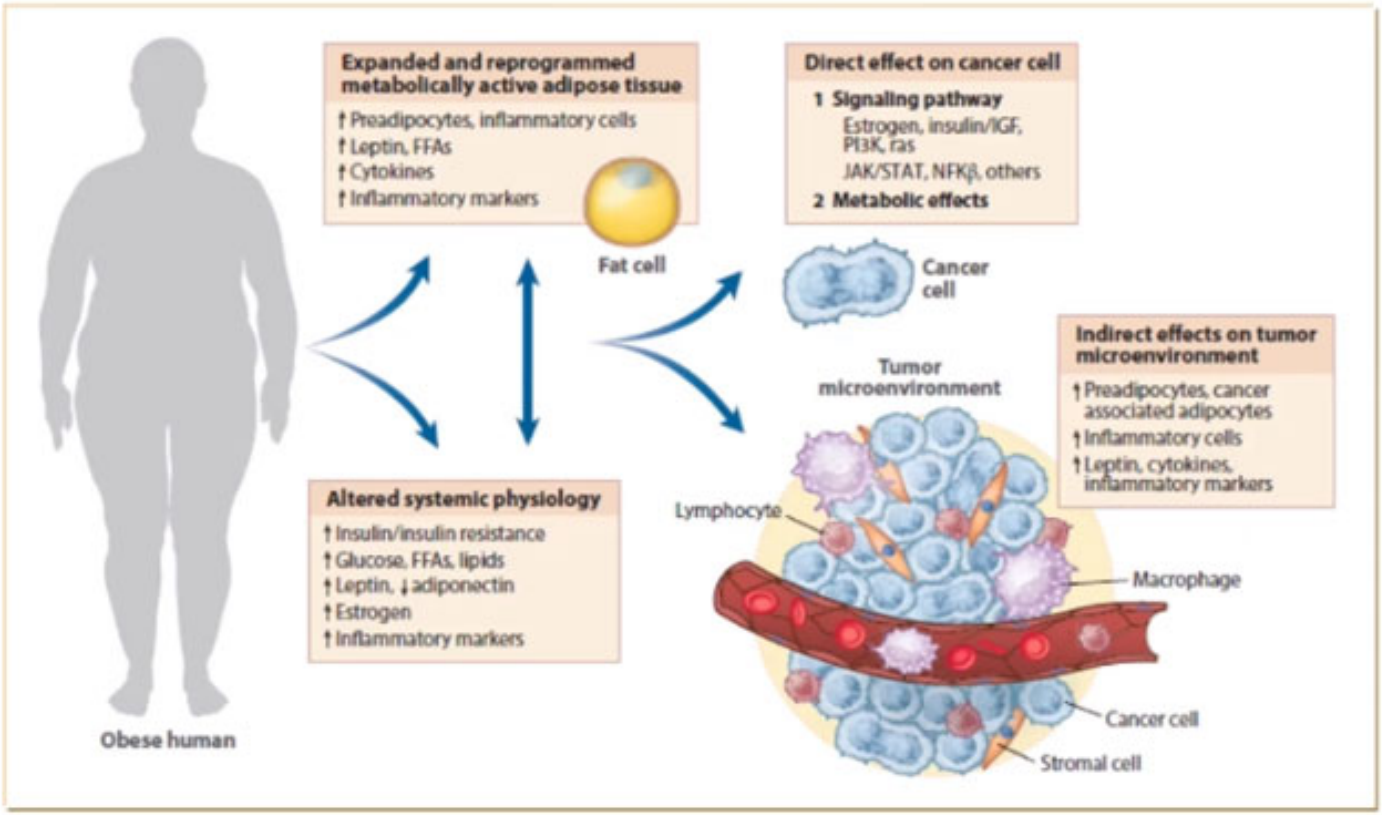
The Tumor Microenvironment.

The cells surrounding and communicating with the tumor cells



 Goodwin, PJ, Ann Rev Med 2015

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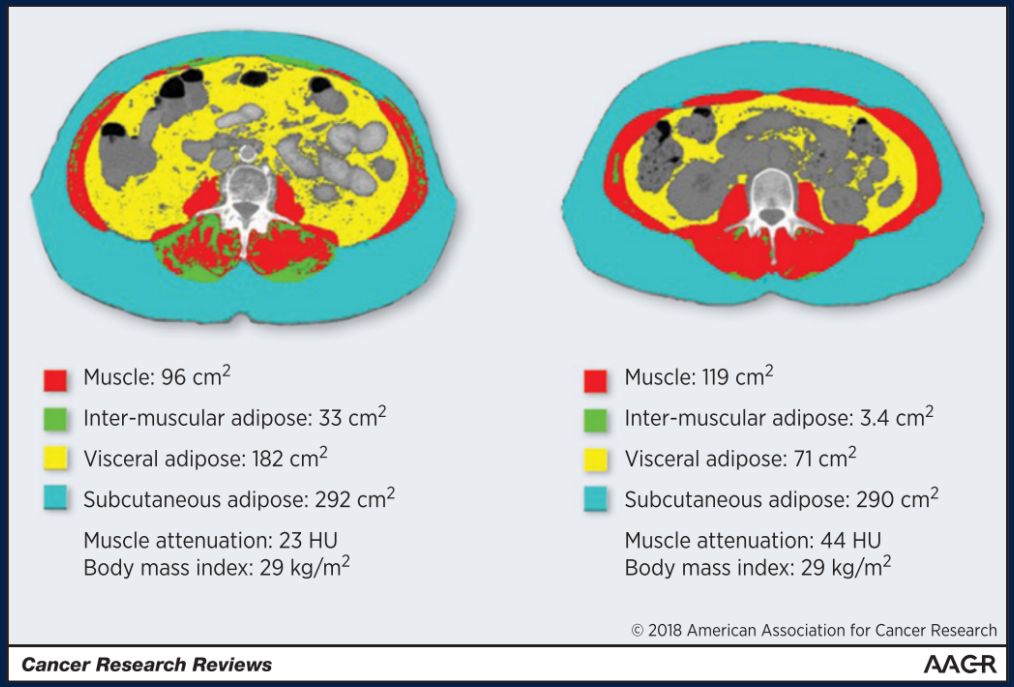
How does exercise prevent and decrease recurrence in cancer?

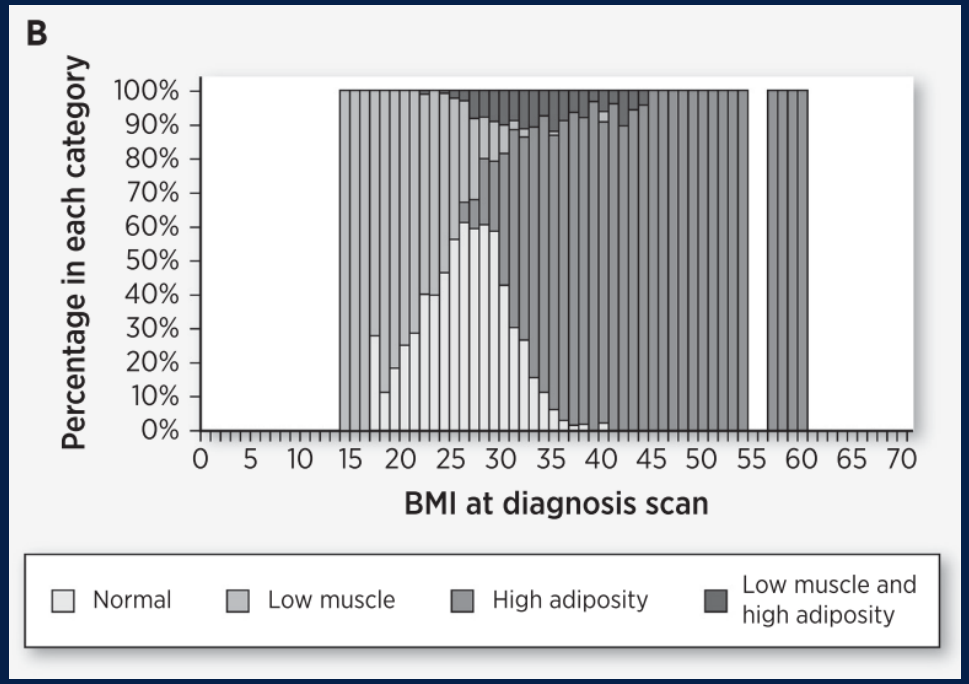
- Lowers insulin
- Lowers sex hormones
- Lowers systemic inflammation
- Lowers adipokines
- Raises myokines
- Lowers oxidative stress

- Changes the tumor microenvironment
- Stimulates the immune system – detectable in the tumor microenvironment
- Alters epigenetic expression of genes in tumor cells.

Body Mass Index (BMI)

An imperfect measure of body composition.





Caan, Cancer Res 2018.

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Non Metastatic Colon Cancer Patients

Muscle mass measured at diagnosis with CT scans

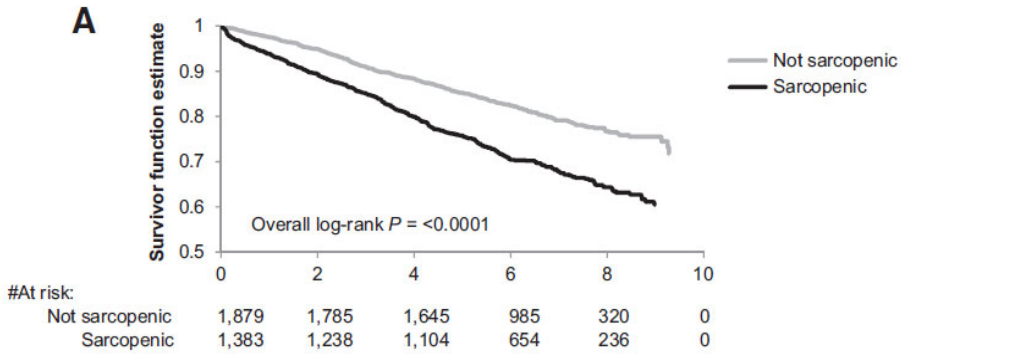
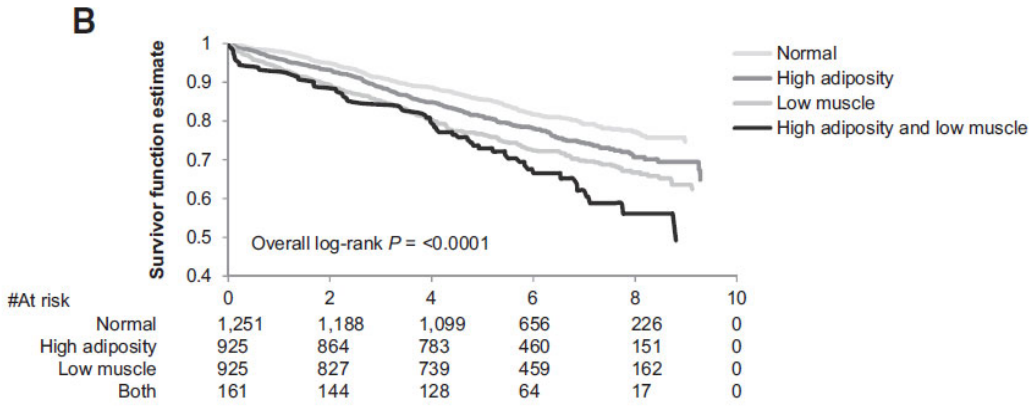


Figure 1.

A, Kaplan–Meier curves for sarcopenia and all-cause mortality. **B,** Kaplan–Meier curves for body composition phenotypes and all-cause mortality.



Caan, BJ et al, 2017 Cancer Epi Bio Prev 26:1008-1015.

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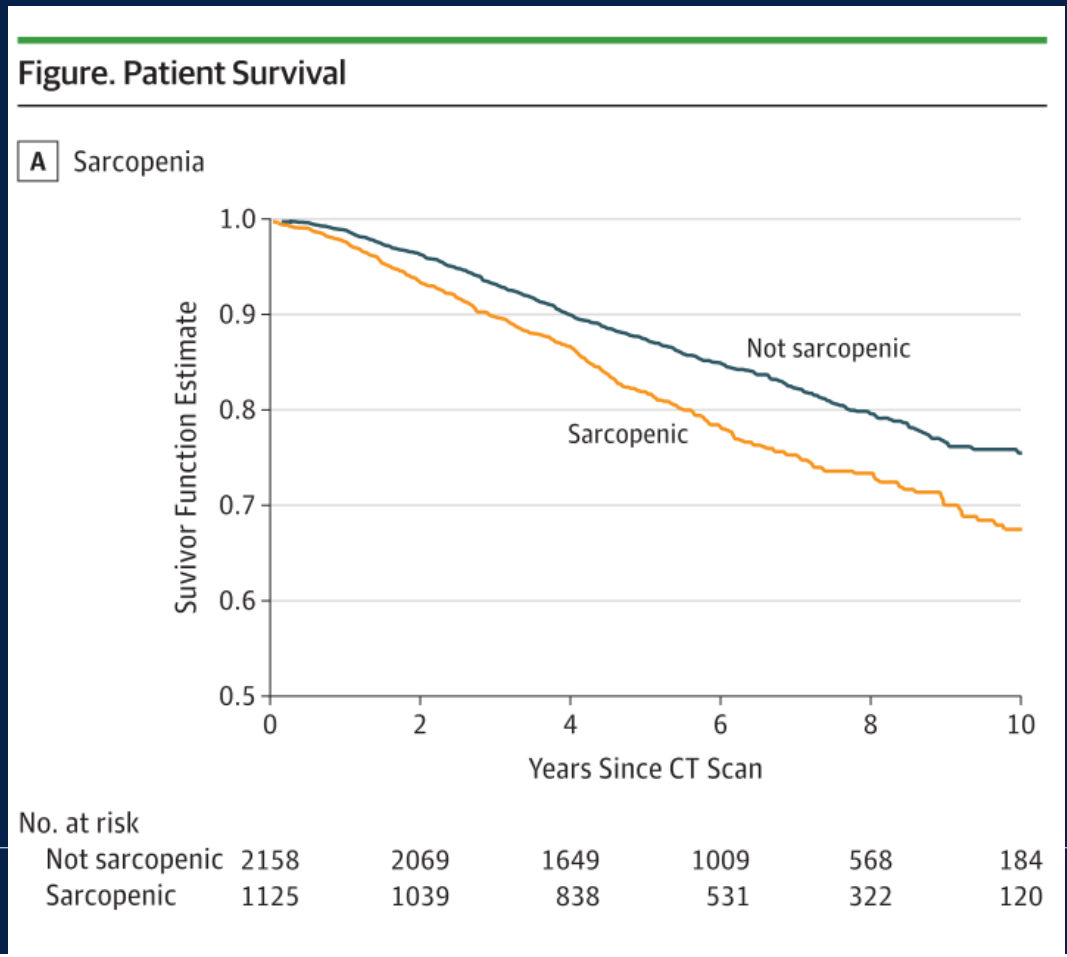
Non metastatic Breast Cancer Patients

Muscle mass measured at diagnosis with CT scans

- 1/3 of patients had sarcopenia
- Worse survival in those with sarcopenia independent of
  - Treatment
  - Stage
  - BMI.



CAAN BJ ET AL. 2018. JAMA Oncol 4: 798-804

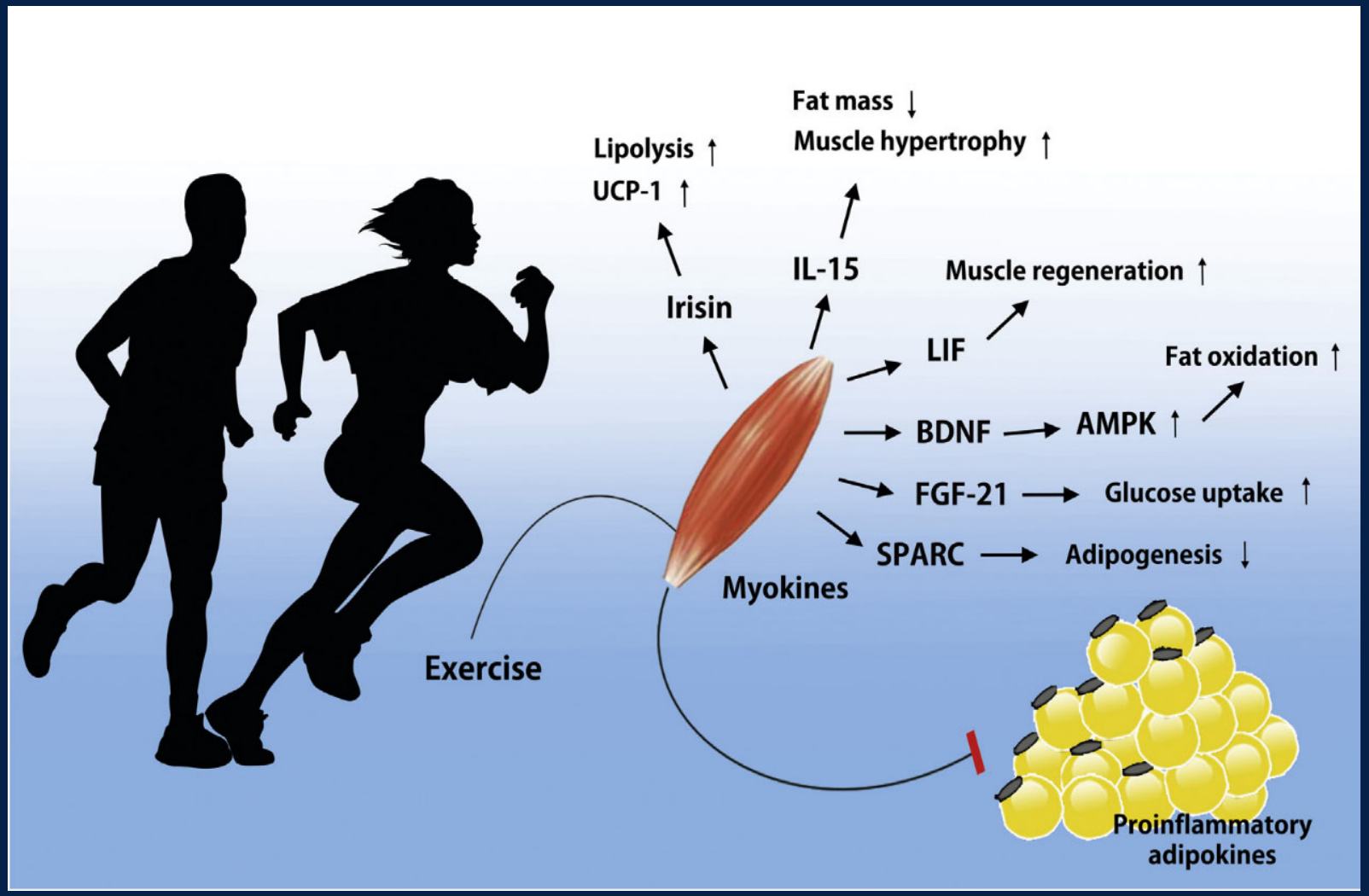
Sarcopenia – low muscle mass

- Common in cancer patients in early and late disease.
- Common with age and cancer is a disease seen with increasing age.
- Is an independent predictor of overall mortality in cancer patients.
- Low muscle mass is consistently associated with greater treatment related toxicity and higher mortality in a variety of cancers.

Risk Factors for Sarcopenia in cancer patients

- Cancer therapies: chemotherapy, radiation, hormone blockers.
- Tumor burden in metastatic disease: increased catabolism.
- Malnutrition due to treatment side effects. Poor overall or protein intake.
- Less muscle reserve with aging.
- Inactivity due to side effects causing loss of lean muscle mass.

- What does muscle do for us?



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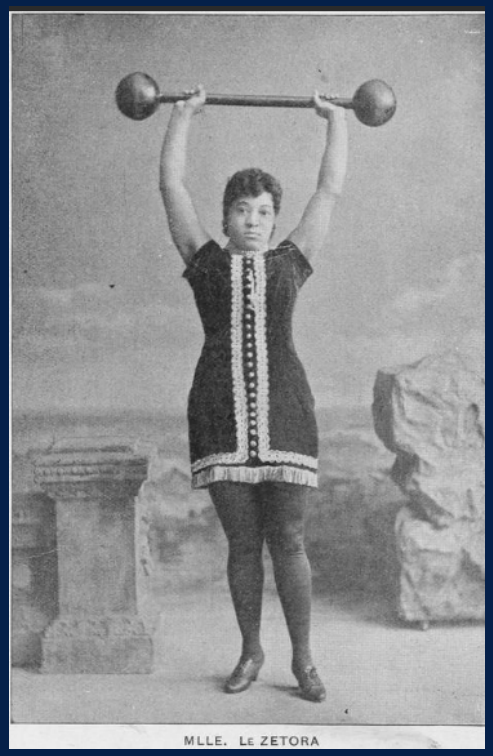
Benefits of Strength Training

- Lowers insulin more than any other type of exercise.
- Increases lean muscle mass.
- Decreases lymphedema in breast cancer patients.
- Increases strength and mobility after treatment.
- Improves quality of life.
- Lowers the risk of fractures.
- Lower risk of being placed in a nursing home.



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Strength Training and Lymphedema

Breast Cancer Patients

- Strength training is safe in breast cancer patients.

- Compared to controls patients who did resistance training had:

  - Less self reported lymphedema severity
  - Increased upper body and lower body strength
  - Less exacerbations of lymphedema when measured by a certified lymphedema therapist 14% vs 29%
  - There were no complications

Schmitz et al, N Engl J Med 2009; 361:664-673

Mind Body Movement Practices

YOGA, TAI CHI, QI GONG

- These practices are complex and incorporate body weight strength training, balance and flexibility training and stress reduction.
- This is similar to how a whole plant extract has a more complex effect than an isolated compound from a plant. For example turmeric root vs cucurmin.
- Yoga has been studied in most cancer populations and has good evidence for lymphedema, strength training, mobility, stress reduction, anxiety and cancer related fatigue.

- Yoga,Tai Chi and Qigong provide bodyweight strength training, balance training and training in flexibility/mobility.
- Good choice or additive activity for those who do not want to lift weights and want to connect to an activity that also decreases anxiety, depression, fatigue and has a meditative component.

Exercise Snacks

- Small strength training or aerobic exercises throughout the day:
- wall push ups, chair squats, a 5 minute walk
- Small amounts of strength training helps patients build confidence to do more.
- Exercise improves energy, motivation, and mood helping to get the person into a victorious cycle.

Let's Try Some Exercise Snacks!

- Chair Marches
- Overhead Hand Pumps
- Chest Punches
- Ankle Circles

Less than 25% of cancer patients are active.

- Patients feel overwhelmed with guidelines
- Cancer treatment related fatigue
- Fear of injury or lymphedema
- Fear of fractures especially in those patients with bone metastases
- Lack of education of the benefits
- Lack of knowledge of how to get started.

Guidelines to work towards

Okay to start small and have these guidelines as the goal.

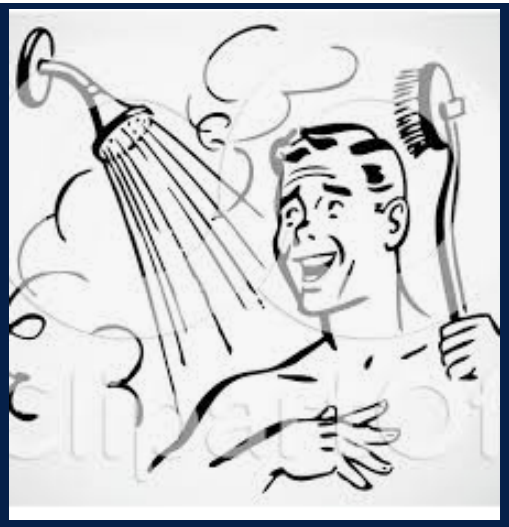
- **ACSM**

- **Cardiorespiratory Exercise:** 150+ min of moderate-intensity exercise per week.
- **Resistance Exercise:** 2-3 days/week, 2-4 sets of each exercise with 8-20 reps
- **Flexibility Exercise:** 2-3 days/week, hold stretches 10-30sec, repeat each stretch 2-4x accumulating 60sec/stretch
- **Neuromotor Exercise:** 20-30min/day, 2-3 days/week
  - -Balance, proprioception, agility

Song/ Talk Test

What intensity are you working at?

- Light: you could sing a song while engaging in the activity.
- Moderate: you could talk but not sing a song.
- Intense: you can not carry on a normal conversation.



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FITT principle

Frequency, Intensity, Time and Type of exercise

- Frequency: days per week.
- Intensity: light, moderate or intense – measured by the
- song/ talk test.
- Time: hours per week.
- Type: aerobic or muscle strengthening activity.

Tips for getting started

Log, Move, Lift, Eat, Sleep

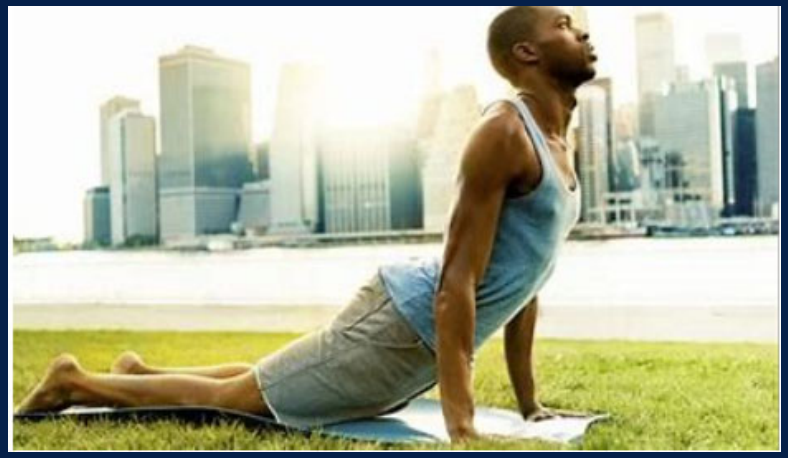
- **Log:** get a notebook and write down what you did and any symptoms like fatigue, side effects, protein intake and sleep. Logging will help you understand how you feel and when you might go easy vs push yourself. Log your FITT.
- **Move:** walk, bike, dance, swim. If you can not talk then you are working too hard. If you cannot already do 30 minutes of exercise start where you are. Any amount of exercise, even 5 minutes is still beneficial. If you can not walk you can exercise in a chair.

Log, Move, Lift, Eat, Sleep

- **Lift:** strength training with body weight, yoga or weights. Try the key 3 if you don't know where to start. Do not do strength training on consecutive days to allow for proper rest. If you can not stand you can do strength training in a chair.
- **Eat** protein as is supports muscle growth. Hydrate to support your cardiovascular system.
- **Sleep** as much as you need to feel rested. That is 7-8 hours for most adults.

5 Components of Fitness for Cancer Patients

- **Cardio**
- **Strength**
- **Balance**
- **Stretching**
- **Rest**



- **Yoga, Tai chi and Qi gong combine multiple components.**

Helpful Equipment

Yoga Mat, Adjustable Dumbbells, Resistance Bands

Adjustable Dumbbells OR Resistance Bands

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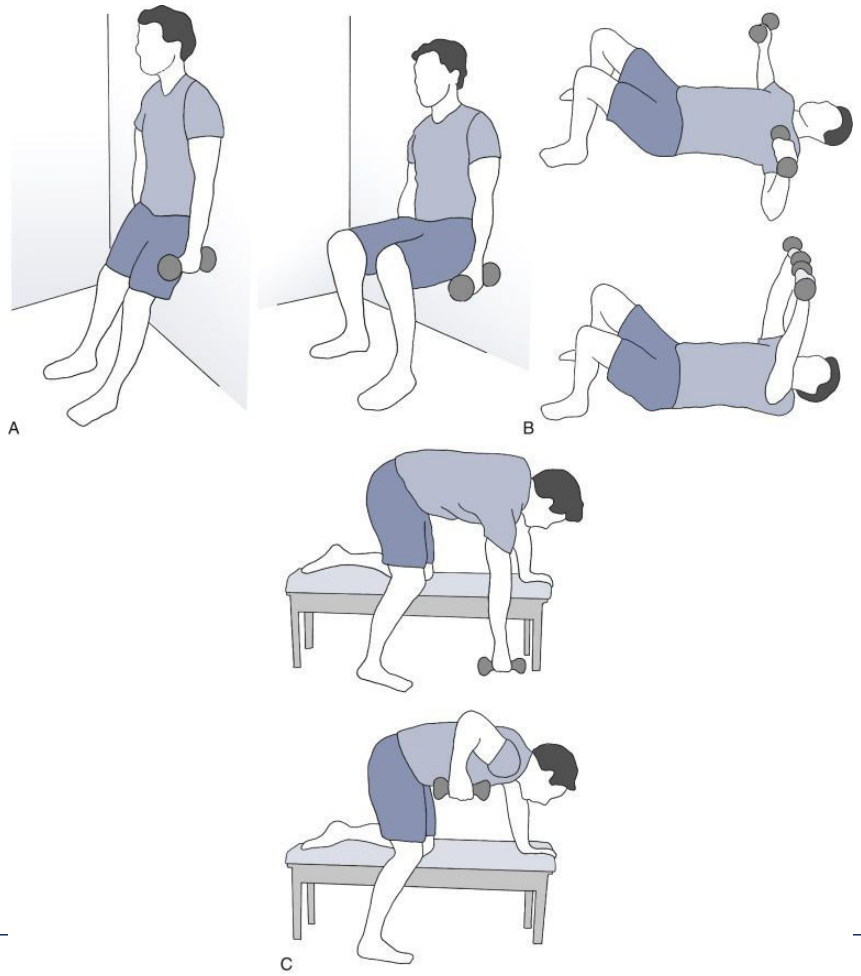
Exercise Prescriptions – Key 3 Strength Program



(Rakel; Hewitt, Canyon Ranch, 2002)

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Overcoming Barriers

Suggestions for helping you stick with it

- Start with exercise snacks during the day
- Set a workday walking routine
- Find a partner
- Exercise at home
- Use a DVD or internet based fitness program
- Use tools to measure steps like a pedometer
- Increase time and intensity as you are able
- Join a gym or work with a fitness professional

Psychology of Exercise

Questions to ask yourself and explore with your health care provider.

- What do you feel you are doing a good job with concerning exercise?
- What activity would you most like to do if you start exercising?
- Are there barriers to starting this exercise? How could they be overcome?
- Can you commit to taking some steps to become more active over the next few weeks?

Strength Training

Options for Everyone

- Body Weight Exercises – press, push ups, squats, lunges, plank and side plank.
- -If chair bound can do strength training in chair and chair yoga.
- Yoga, Pilates, Tai Chi, Qi Gong
- Weightlifting basics: squats, lunges, deadlift, row and press
  - Push and pull for upper and lower body
  - Key 3 is a easy way to start uses 80% of major muscle groups.

Parting Reflections on Exercise

Never Do Nothing! Change the way you look at Exercise!

- Any exercise is better than none! A little exercise goes a long way and is additive during the day.
- Exercise helps independent of weight loss or BMI.
- Increasing muscle mass, fighting sarcopenia and increasing relative strength for aerobic activity is best accomplished by strength and resistance training.
- Exercise for cancer helps with prevention, recovery of function and risk of recurrence reduction.

Moving Through Cancer Rx Pad

Moving Through Cancer

Exercise is Medicine® | AMERICAN COLLEGE of SPORTS MEDICINE

Name: _____ Date: _____

Aerobic Activity 3 or more days/week

Intensity: ❑ Light (casual walk) ❑ Moderate (brisk walk) ❑ Vigorous (like jogging)

Time (minutes/day): Build up to 30 minutes/day

Type: ❑ Walk ❑ Run ❑ Bike ❑ Swim/Water Exercise ❑ Other _____

Steps/day: ❑ 2,500 ❑ 5,000 ❑ 7,000 ❑ 9,000 or more ❑ Other _____

What about aerobic activity?

- Moderate activity is at a pace where you can talk but cannot "sing." Examples: *brisk walking, light biking, water exercise* and *dancing.*
- Vigorous activity is at a pace where you have trouble talking and may be out of breath. Examples: *jogging, tennis* and *fast bicycling.*
- While the recommendation is to build up to 30 min/day, at least 3 days/week, you can exercise for any length of time. For example, you might walk:
  - 5 minutes here, 10 minutes there
  - 15 minutes daily
  - Just work your way up to 30 minutes 3 days/week
- Gradually build up to a daily step count of 7,000-9,000 steps/day.

Muscle Strength Training 2 days/week

What about strength training?

- You don't have to go to a gym. You can use elastic bands, do body weight exercises (kitchen counter push-ups, chair sit-to-stands) or lift dumbbells. Heavy work around your home also builds strength.
- Strengthen your legs, back, chest and arms. To start, try 10-15 repetitions using light effort. Build up to medium or hard effort for 8-12 repetitions. Repeat 2-4 times, 2-3 days/week.
- Give yourself a rest day between each strength training session.

Notes (local programming, specific risks or instructions):

See www.exerciseismedicine.org/movethruca for a registry of local programs.

Prescriber's Signature:

How will you get started **this week?**

UCSF


THE ATHLETIC LASS
Oh, the girl who goes in for brawn,
Who's in training from daylight till dawn,
Should from such stunts refrain
And develop her brain,
And thank us for "putting her on!"

UCSF

www.exerciseismedicine.org/movingthroughcancer

www.exerciseismedicine.org/movingthroughcancer

https://www.exerciseismedicine.org/wp-content/uploads/2021/04/EIM_Rx-for-Health_Sit-Less-Move-More.pdf

https://www.exerciseismedicine.org/wp-content/uploads/2021/04/EIM_Rx-for-Health_Cancer.pdf

Helpful Resources

- https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf
- www.exerciseismedicine.org/movingthroughcancer
- https://www.nia.nih.gov/health/exercise-physical-activity
- https://www.mapletreecanceralliance.org/
- https://www.livestrong.org/what-we-do/program/livestrong-at-the-ymca

Special Thanks

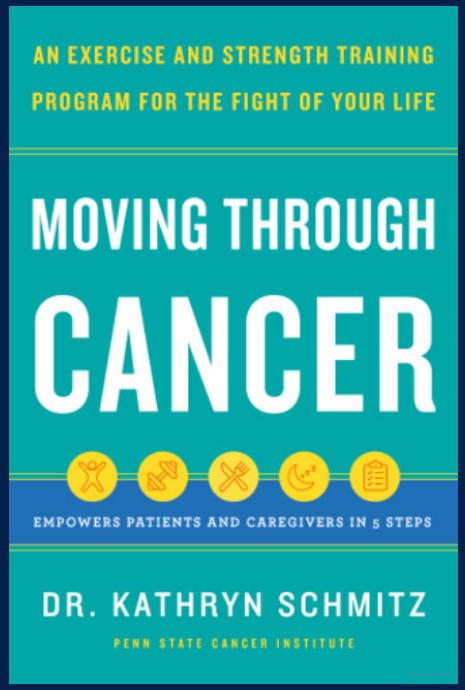
Kathryn H. Schmitz, PhD, MPH, FACSM, FTOS, FNAK

Professor, Penn State COM

Second Past President, ACSM

Chair, Exercise Is Medicine Governing Board

Founder, Moving Through Cancer



Check out her book, Moving Through Cancer