Cancer and Aging

- move more and sit less

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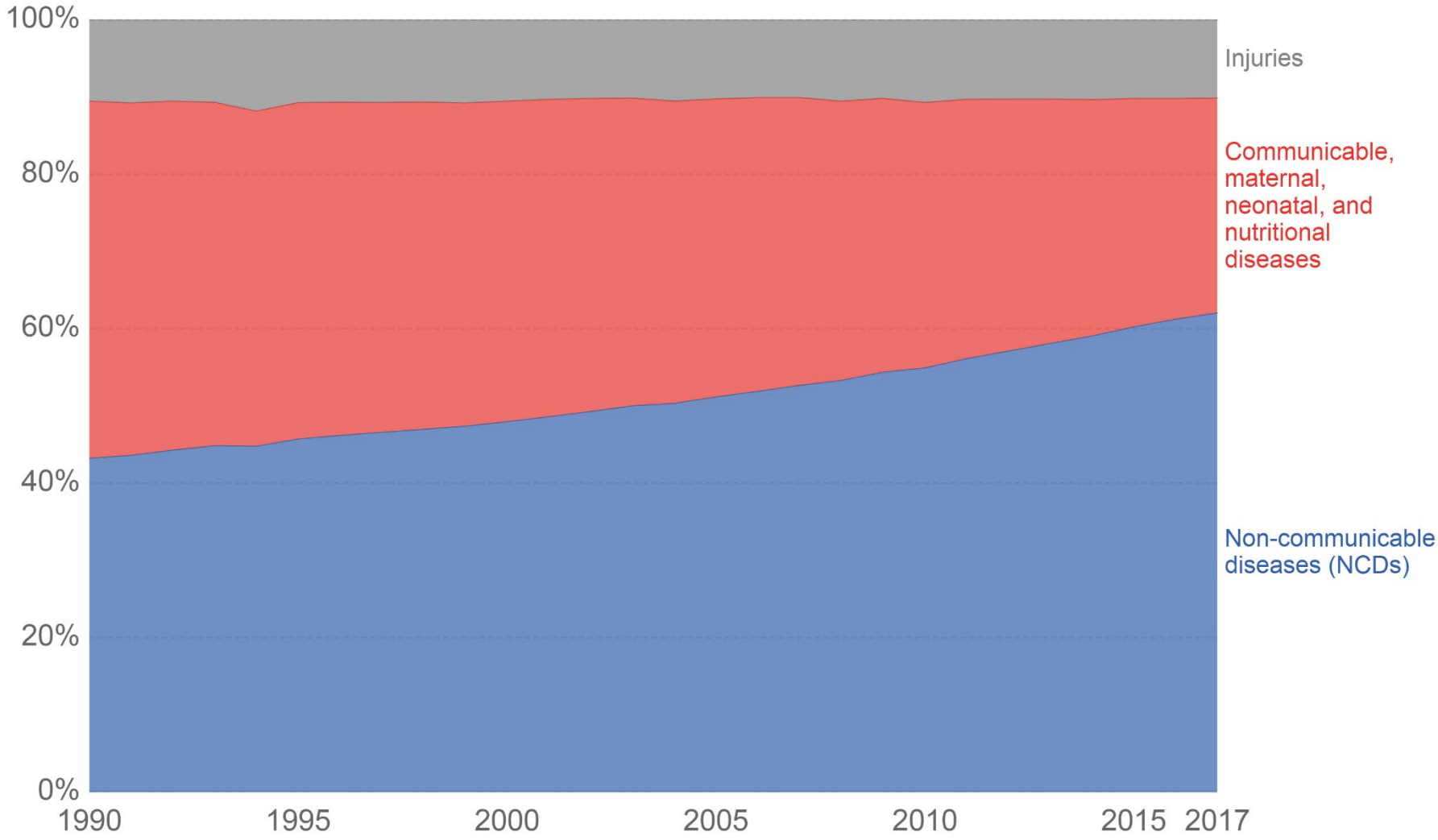
Total disease burden by cause, World

Total disease burden measured as Disability-Adjusted Life Years (DALYs) per year.
DALYs measure the total burden of disease – both from years of life lost due to premature death and years lived with a disability. One DALY equals one lost year of healthy life.



Source: IHME, Global Burden of Disease

Insufficient physical activity is amongst the leading risk factors for non-communicable diseases and death

World Health Organization

HOW MUCH PHYSICAL ACTIVITY IS NEEDED FOR GOOD HEALTH?

FOR ADULTS AND OLDER ADULTS

MINUTES PER WEEK

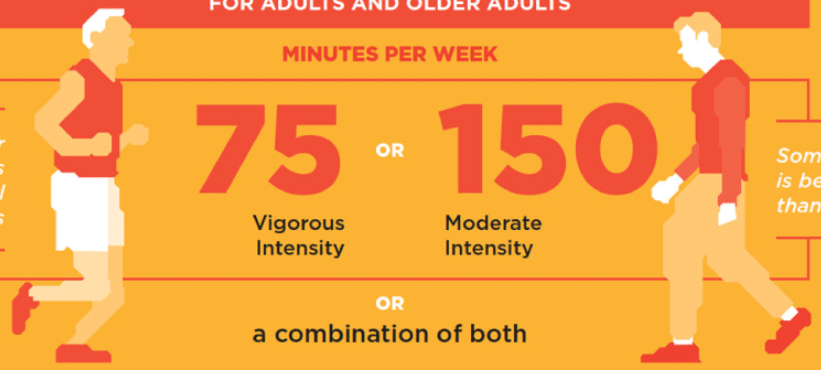
More is better and provides additional health benefits

75 Vigorous Intensity OR **150** Moderate Intensity

Something is better than nothing

OR

a combination of both



FOR CHILDREN

AIM FOR AT LEAST

60 Minutes everyday

FOR OLDER ADULTS with poor mobility

PERFORM PHYSICAL ACTIVITY

to enhance balance and prevent falls on

3 or more days per week

EVERYONE

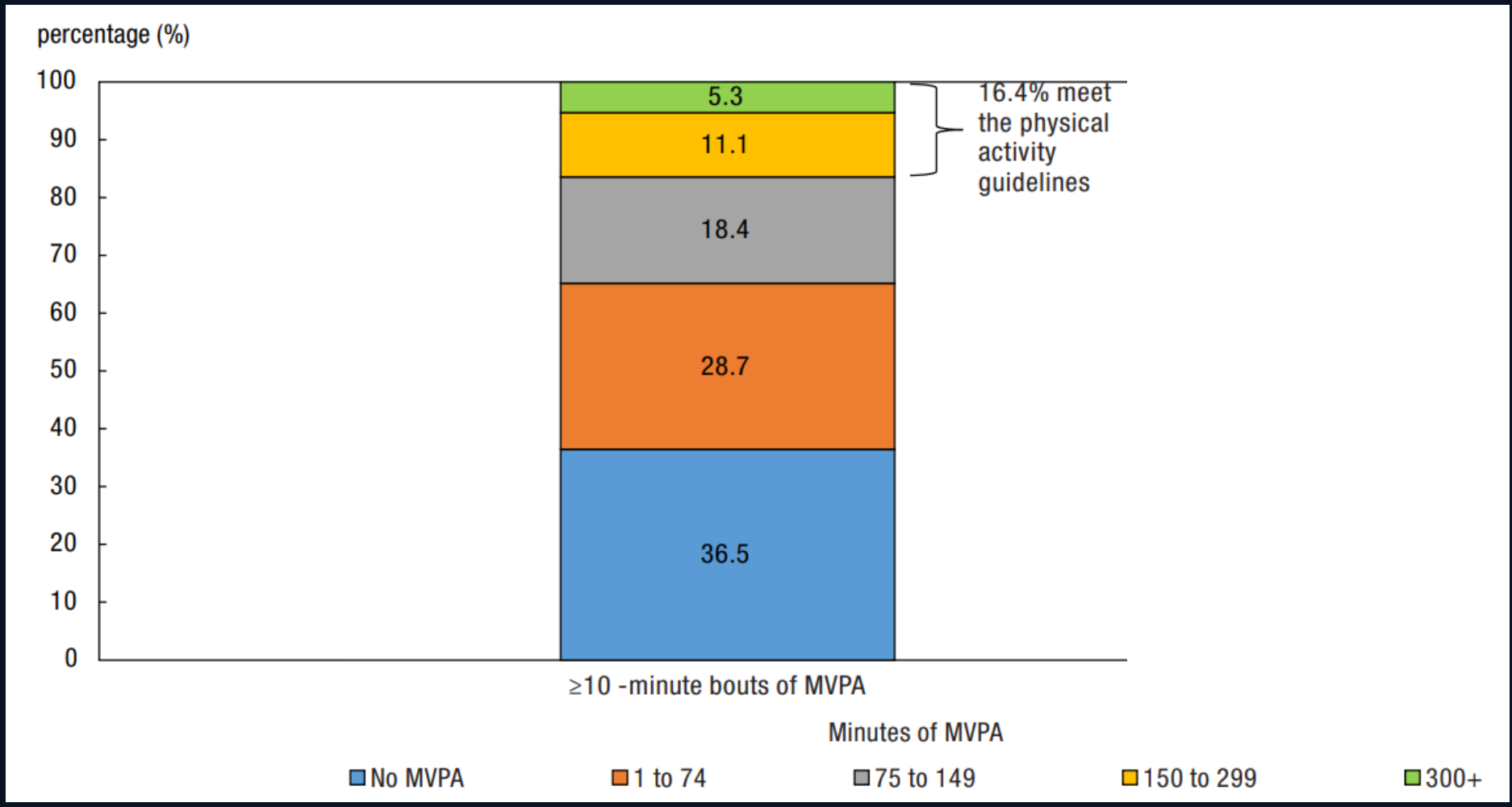
PERFORM MUSCLE-STRENGTHENING ACTIVITIES

Involving major muscle groups, on

2 or more days a week

Start small and increase gradually

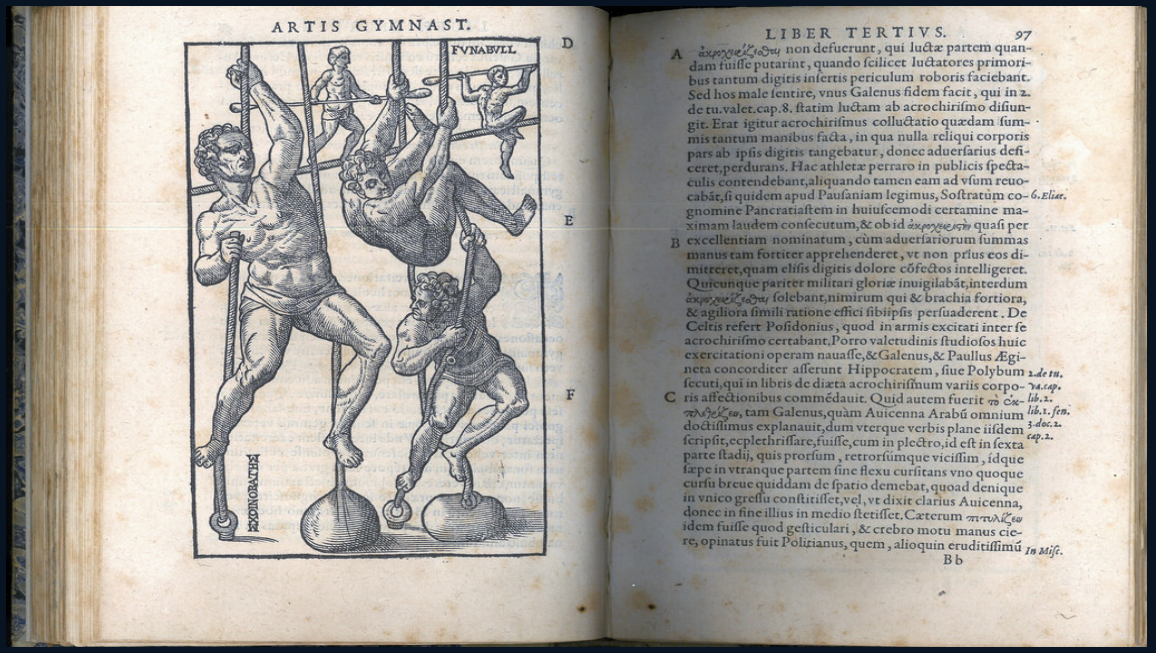
Distribution of weekly moderate-to-vigorous physical activity (MVPA), all minutes compared with ≥10-minute bouts, household population aged 18 to 79 years, Canada, combined 2016 to 2017

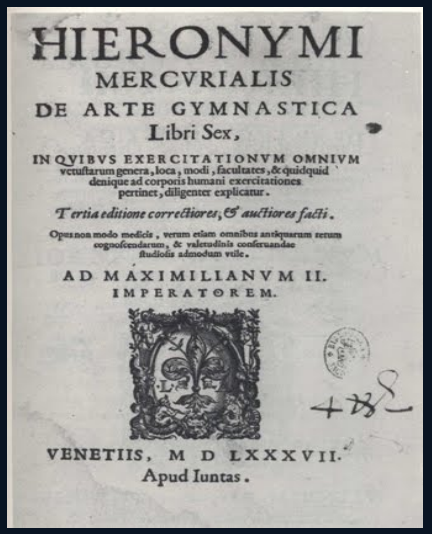


Clarke et al. Health Reports. 2019.

“People who are ill should not be given exercise that might aggravate existing conditions; special exercise should be prescribed on an individual basis for convalescence, and for weak and older patients; people who lead sedentary lives need exercise urgently, and each exercise should preserve the existing healthy state; exercise should not disturb the harmony among the principal humors; exercise should be suited to each part of the body; and all healthy people should exercise regularly.”

Girolamo Mercurialis,
1569.
The art of Gymnastics Among the Ancients.





BMJ 2020.

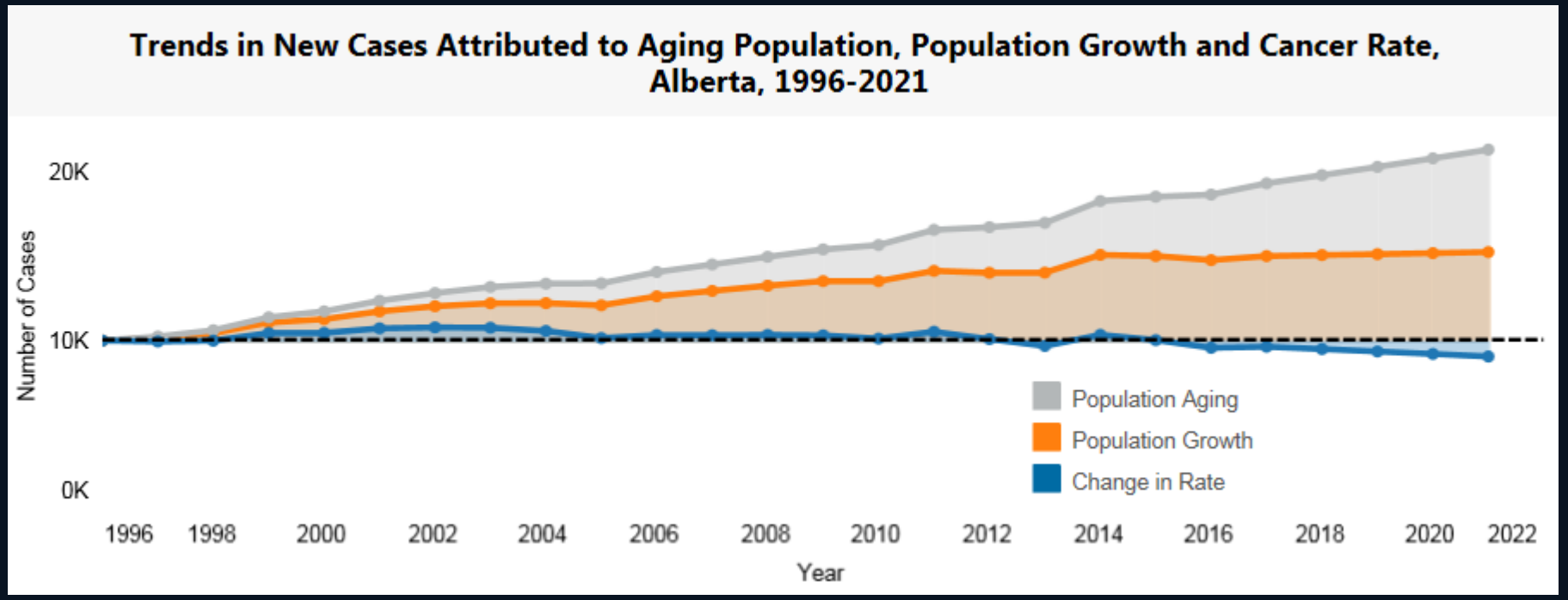
Exercise in people over 85

BMJ 2020 ; 368 doi: https://doi.org/10.1136/bmj.m402 (Published 05 February 2020)
Cite this as: *BMJ* 2020;368:m402

Linked Opinion
Exercise is the miracle cure

Article | Related content | Metrics | Responses

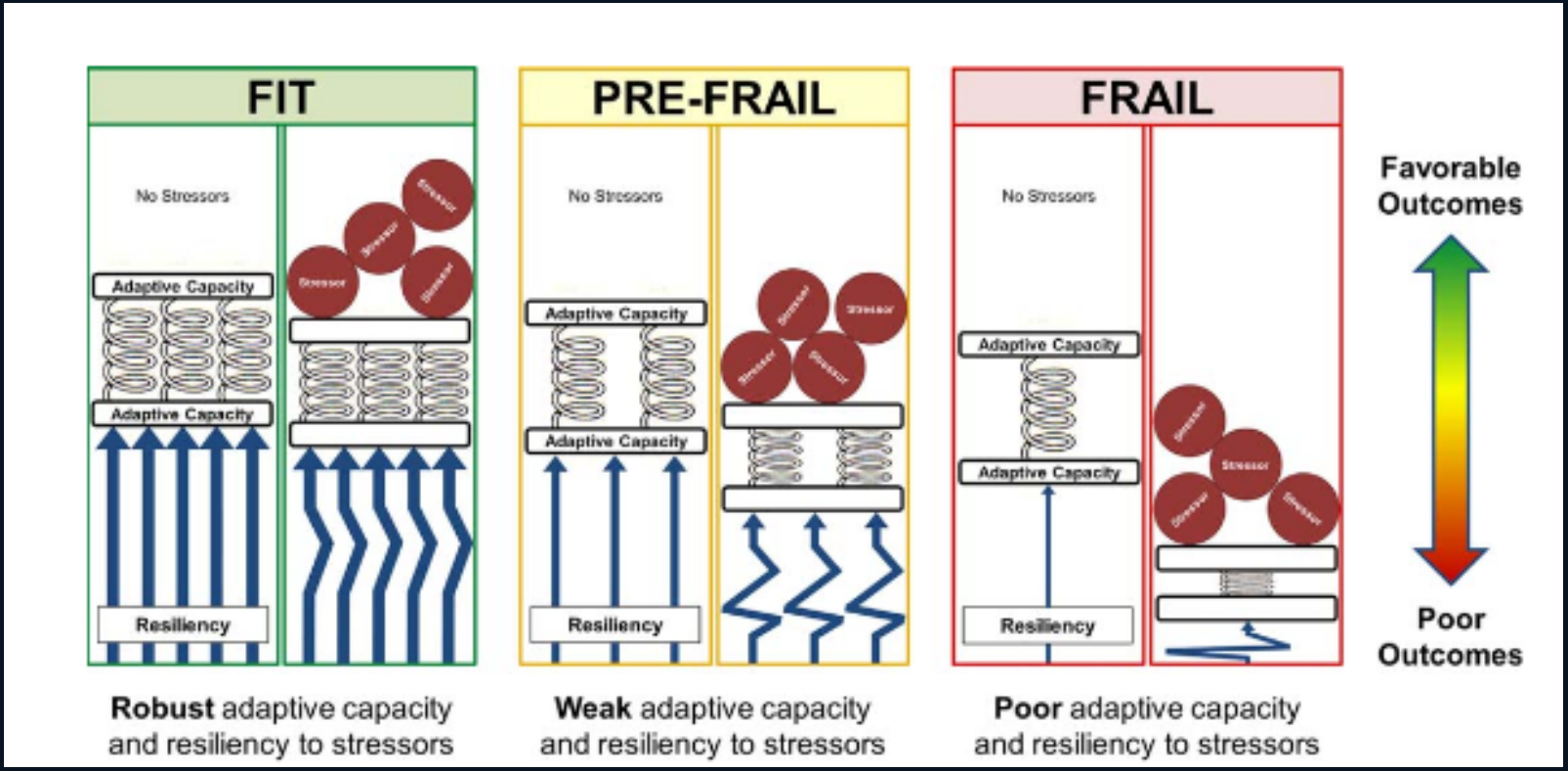
Cancer burden associated with ageing in Alberta



Surveillance & Reporting Reports, AHS

What does “older” mean?

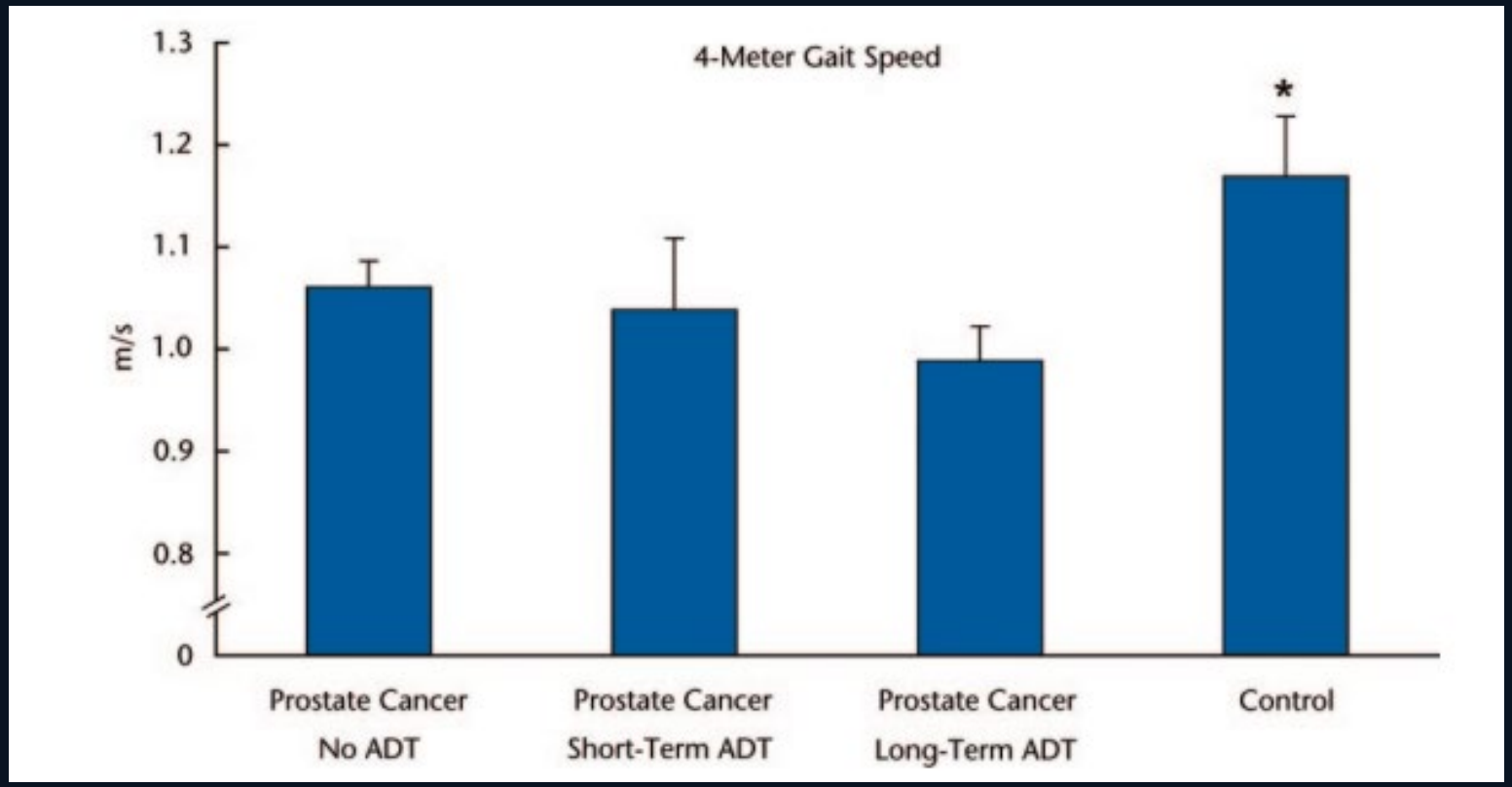
Is older equal to weak?



Ethun, et al. CA Cancer J Clin. 2017

Aging and Health, WHO

Reduced physical function in men with prostate cancer



Caly, et al. Phys Ther. 2007

Guidelines for cancer survivors

Early guidelines published in 2012

CA: A Cancer Journal for Clinicians

Article | Free Access

Nutrition and physical activity guidelines for cancer survivors†

Correction(s) for this article

Cheryl L. Rock PhD, RD, Colleen Doyle MS, RD, Wendy Demark-Wahnefried PhD, RD, Jeffrey Meyerhardt MD, MPH, Kerry S. Courneya PhD, Anna L. Schwartz FNP, PhD, FAAN ... See all authors

First published:26 April 2012 | https://doi.org/10.3322/caac.21142 | Citations: 763

Rock et al. CA Cancer J Clin. 2012

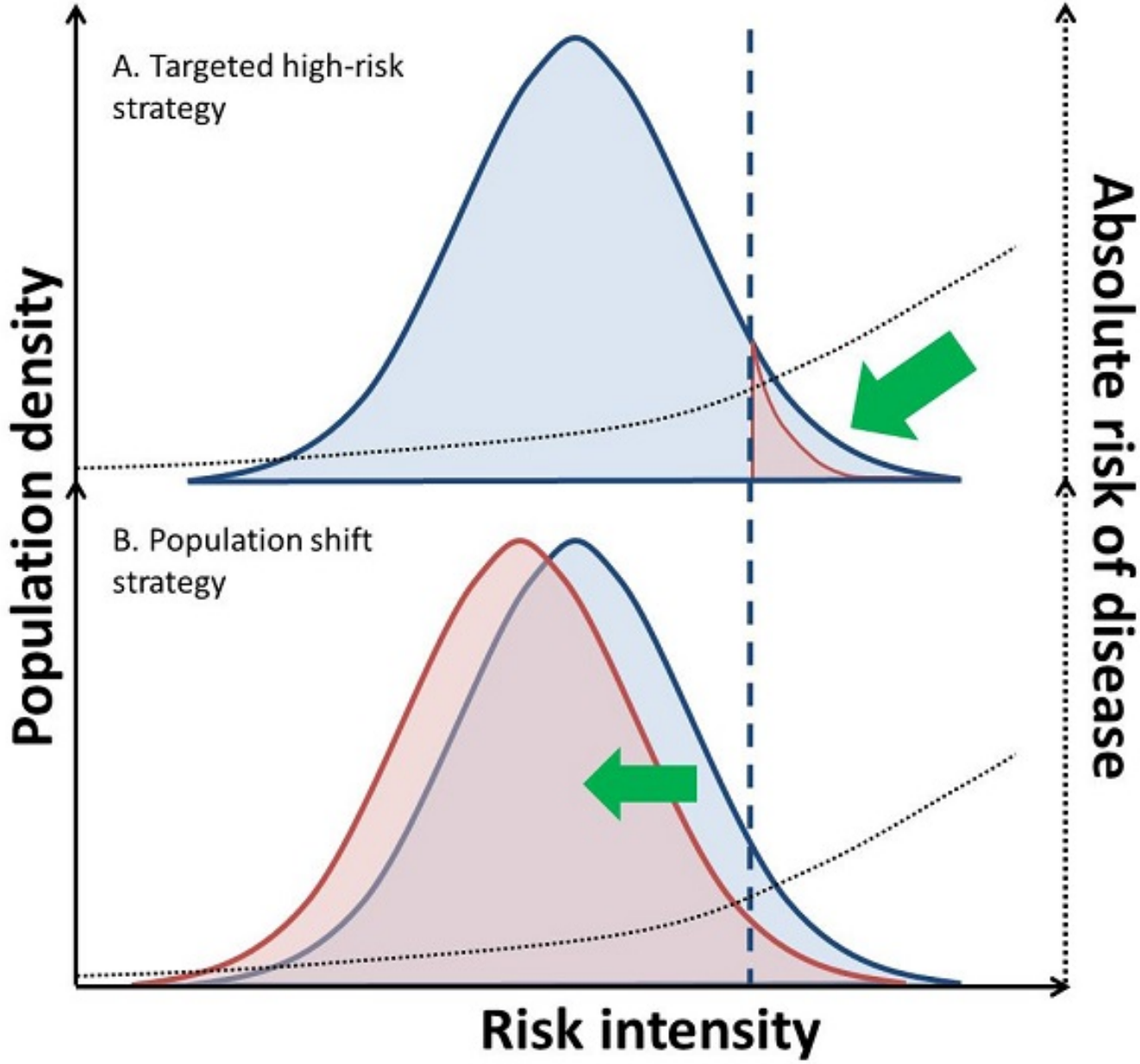
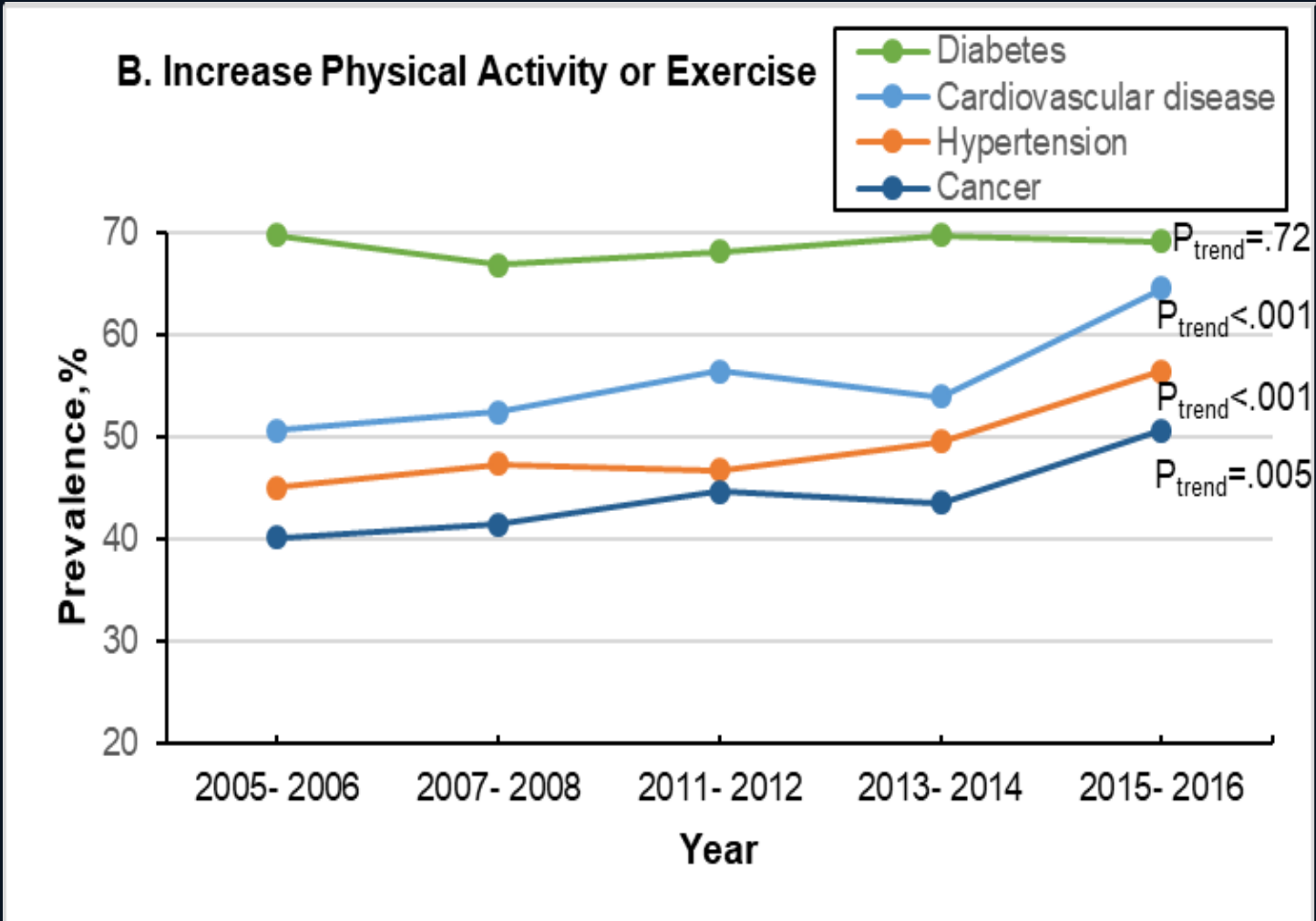


Figure 1. Illustration of disease prevention strategies.
Inspired by Rose 1985 *IJE*.

Trends in Receiving Physical Activity or Exercise Counselling Among US Adults by Chronic Conditions, NHANES 2005-2016



Grabovac… & Yang. (under review at BMJ)

Does it work?

Table 4. Association between Receiving Advice on Lifestyle Behaviors and Adopting Behaviors Changes Among US Adults, NHANES 2005-2016[a]

	Odds Ratio (95% CI)[b]							
	All age		20-39 y		40-64 y		≥65 y	
	Age-adjusted	MV-adjusted	Age-adjusted	MV-adjusted	Age-adjusted	MV-adjusted	Age-adjusted	MV-adjusted
All								
Control Weight	3.99 (3.59 to 4.45)	2.85 (2.53 to 3.20)	4.26 (3.65 to 4.98)	2.74 (2.25 to 3.33)	3.78 (3.23 to 4.41)	2.87 (2.37 to 3.47)	3.40 (2.85 to 4.05)	2.64 (2.19 to 3.18)
Increase Physical Activity	2.91 (2.69 to 3.16)	2.87 (2.61 to 3.14)	3.14 (2.78 to 3.55)	2.74 (2.39 to 3.15)	2.72 (2.40 to 3.08)	2.74 (2.36 to 3.20)	2.84 (2.46 to 3.27)	3.20 (2.73 to 3.74)
Reduce fat/calories in diet	5.50 (5.01 to 6.04)	4.25 (3.83 to 4.73)	5.06 (4.31 to 5.93)	3.66 (3.04 to 4.42)	5.21 (4.58 to 5.92)	4.10 (3.54 to 4.75)	5.91 (4.81 to 7.26)	5.19 (4.10 to 6.61)
Non-Hispanic White								
Control Weight	3.82 (3.32 to 4.38)	2.85 (2.46 to 3.31)	4.39 (3.38 to 5.71)	3.03 (2.25 to 4.08)	3.61 (2.95 to 4.42)	2.85 (2.24 to 3.62)	3.03 (2.46 to 3.73)	2.37 (1.88 to 2.99)
Increase Physical Activity	2.98 (2.66 to 3.33)	3.08 (2.71 to 3.49)	3.27 (2.63 to 4.06)	3.01 (2.38 to 3.81)	2.84 (2.39 to 3.36)	3.08 (2.50 to 3.78)	2.77 (2.32 to 3.29)	3.19 (2.65 to 3.85)
Reduce fat/calories in diet	5.31 (4.72 to 5.96)	4.22 (3.71 to 4.79)	5.15 (3.95 to 6.71)	4.01 (2.96 to 5.44)	4.97 (4.26 to 5.81)	4.10 (3.41 to 4.91)	5.25 (4.12 to 6.69)	4.58 (3.47 to 6.03)
Non-Hispanic Black								
Control Weight	4.30 (3.72 to 4.96)	2.99 (2.47 to 3.62)	4.47 (3.38 to 5.92)	2.74 (1.92 to 3.92)	3.80 (3.13 to 4.61)	3.06 (2.39 to 3.92)	4.84 (3.48 to 6.75)	4.30 (2.79 to 6.65)
Increase Physical Activity	2.67 (2.33 to 3.06)	2.58 (2.13 to 3.13)	3.08 (2.38 to 3.99)	2.54 (1.82 to 3.54)	2.35 (1.88 to 2.93)	2.41 (1.76 to 3.30)	2.55 (1.98 to 3.27)	2.95 (2.11 to 4.12)
Reduce fat/calories in diet	5.58 (4.74 to 6.56)	4.48 (3.69 to 5.43)	4.74 (3.58 to 6.29)	3.39 (2.37 to 4.85)	5.33 (4.32 to 6.57)	4.51 (3.51 to 5.80)	8.51 (5.89 to 12.3)	8.73 (5.52 to 13.8)
Hispanic								
Control Weight	3.73 (3.16 to 4.41)	2.65 (2.12 to 3.32)	3.64 (2.83 to 4.68)	2.49 (1.72 to 3.60)	3.46 (2.78 to 4.31)	2.58 (1.95 to 3.42)	4.50 (3.24 to 6.26)	4.71 (3.14 to 7.07)
Increase Physical Activity	2.53 (2.22 to 2.88)	2.36 (2.03 to 2.75)	2.84 (2.36 to 3.41)	2.49 (1.97 to 3.15)	2.10 (1.74 to 2.54)	2.07 (1.64 to 2.61)	3.07 (2.34 to 4.04)	3.78 (2.80 to 5.10)
Reduce fat/calories in diet	5.28 (4.52 to 6.17)	4.33 (3.57 to 5.24)	4.96 (3.92 to 6.27)	4.15 (3.03 to 5.69)	5.12 (4.04 to 6.49)	4.25 (3.21 to 5.62)	6.97 (4.89 to 9.93)	7.53 (4.92 to 11.5)

[a] All estimates were weighted to be nationally representative.

[b] All multivariable (MV) adjusted models were adjusted for survey cycle, age (continues), gender, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, others), household income, insurance status, leisure time physical activity, educational attainment, physical limitation, smoking status, comorbidity (hypertension, high blood cholesterol, cardiovascular disease, osteoarthritis, cancer and diabetes) and depression.

Grabovac… & Yang. (under review at BMJ)

Does it work?

	Odds Ratio (95% CI)[b]	
	All age	
	Age-adjusted	MV-adjusted
All		
Control Weight	3.99 (3.59 to 4.45)	2.85 (2.53 to 3.2
Increase Physical Activity	2.91 (2.69 to 3.16)	2.87 (2.61 to 3.1
Reduce fat/calories in diet	5.50 (5.01 to 6.04)	4.25 (3.83 to 4.7
Non-Hispanic White		
Control Weight	3.82 (3.32 to 4.38)	2.85 (2.46 to 3.3
Increase Physical Activity	2.98 (2.66 to 3.33)	3.08 (2.71 to 3.4
Reduce fat/calories in diet	5.31 (4.72 to 5.96)	4.22 (3.71 to 4.7
Non-Hispanic Black		
Control Weight	4.30 (3.72 to 4.96)	2.99 (2.47 to 3.6
Increase Physical Activity	2.67 (2.33 to 3.06)	2.58 (2.13 to 3.1
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Hispanic		
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status, leisure time physical activity, educational attainment, physic
diabetes) and depression.

Guidelines for cancer survivors

Newer guidelines published in 2019, urge for clinician engagement

CA: A Cancer Journal for Clinicians

Article | Free Access

Exercise is medicine in oncology: Engaging clinicians to help patients move through cancer

Kathryn H. Schmitz PhD, MPH, Anna M. Campbell PhD, Martijn M. Stuiver PT, PhD, Bernardine M. Pinto PhD, Anna L. Schwartz PhD, G. Stephen Morris PT, PhD, Jennifer A. Ligibel MD, Andrea Cheville MD, Daniel A. Galvão PhD, Catherine M. Alfano PhD, Alpa V. Patel PhD, Trisha Hue PhD, Lynn H. Gerber MD, Robert Sallis MD, Niraj J. Gusani MD, MS, Nicole L. Stout PT, PhD, Leighton Chan MD, PhD, Fiona Flowers BS, Colleen Doyle MS, RD, Susan Helmrich PhD, William Bain PhD, Jonas Sokolof DO, Kerri M. Winters-Stone PhD, Kristin L. Campbell BSc, PT, PhD, Charles E. Matthews PhD

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Schmitz et al. CA Cancer J Clin. 2019.

What is the evidence base?

TABLE 1. Summary of Evidence That Physical Activity Prevents Cancer and Improves Cancer-Specific Survival[6]

LEVEL OF EVIDENCE	PHYSICAL ACTIVITY AND LOWER RISK OF DEVELOPING CANCER[a]	SEDENTARY TIME AND HIGHER RISK OF DEVELOPING CANCER[a]	PREDIAGNOSIS PHYSICAL ACTIVITY AND LOWER RISK OF CANCER-SPECIFIC SURVIVAL[b]	POSTDIAGNOSIS PHYSICAL ACTIVITY AND LOWER RISK OF CANCER-SPECIFIC SURVIVAL[b]
Strong	Colon, breast, endometrial, kidney,[c] bladder,[c] esophageal (adenocarcinoma),[d] stomach (cardia)[c]			
Moderate	Lung[c]	Endometrial,[d] colon,[c] lung[c]	Breast, colon	Breast, colon, prostate
Limited	Myeloma and hematologic,[c] head and neck,[c] pancreas,[c] ovary,[c] prostate[c]	Liver[e]		

[a]Level of evidence was based on the Physical Activity Guidelines Advisory Committee (PAGAC)[8] and World Cancer Research Fund (WCRF)[7] reports (2018).
[b]Level of evidence was based on a review by the American College of Sports Medicine Roundtable[6].
[c]Level of evidence conclusion was only by the PAGAC[8].
[d]Level of evidence was considered limited by the WCRF[7].
[e]Level of evidence conclusion was only by the WCRF[7].

Benefit of physical activity after cancer were identified in cancers of the breast, colon and prostate (vigorous intensity).

Schmitz et al. CA Cancer. 2019.

What is the evidence base?

TABLE 2. Level of Evidence for the Benefit of Exercise on Cancer-Related Health Outcomes[10]

STRONG EVIDENCE[a]	MODERATE EVIDENCE	INSUFFICIENT EVIDENCE
Reduced anxiety	Sleep	Cardiotoxicity
Fewer depressive symptoms	Bone health (for osteoporosis prevention, not bone metastases)	Chemotherapy-induced peripheral neuropathy
Less fatigue		Cognitive function
Better QOL		Falls
Improved perceived physical function		Nausea
No risk of exacerbating upper extremity lymphedema		Pain
		Sexual function
		Treatment tolerance

Abbreviation: QOL, quality of life.
[a]Effective exercise programs for improving these outcomes are thrice-weekly, moderate-intensity, aerobic and/or resistance training with one exception. Anxiety and depressive symptoms do not appear to be improved by a program of resistance training alone but do improve with aerobic training alone or in combination with resistance training. The scientific evidence review and scheme used for evidence evaluation are described in another article from the American College of Sports Medicine (ACSM) Roundtable.[10]

Benefit of physical activity after cancer were identified in treatment-related side-effects and quality of life among long-term cancer survivors.

Schmitz et al. CA Cancer. 2019.

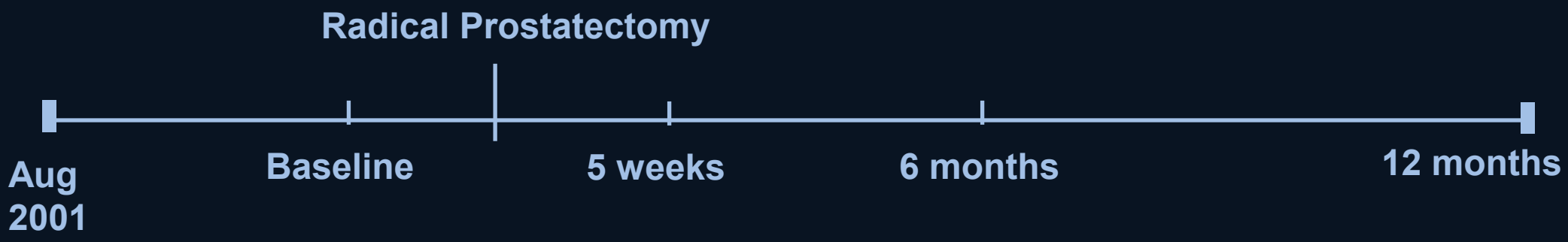
Physical activity appears to benefit cancer survivors, but…

Vigorous intensity for prostate cancer survivors?

PIE

Prostatectomy, Incontinence and Erectile Function

Longitudinal study of prostate cancer patients



440 localized prostate cancer patients

- 42 – 78 yrs old
- 94% White
- 31% BMI≥30kg/m^2
- 14% living alone
- 30% household income below $75,000

Obesity

Physical activity

Urinary function

Urinary bother

Sexual function

Sexual bother

- Socio-demographic
- Health behavior
- Disease related factors
- Surgery related factors
- Built environment

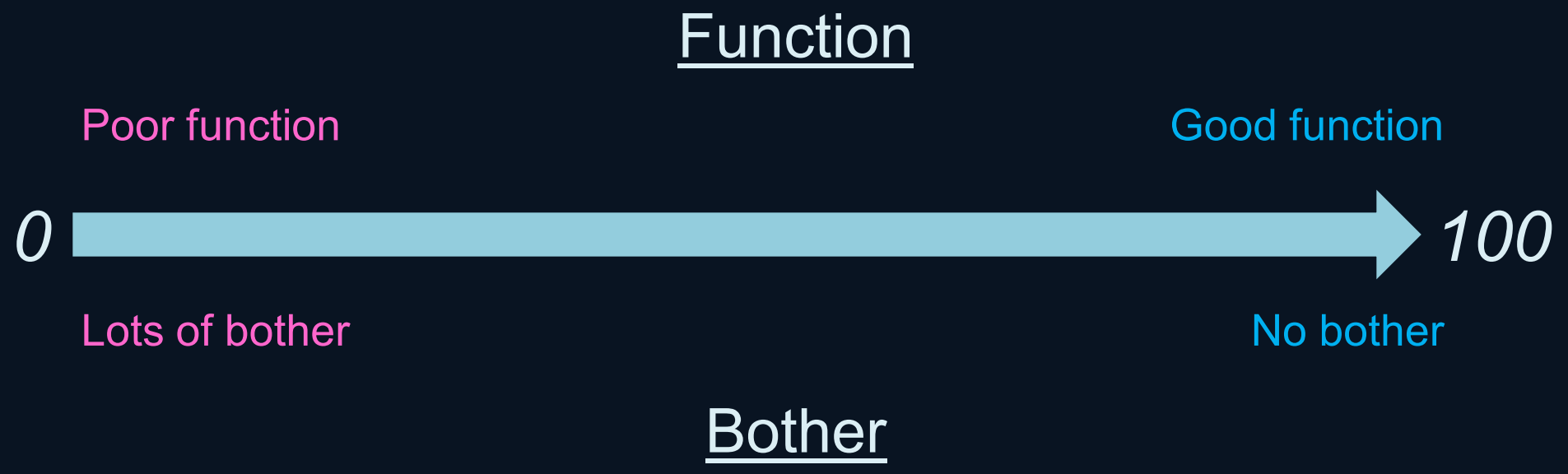
Longitudinal study of prostate cancer patients

Exposure assessment

- *Physical activity*:
  - Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity questionnaire for older adults. (reproducibility Pearson's r=0.58-0.67).
  - Actigraph GT3X+ in a sub-sample
- *Obesity*:
  - Calculated by measured weight and height.
  - WHO cut-points defined normal, over weight and obesity.

Outcome assessment

- *The Expanded Prostate Cancer Index Composite (EPIC)-50. (reliability r≥0.80)*



The impact of pre-surgical obesity and physical activity on short- and long-term urinary and sexual outcomes in prostate cancer survivors.

Yang et al. In progress

LEVELS AND PATTERNS OF OBJECTIVELY MEASURED FREE-LIVING ACTIVITY AMONG PROSTATE CANCER SURIVORS:

A PROSPECTIVE COHORT STUDY

Smith...& Yang. Cancer. 2019

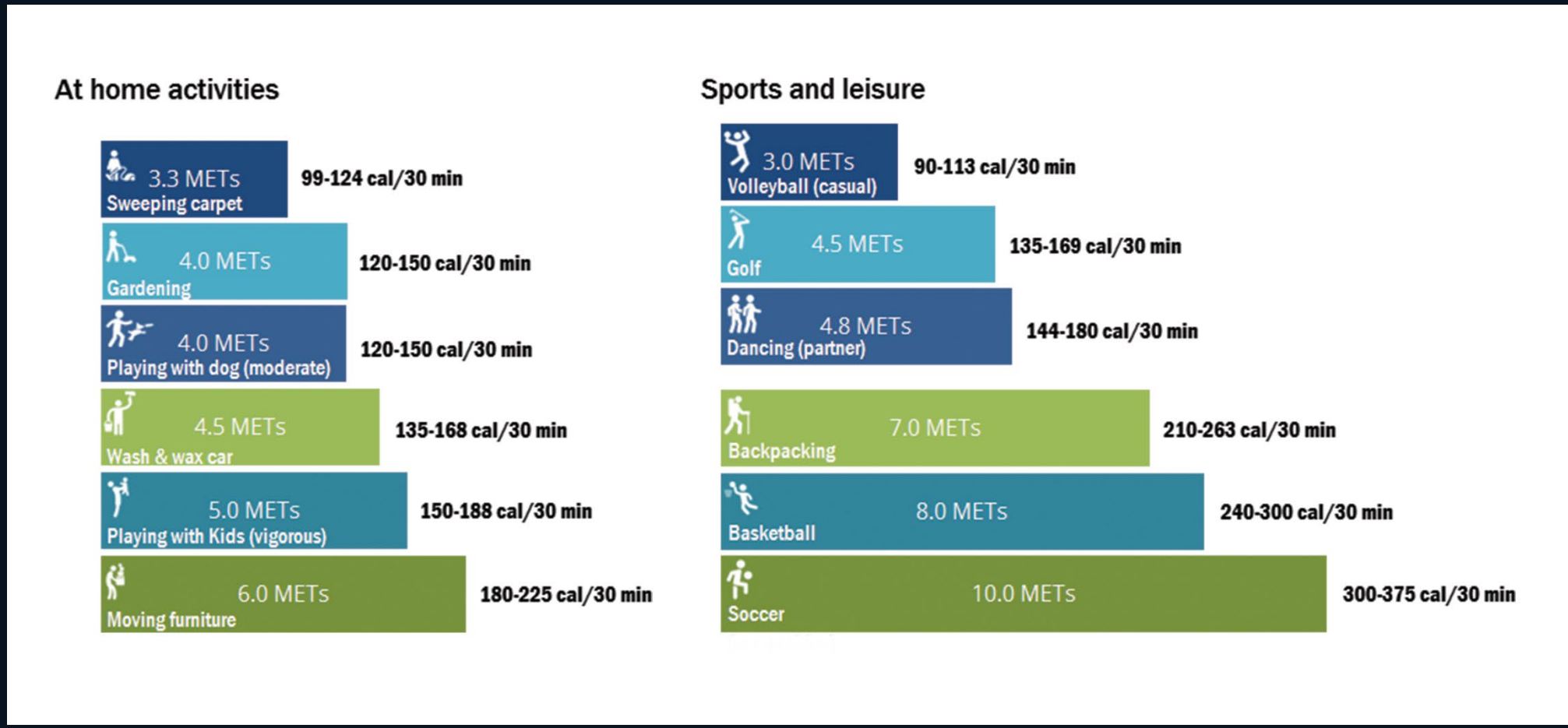
Background

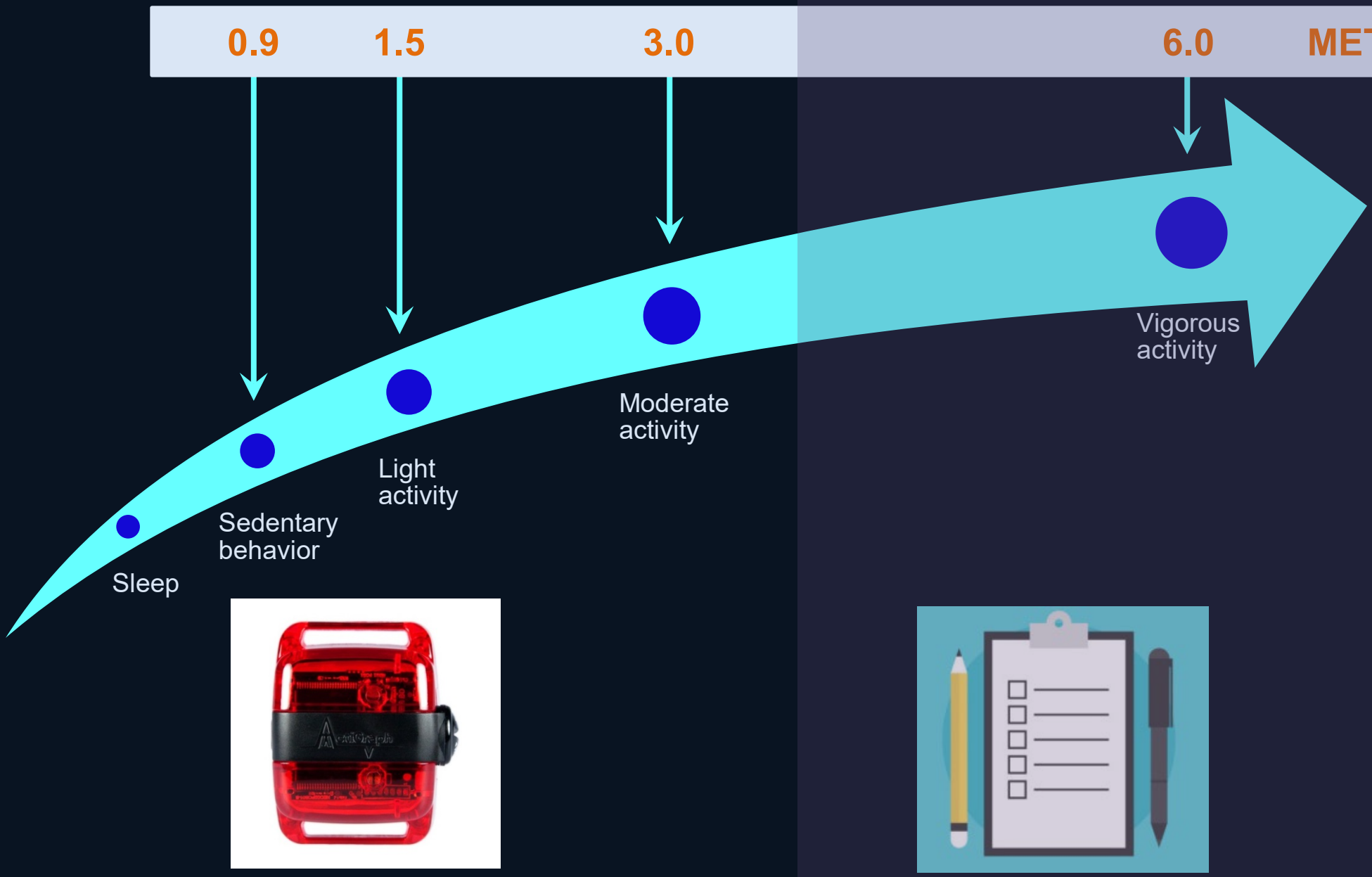
- Cancer survivors are advised to follow the general physical activity guidelines (150 minutes weekly of moderate-to-vigorous intensity physical activity).
- Much of the knowledge on health benefits of physical activity among cancer survivors were derived using data collected via self-reported physical activity.
- To date, there is no study has investigated trajectories of objectively measured activity levels in prostate cancer survivors.

Aim

- To investigate the levels and patterns of physical activity before and after radical prostatectomy (RP) using *accelerometer* and *questionnaire* data from the PIE study.

One **metabolic equivalent** (**MET**) is defined as the amount of oxygen consumed while sitting at rest and is equal to 3.5 ml O2 per kg body weight x min.




0.9
1.5
3.0
6.0
METs
Sleep
Sedentary behavior
Light activity
Moderate activity
Vigorous activity

Physical activity assessment

- *Accelerometer; objective measure*:

  Actigraph GT3X+

  – 1 second epoch

  – 7 consecutive days, hip/waist wearing

www.actigraphcorp.com

  – Missing data definition: 60 min of consecutive zero counts

  – Moderate to vigorous physical activity (MVPA): minutes spent in >1951 counts per minute (cpm), at least 10 minutes a bout

  – Sedentary behavior (SB): minutes spent in <100 cpm

  – Light intensity physical activity (LPA)

**Daily MVPA, SB, and LPA were adjusted for wearing time in the analyses*

Physical activity assessment

- *Questionnaire, self-reported measure*:
  - Community Healthy Activities Model Program for Seniors (CHAMPS) physical activity questionnaire for older adults. (reproducibility Pearson's r=0.58-0.67).
  - **MVPA**: summarized in total daily minutes using their scoring rules.

Stewart et al. Med Sci Sports Exerc. 2001

Longitudinal study of prostate cancer patients

440 localized prostate cancer patients

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Sexual bother

- Socio-demographic
- Health behavior
- Disease related factors
- Surgery related factors
- Built environment

Median and interquartile range of activity patterns among prostate cancer survivors in the PIE study (n=91)

		Baseline	5 weeks	6 months	12 months	p-value[g]
		Questionnaire (CHAMP[e])				
MVPA[a]	Daily minutes	45.0 (30.0-79.3)	15.0 (4.3-47.1)	45.0 (27.9-77.1)	47.1 (23.6-81.4)	<.001
		Accelerometer (Actigraph GTX 3)				
MVPA[a]	Daily minutes	3.5 (0-9.7)	3.9 (0-11.3)	0 (0-7.5)	2.1 (0-11.1)	0.31
LPA[b]	Daily minutes	203.0 (157.7-245.5)	180.4 (136.5-214.3)	200.6 (157.3-249.2)	189.7 (163.1-239.1)	0.001
SB[c]	Daily minutes	487.9 (438.5-533.3)	511.5 (467.3-557.1)	489.9 (443.0-532.6)	501.8 (450.8-530.1)	0.008

[a]MVPA: Moderate-to-vigorous intensity physical activity.
[b]PAL: Light intensity physical activity.
[c]SB: Sedentary behavior.
[d]PA: Physical activity.
[e]CHAMP: Community Healthy Activities Model Program for Seniors.
[f]Post-hoc analyses using Wilcoxon's signed-rank tests to compare the change to the previous data point.
[g]P-value for Friedman's test.

Smith...& Yang. Cancer. 2019

Proportions of meeting physical activity guideline among prostate cancer survivors in the PIE study (n=91)

	Baseline	5 weeks	6 months	12 months
Questionnaire (CHAMP[e])				
MVPA[a]				
Meeting PA[d] guideline	83.5%	45.0%	84.6%	79.1%
Accelerometer (Actigraph GTX 3)				
MVPA[a]				
Meeting PA[d] guideline	11.0%	9.9%	9.9%	5.5%

[a]MVPA: Moderate-to-vigorous intensity physical activity.
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Smith...& Yang. Cancer. 2019

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[f]Post-hoc analyses using Wilcoxon's signed-rank tests to compare the change to the previous data point.
[g]P-value for Friedman's test.

Smith...& Yang. Cancer. 2019

Post-hoc analyses (Wilcoxon's signed-rank test) on change in activity patterns among prostate cancer survivors in the PIE study (n=91)

		Baseline	5 weeks	6 months	12 months	p-value[g]
		Questionnaire (CHAMP[e])				
MVPA[a]	Daily minutes	45.0 (30.0-79.3)	15.0 (4.3-47.1)	45.0 (27.9-77.1)	47.1 (23.6-81.4)	<.001
	Post-hoc p-value[e]		<.001	<.001	0.34	
		Accelerometer (Actigraph GTX 3)				
MVPA[a]	Daily minutes	3.5 (0-9.7)	3.9 (0-11.3)	0 (0-7.5)	2.1 (0-11.1)	0.31
	Post-hoc p-value[f]		0.77	0.04	0.51	
LPA[b]	Daily minutes	203.0 (157.7-245.5)	180.4 (136.5-214.3)	200.6 (157.3-249.2)	189.7 (163.1-239.1)	0.001
	Post-hoc p-value[f]		<.001	0.003	0.83	
SB[c]	Daily minutes	487.9 (438.5-533.3)	511.5 (467.3-557.1)	489.9 (443.0-532.6)	501.8 (450.8-530.1)	0.008
	Post-hoc p-value[f]		<.001	0.008	0.86	

[a]MVPA: Moderate-to-vigorous intensity physical activity.
[b]PAL: Light intensity physical activity.
[c]SB: Sedentary behavior.
[d]PA: Physical activity.
[e]CHAMP: Community Healthy Activities Model Program for Seniors.
[f]Post-hoc analyses using Wilcoxon's signed-rank tests to compare the change to the previous data point.
[g]P-value for Friedman's test.

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Activity patterns among prostate cancer survivors in the PIE study (n=91)

		Baseline	5 weeks	6 months	12 months	p-value[g]
		Questionnaire (CHAMP[e])				
MVPA[a]	Daily minutes	45.0 (30.0-79.3)	15.0 (4.3-47.1)	45.0 (27.9-77.1)	47.1 (23.6-81.4)	<.001
	Meeting PA[d] guideline	83.5%	45.0%	84.6%	79.1%	
	Post-hoc p-value[e]		<.001	<.001	0.34	
		Accelerometer (Actigraph GTX 3)				
MVPA[a]	Daily minutes	3.5 (0-9.7)	3.9 (0-11.3)	0 (0-7.5)	2.1 (0-11.1)	0.31
	Meeting PA[d] guideline	11.0%	9.9%	9.9%	5.5%	
	Post-hoc p-value[f]		0.77	0.04	0.51	
LPA[b]	Daily minutes	203.0 (157.7-245.5)	180.4 (136.5-214.3)	200.6 (157.3-249.2)	189.7 (163.1-239.1)	0.001
	Post-hoc p-value[f]		<.001	0.003	0.83	
SB[c]	Daily minutes	487.9 (438.5-533.3)	511.5 (467.3-557.1)	489.9 (443.0-532.6)	501.8 (450.8-530.1)	0.008
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[a]MVPA: Moderate-to-vigorous intensity physical activity.
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[f]Post-hoc analyses using Wilcoxon's signed-rank tests to compare the change to the previous data point.
[g]P-value for Friedman's test.

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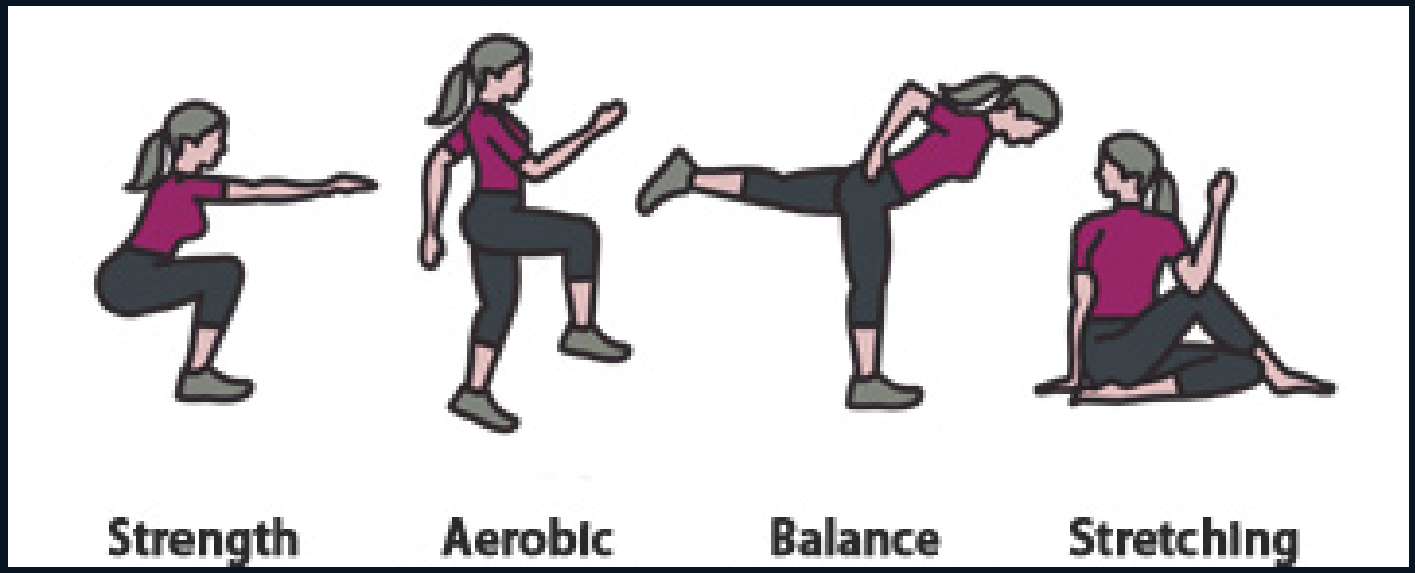
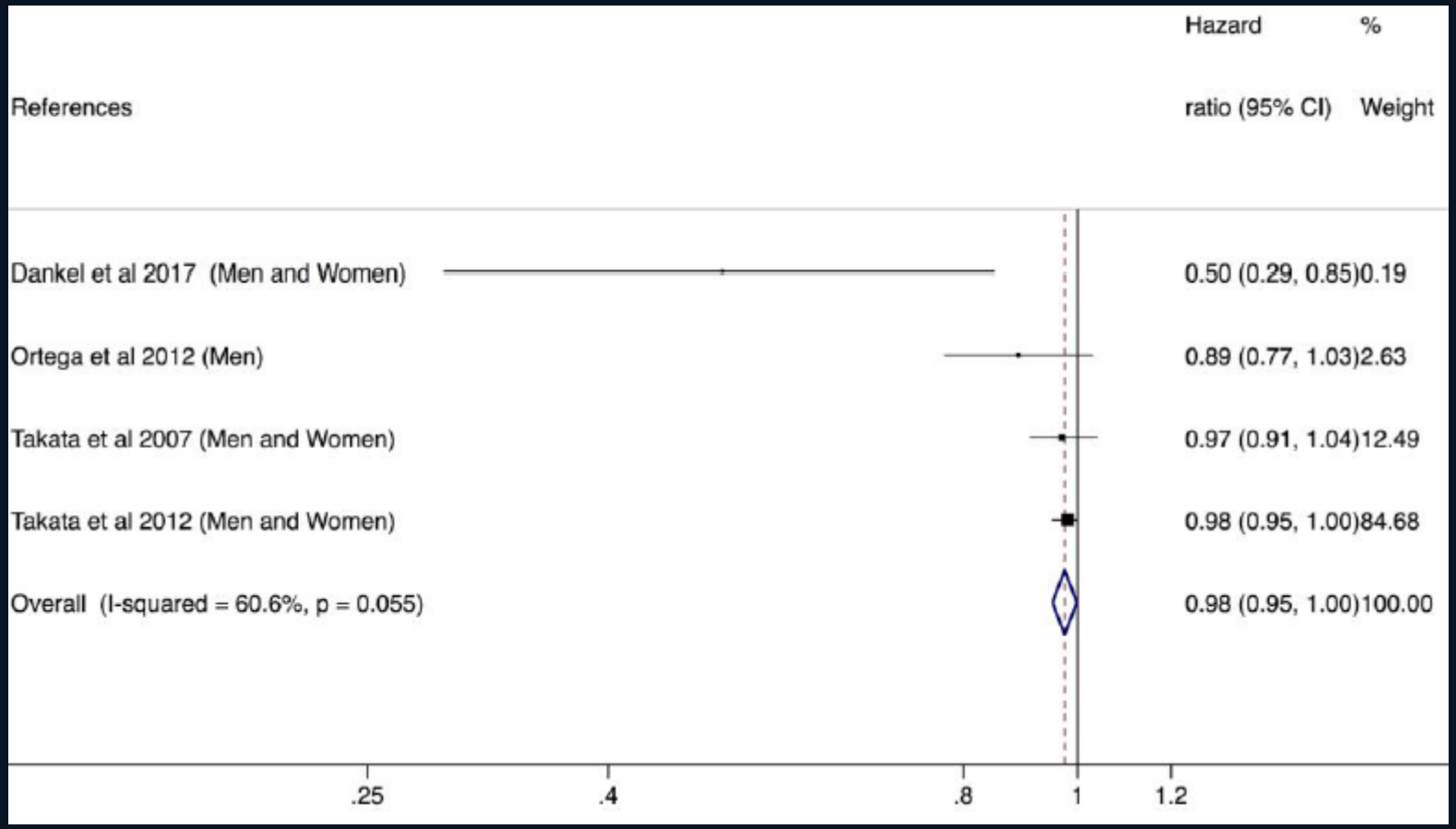
Conclusions

- In a population with critically low level of MVPA, self-reported measures over estimate MVPA and may predominantly reflect LPA.

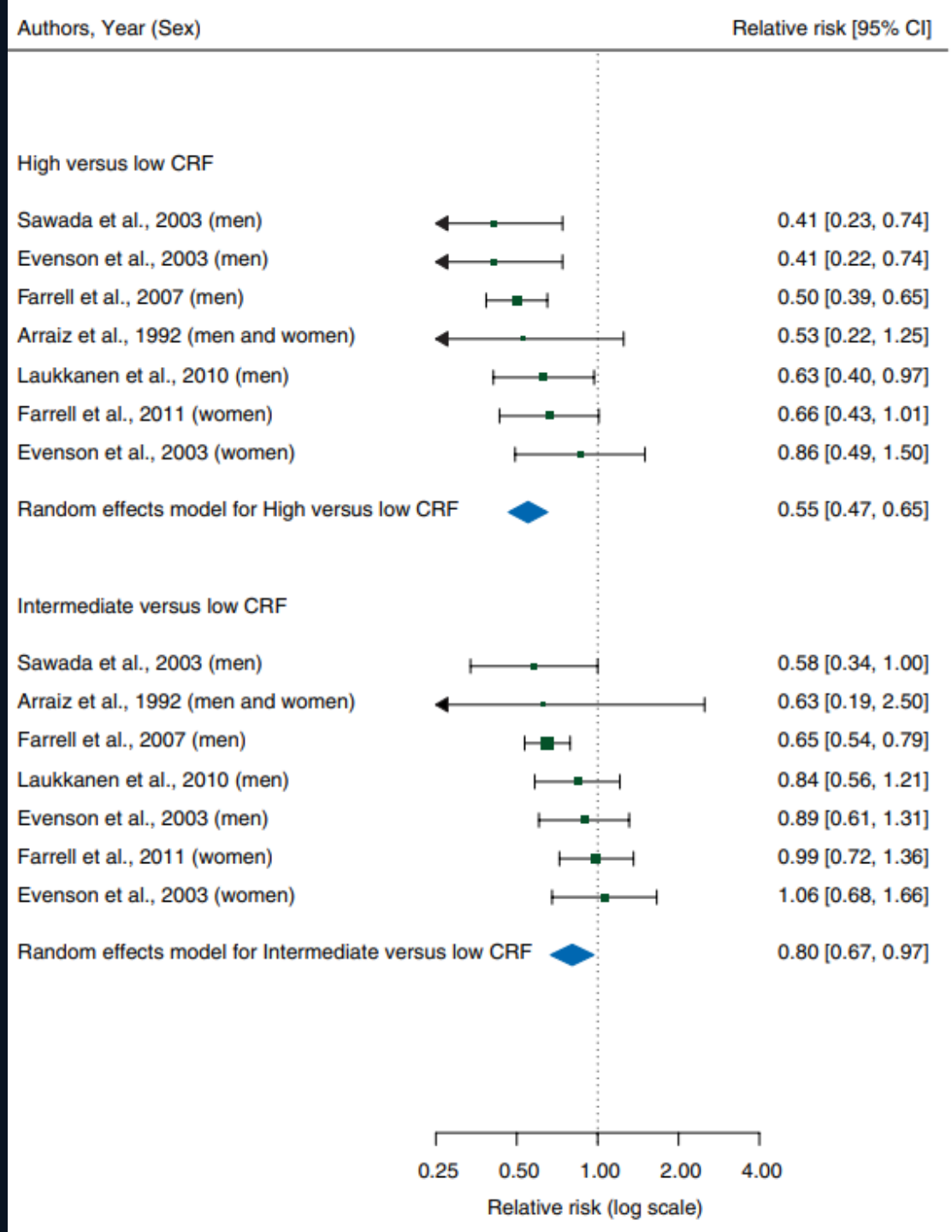
What types of exercise?





Suggestive association between increased knee extension strength and decreased cancer mortality risk.

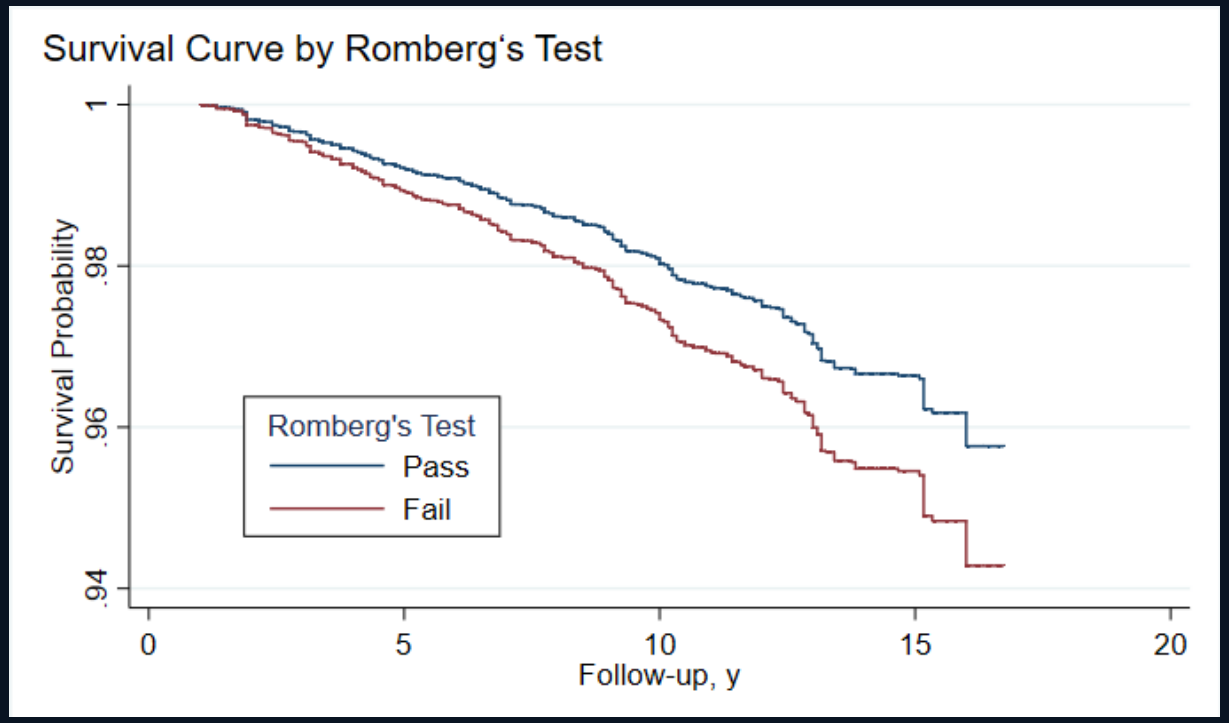
Garciz-Hermono et al. Scand J Med Sci Sport. 2018

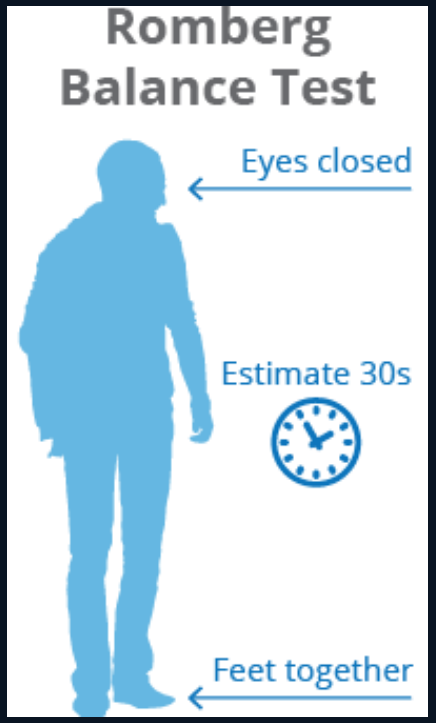


Increased cardiorespiratory fitness represents a strong predictor of decreased total cancer mortality risk.

Schmid and Leitzmann, Annals of Oncology. 2015

Balance is associated with cancer-specific mortality

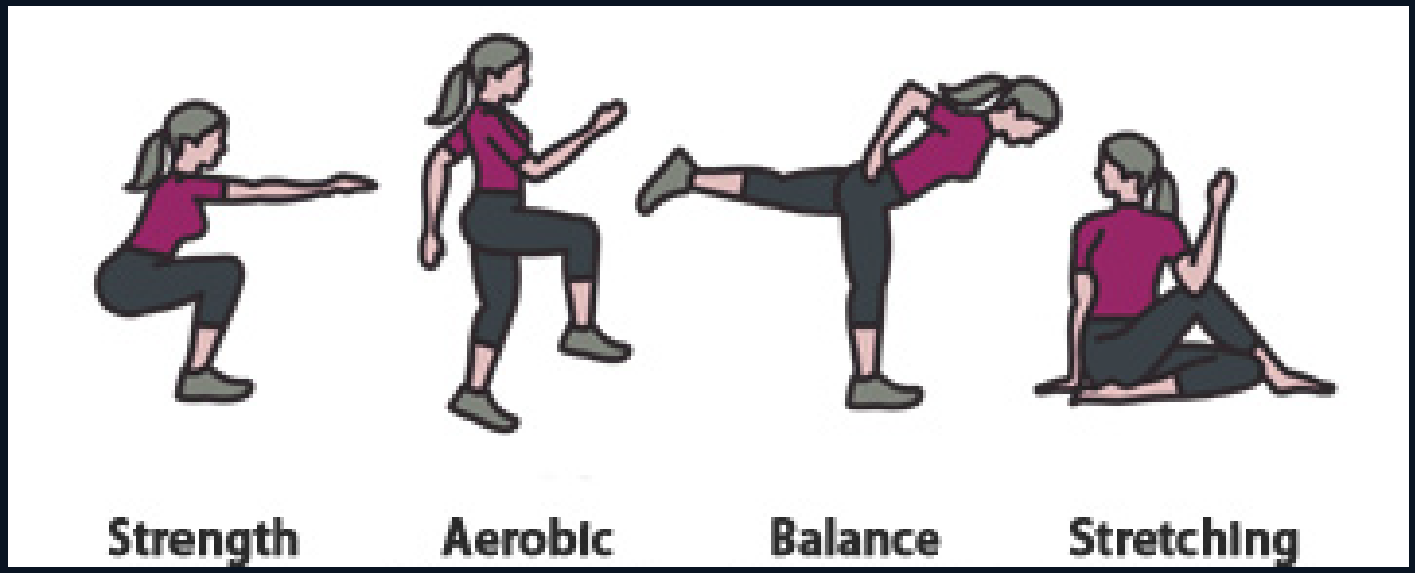




Good balance ability is associated with reduced cancer mortality risk.

Cao…& Yang. In preparation.

What types of exercise?



What types of exercise?

Table 1. Summary of Evidence Grading (GRADE) [a] for Meta-Analyses of Tai Chi Randomized Controlled Trials among Populations with Chronic Illnesses Diagnosis.

Disease/type of control group	Moderate
Parkinson's disease	
Non-active	Severity of depression; Mobility; Unified Parkinson's Disease Rating Scale
Active	Balance; Rate of falls; Fall risk; Unified Parkinson's Disease Rating Scale
Stroke	
Non-active	Physical function
Active	Activity of daily living
Osteoarthritis	
Non-active	Physical function; Severity of pain; Level of disability
Active	Flexion; Fear of falling; Cardiorespiratory fitness
Heart failure	
Non-active	Heart left ventricular ejection fraction
Active	Functional capacity; Diastolic blood pressure; Cardiorespiratory fitness
COPD	
Non-active	Functional capacity; Lung function
Active	
Coronary heart disease	
Active	Cardiorespiratory fitness
Cancer	
Active	Interleukin-6; Level of fatigue; Body mass index; Cortisol level; Severity of depression; Physical function; Muscle strength

Zou...& Yang. (under review @ Sports Medicine)

Ongoing work

- Tai Chi clinical trial: A prehabilitation intervention for psychosocial and physical preparation prior to radical prostatectomy.
- Developing similar intervention in prostate cancer survivors on other treatment modalities.
- Always looking for more research questions to fill the needs of cancer survivors.

Take home messages

- Chronological age does not mean physiological or functional age, which can be informed by geriatric and frailty assessment.
- Cancer and cancer treatment may induce accelerated aging.
- No one should be precluded from the benefit of exercise.

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