

Physical Activity for Positive Mental and Physical Health

Ramaswamy Viswanathan, MD, DrMedSc
(Ramaswamy.Viswanathan@downstate.edu)

Past President, American Psychiatric Association
(2024 May – 2025 May) (on Board of Trustees till 2028 May)

Professor Emeritus, Department of Psychiatry and Behavioral Sciences
State University of New York Downstate Health Sciences University,
Brooklyn, New York

Disclosures

- Neither I nor my spouse have a relevant financial relationship with a commercial interest to disclose.

Venus Williams and Viswanathan

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 **Massachusetts General Hospital**
Founding Member, Mass General Brigham
Psychiatry Academy



Objectives

1. Understand why we prefer the term physical activity as a lifestyle pillar instead of exercise.
2. Learn the evidence for association between physical activity and various physical and mental disorders and positive health.
3. Know the common and distinguishing effects of different types of physical activity – aerobic exercise, strength training, socially connected physical activities including sports, group dancing, mindful movement exercises, flexibility, stability; a number of activities incorporate more than one aspect.

Objectives

4. Biological and psychological mechanisms through which mental/brain health and general health are promoted by physical activities.
5. Assessment of physical activities and fitness as part of routine evaluation.
6. Facilitating execution and adherence to physical activities programs.

Quiz

- Who lives longer, a jogger, or a tennis player?
- Does physical exercise affect hippocampus volume?
- Does grip strength in elderly predict mortality?
- Does ability to squat on the floor and get up predict longevity?
- How old do you feel? (Give yourself a number)

Aging – How Old do you feel?

- 395 men and 770 women aged 65–84 years at baseline in Finland
- The fully adjusted relative risk (RR) of death over 13 years with the perceived younger physical age category as referent:

Older category 1.42 (95% CI 1.00–2.02) Same age category 1.28 (1.03–1.60) (P=0.049)

Uotinen v et al. Perceived age as a predictor of old age mortality: a 13-year prospective study. Age and Ageing 2005;34:368–372

Pillars of Lifestyle for Health*

- Physical Activity (different kinds of Exercise, avoidance of prolonged sitting)
- Restorative Sleep
- Healthy Nutrition (predominantly whole food plant-based balanced food, variety, timing, calorie management)
- Connectedness (Positive Social, Meaningful Life)
- Stress Management (Emotional Health, Instrumental and Palliative Coping)
- Avoidance of risky behaviors and substances such as smoking

*(*As recognized by American College of Lifestyle Medicine)*

Physical activity

Physical activity encompasses all movements of which exercise is an important subset.

Physical Exercise is deliberately designed, repetitive intentional movement to achieve specific physical improvement objectives.

Both exercise and non-exercise physical activities are important for physical and mental health. Many people live long without doing formal physical exercise, but doing moderately intense or intense physical activities during the course of their every day life. In modern societies many people have become less active and need exercise.

Why is physical activity important

Use it or lose it.

- Functions, skills, physical and mental capabilities—including muscle strength, coordination, balance, language, cognitive functions —will deteriorate or weaken if not used regularly.
- Without use, muscles atrophy.
- Unused neural pathways are degraded or pruned.
- Without ongoing optimal stress, bone architecture deteriorates.

Grgic J. Use it or lose it? A meta-analysis on the effects of resistance training cessation (detraining) on muscle size in older adults. International Journal of Environmental Research and Public Health. 2022 Oct 28;19(21):14048.

Levels M, Van Der Velden R. Can work protect against age-related decline of cognitive skills?: An empirical test of the use-it-or-lose-it hypothesis. In A Research Agenda for Skills and Inequality 2023 Mar 21 (pp. 161-176). Edward Elgar Publishing.

Hormesis

Low doses of a stressor or toxin induce beneficial, adaptive effects, while high doses are harmful.

“What does not kill me makes me stronger.” - Friedrich Nietzsche, 1844-1900.

“The dose makes the poison” - Paracelsus, 1493-1541.

Mithridates VI, 120-63 BC, made himself immune to a variety of toxins by regular exposure to small doses. Many other ancient practices.

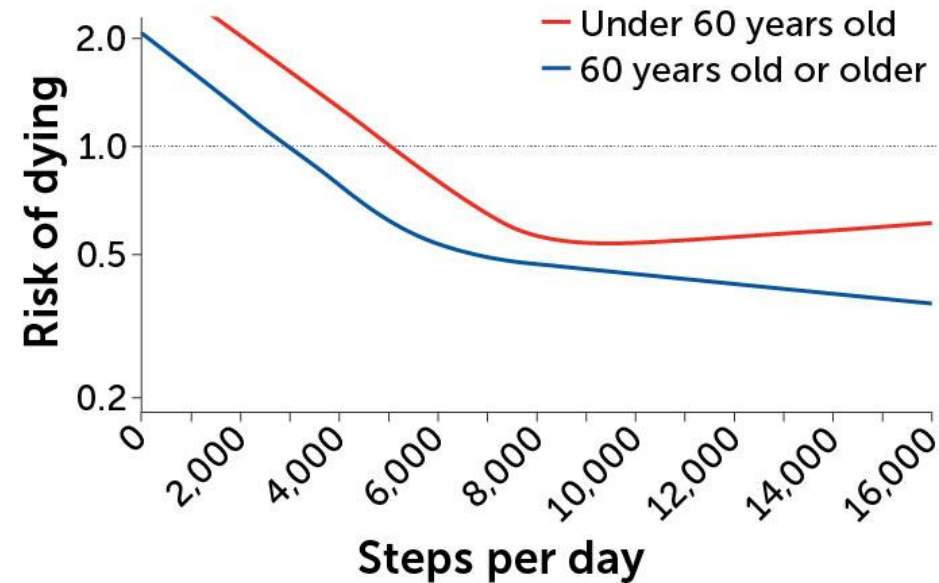
Current examples: Immunization, **physical exercise**, exposure psychotherapy, intermittent calorie restriction?, metformin? Vigorous exercise is inflammatory when done, but regular exercise is anti-inflammatory in the long run as a defensive reaction.

Viswanathan R. *Hormesis, Resilience, and Positive Psychiatry*. *Psychiatric News*, Volume 59, Number 09, 2024 September, p 2, From the President.

<https://psychiatryonline.org/doi/10.1176/appi.pn.2024.09.9.21>

A.E. Paluch, AE, et al., The Lancet Public Health, 2022

Lee I et Al: Association of Step Volume and Intensity With All-Cause Mortality in Older Women. JAMA Intern Med. 2019;179:1105-1112



Leisure Time Physical Activity Type & Longevity

- 8577 participants in Copenhagen followed up to 25 years for all-cause mortality from their examination between October 10, 1991, and September 16, 1994 until March 22, 2017.
- Multivariable-adjusted life expectancy gains compared with the sedentary group:
- Tennis: 9.7 years Badminton: 6.2 Soccer: 4.7 Cycling: 3.7
- Swimming: 3.4 Jogging: 3.2 Calisthenics: 3.1 Health club: 1.5

Schnohr, Peter et al. Various Leisure-Time Physical Activities Associated With Widely Divergent Life Expectancies: The Copenhagen City Heart Study. Mayo Clinic Proceedings, 2018;Volume 93, Issue 12, 1775 – 1785

Is Sitting “the new smoking”?

Absolute Risk Excess Deaths from any cause per 100,000 persons per year:

Smoking >40 cigarettes/day compared with never smokers: **2000** (Hazard ratio 4.08) (For developing depression, 1.62)

Highest volume of **Sitting > 8 hours/day** compared to <4 hours/day: **190. (HR 1.22)** (For developing Type 2 diabetes 1.91, Depression 1.14). Heightened mortality risk from sitting 7 hours/day or more.

5.9% of deaths could be attributed to total daily sitting time.

Vallance JK, et al. Evaluating the Evidence on Sitting, Smoking, and Health: Is Sitting Really the New Smoking? Am J Public Health. 2018;108(11):1478-1482

Exercise – Hippocampal Volume Schizophrenia Study

- Hippocampal volume is lower than expected in patients with schizophrenia, depression, and Alzheimer's dementia.
- Exercise is a stimulus to hippocampal plasticity.

Schizophrenia Study - Munich

- Age- 20 to 51 years of age
- Patients and non-patients: Cycling 30 minutes 3 times a week for 12 weeks at a heart rate (± 10 beats/min) corresponding to a blood lactate concentration of about 1.5 to 2 mmol/L (14-18 mg/dL) derived from the results of a pretest, (Zone 3 exercise, vigorous enough to be near the lactate threshold without lactate accumulation.)
- Comparison patient group played tabletop football.

Pajonk FG et al. Hippocampal Plasticity in Response to Exercise in Schizophrenia. Arch Gen (JAMA) Psychiatry. 2010;67:133-143

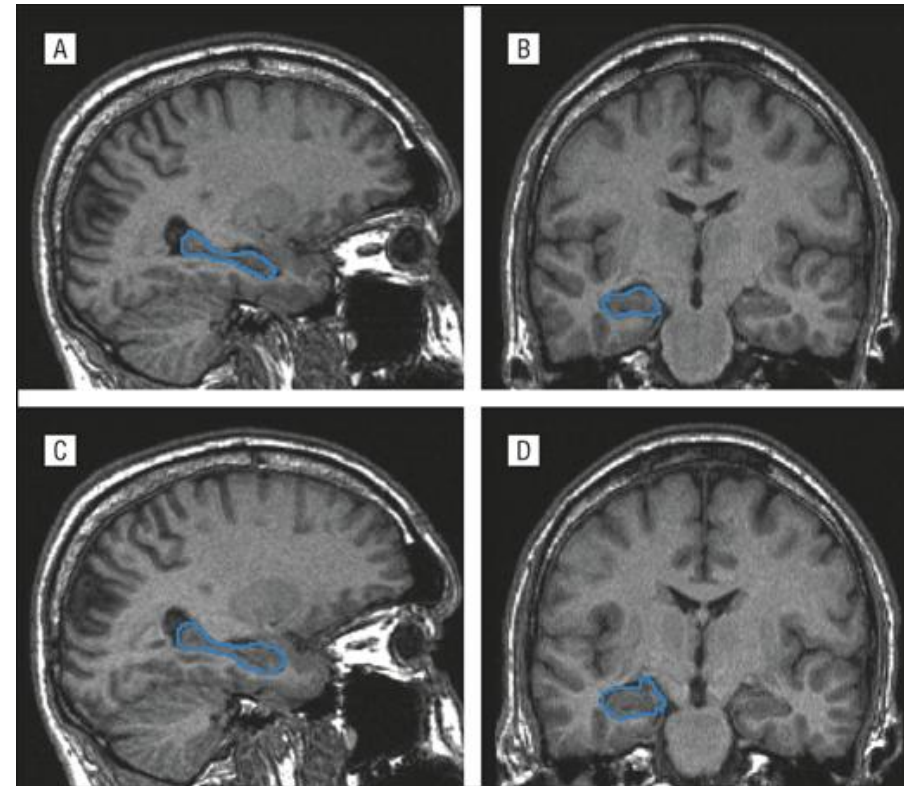
Results of Munich Exercise Schizophrenia Study

- Following exercise training, change in relative hippocampal volume:
 - Patients: Increased 12%
 - Healthy subjects : Increased 16%
 - Non-exercise group of patients: No change (–1%)
- Schizophrenia exercise group: Change in hippocampal volume was associated with a 35% increase in the N-acetylaspartate (marker of neuronal integrity) to creatine ratio in the hippocampus, and cognitive improvement.
- PANSS showed reduction in negative symptoms in patients with schizophrenia with exercise intervention.

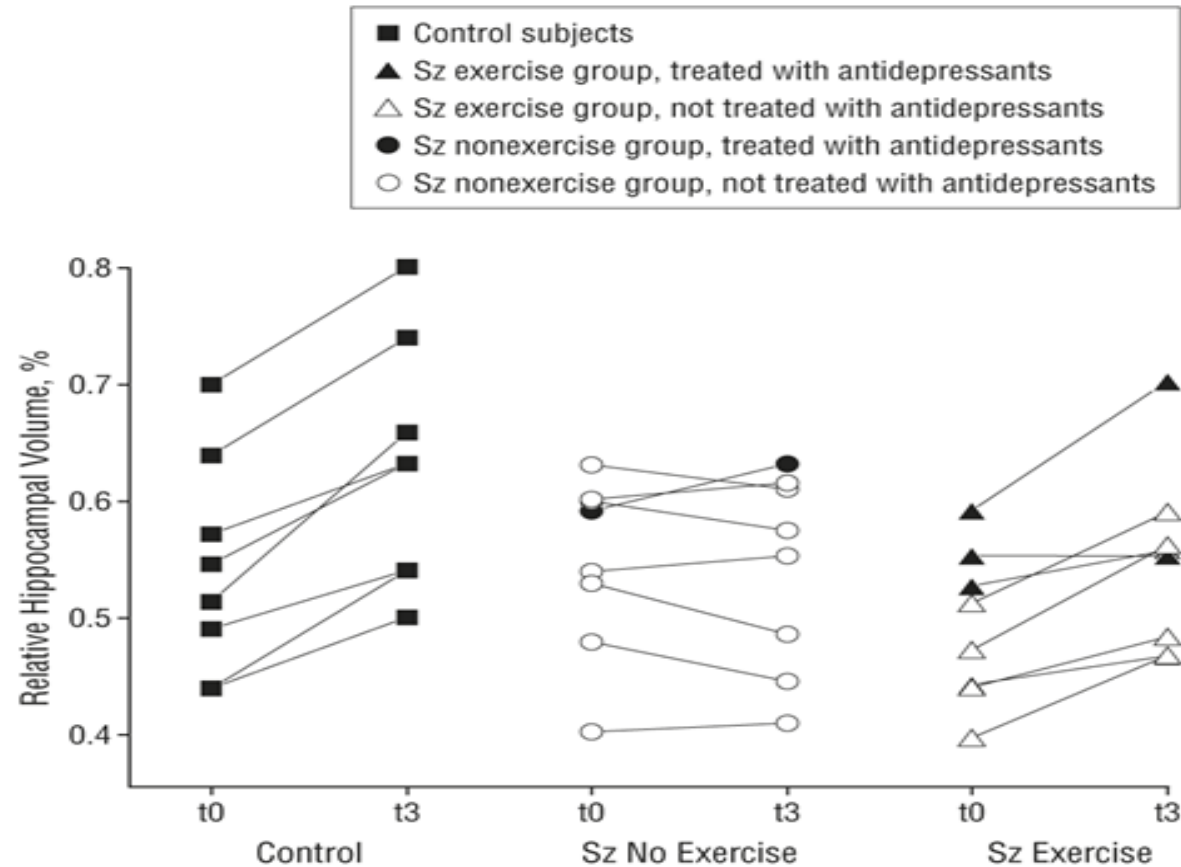
Hippocampal volume increase after 3 months of exercise

- T1-weighted magnetic resonance images in the sagittal and coronal plane, with the right hippocampus marked in blue, comparing baseline (A and B) and end point (C and D) of the patient in the schizophrenia exercise group with the largest increase in hippocampal volume (from 3.898 cm³ to 4.667 cm³; +19.7%).

Pajonk FG et al. Hippocampal Plasticity in Response to Exercise in Schizophrenia. Arch Gen (JAMA) Psychiatry. 2010;67:133-143



The data points present the relative hippocampal volume of each subject as a percentage of the total brain volume at baseline (t0) and 3 months later at end point (t3).



Sz=Schizophrenia

Brain-Derived Neurotrophic Factor (BDNF) (Abrineurin)

- Activates TrkB tyrosine kinase receptor
- Supports survival of existing neurons, growth, adaptation of neurons and synaptic connections in hippocampus, cortex, basal forebrain. Also expressed in skeletal muscle.
- Patients with major depressive disorder, anxiety disorders and neurocognitive disorders have lower BDNF levels
- Gene-Environment Interaction (Epigenetic Changes)

People with a variant of BDNF gene Val66Met –

BDNF production low under stress including adverse childhood events

(ACE)

Frequent in depression, anxiety, neurodegenerative disorders such as Parkinson's and Alzheimer's.

Zhao M et al. BDNF Val66Met Polymorphism, life stress and depression: A meta-analysis of gene-environment interaction. J Affect Dis 2018; 227:226-35

Neurobiological Mechanisms – Physical Activity

- **Neurogenesis:**

Exercise increases Brain-Derived Neurotrophic Factor (BDNF), which promotes neurogenesis and synaptic connections and neuronal health in hippocampus and other areas.

van Praag H, Shubert T, Zhao C, et al: Exercise enhances learning and hippocampal neurogenesis in aged mice. J Neurosci 25:8680–8685, 2005.

- **Neurotransmitter Systems**

- Enhances serotonin availability and tryptophan hydroxylase activity.
- Norepinephrine increases in brain regions managing emotional and stress responses.
- Release of beta-endorphins reduces pain.
- Endocannabinoids contribute to reduced pain sensitivity and anxiolytic effects.

Lynch WJ, Peterson AB, Sanchez V, et al: Exercise as a novel treatment for drug addiction: a neurobiological and stage dependent hypothesis. Neurosci Biobehav Rev 37(8):1622–1644

- **Hypothalamic-Pituitary-Adrenal (HPA) Axis Regulation**

- Regular Physical Activity attenuates the body's cortisol response to stress.

- **Mitigating Neuroinflammation**

- Increase in PGC1 α gene expression, a transcriptional co-activator involved in reducing the synthesis and releasing of pro-inflammatory cytokines, and an increase in anti-inflammatory cytokines, and reduces glutamatergic neurotoxicity.

Ignácio ZM, da Silva RS, Plissari ME, et al: Physical exercise and neuroinflammation in major depressive disorder. Mol Neurobiol 56:8323–8335, 2019

- **Microbiota:** Regular Exercise promotes good diversity in intestinal microbiota.

Aerobic Exercise - Physiologic Effects

Improving mitochondrial number, density, and function

Cai Y, Gan F, Chen Y, He Q, Chen W, Peng Z, Gong L. Mitochondria as a Therapeutic Target in Metabolic Disorders. Mini-Reviews in Medicinal Chemistry. 2025.

Memme JM, Erlich AT, Phukan G, et al: Exercise and mitochondrial health. J Physiol 599(3):803–817, 2021 31674658

Capillary development, collateral circulation

Mølmen KS, Almquist NW, Skattebo Ø. Effects of exercise training on mitochondrial and capillary growth in human skeletal muscle: a systematic review and meta-regression. Sports Medicine. 2025 Jan;55(1):115-44.

Fat oxidation

Brun JF, Myzia J, Varlet-Marie E, Raynaud de Mauverger E, Mercier J. Beyond the calorie paradigm: taking into account in practice the balance of fat and carbohydrate oxidation during exercise?. Nutrients. 2022 Apr 12;14(8):1605.

Cardiorespiratory Fitness – increase ability to consume more oxygen and use it efficiently; one measure of it is $\text{VO}_{2\text{max}}$, an excellent predictor of longevity.

Lazarus NR, Harridge SD. Exercise and Functional Integrity in Non-Disease and Disease States during human ageing: the relevance of $\text{VO}_{2\text{max}}$. Free Radical Biology and Medicine. 2025 Nov 20.

Psychological Pathways - Physical Activity – Mental Health

Self-Efficacy and Mastery

- Successfully meeting exercise goals builds a belief in one's ability to manage challenges.
- Improvements in self-efficacy mediate some of exercise's antidepressant effects.
- Sense of physical fitness influences mood.
- Exercise often provides opportunities for social connectedness, and connectedness with Nature.

Wang K, Li Y, Zhang T, Luo J. The relationship among college students' physical exercise, self-efficacy, emotional intelligence, and subjective well-being. International journal of environmental research and public health. 2022 Sep 15;19(18):11596.

Exercise – Immune Stimulation

- “Using newly developed reporter and lineage-tracing mice, [Shen et al.](#) found perivascular [stromal cells](#) coexpressing ostelectin and [leptin receptor](#) in the bone marrow that specifically supported lymphoid progenitors, served as [osteoblast](#) progenitors, and were maintained by [mechanical stimulation](#). Exercise may thus have joint positive influences on [lymphopoiesis](#) and bone formation.”
- Dietlein N, Rodewald H-R. Runner's niche: multipurpose stromal cells maintained by exercise. *Trends in Immunology* 2021;42:841-843

Gut Microbiota and Physical Activity

- “Exercise modulates the gut microbiome via splanchnic hypoperfusion, hyperthermia, altered transit time, and immune-mediated barrier regulation. Moderate-intensity continuous training consistently increases alpha diversity and enriches butyrate-producing taxa (*Faecalibacterium prausnitzii*, *Roseburia hominis*) and mucin-degrading *Akkermansia muciniphila*. High-intensity interval training transiently increases intestinal permeability in untrained individuals but, following adaptation, stimulates butyrate production via lactate cross-feeding metabolism—a recent breakthrough. Effects are transient and reversible upon detraining.”
- - Alsinani Y, Rostamkhani F, Shirvani H. Exercise and the Gut Microbiome: From Mechanisms to Clinical Applications. *Nutrients*. 2026; 18(10):1565. (Review of 47 human and 42 animal studies)

Inflammation

- Chronic inflammation associated with depression, anxiety, atherosclerosis
- Imbalance proinflammatory molecules > anti-inflammatory -> neuron loss, synaptic loss
- One-third of patients with depression have high levels of inflammation markers (C-reactive protein, Interleukin-6)

Feigler JC et al. Inflammation is associated with decreased functional connectivity within corticostriatal reward circuitry in depression. Molecular Psychiatry 2016;21:1358-65

Physical Activity and Mental Health



Physical Activity levels **inversely correlate with risk of developing depression**. Adults engaging in even half the guideline-recommended activity level (4.4 marginal MET hours/week) had 18% lower risk of developing depression; accumulating the recommended volume of 8.8 mMET hours per week had 25% reduction. Diminishing and less certain potential benefits beyond that level.

Pearce M, Garcia L, Abbas A, et al. Association Between Physical Activity and Risk of Depression: A Systematic Review and Meta-analysis. JAMA Psychiatry. 2022;79:550–559.

Physical activity showed strong evidence of effectiveness in protective effect and treatment of Depression, Anxiety, Psychotic disorders, ADHD.

Firth J, et al. A meta-review of “lifestyle psychiatry”: the role of exercise, smoking, diet and sleep in the prevention and treatment of mental disorders. World Psychiatry 2020;19:360–380.

Schuch FB, Vancampfort D, Firth J, et al: Physical activity and incident depression: a meta-analysis of prospective cohort studies. Am J Psychiatry 175(7):631–648, 2018

Hippocampal volume is reduced in major depressive disorder, schizophrenia, Alzheimer’s dementia. **Physical activity promotes neuroplasticity and hippocampal growth, partly through increase in brain-derived neurotrophic factor (BDNF).**

Physical activity improves sleep which in turn is related to mental functioning and disorders.

ACLM ECS – Major Depressive Disorder

Merlo G, Sugden S, Rosenfeld RM, Baron D, Karlsen MC, Keyes SA, McHugh JP, Miller LA, Nemeroff CB, Ramas ME, Staffier KL, Williams KA, Wilson KP, Wong WT, Viswanathan R. Lifestyle Interventions for Major Depressive Disorder (MDD): An Expert Consensus Statement From the American College of Lifestyle Medicine. *American Journal of Lifestyle Medicine*. 2026 Jan 8:15598276251408353. [doi:10.1177/15598276251408353](https://doi.org/10.1177/15598276251408353).

Some statements pertaining to physical activity:

- **Physical activity** is the lifestyle intervention that has the most compelling and **robust evidence** regarding efficacy for MDD. (Mean 8.09, no outliers)
- Sedentary behavior may increase risk for MDD. (Mean 7.82, no outliers)
- **Cardiovascular training and muscle training** are important for treating MDD and preventing complications. (Mean 7.82, no outliers)
- **Enjoyable activity** is more desirable because of an increased likelihood of individuals maintaining it. (Mean 8.27, no outliers)

Running – Rx Depression

- 16 weeks escitalopram v running (group) 45-minute outdoor, 2-3 times a week, supervised
- 141 patients, 58% women, mean age 38, Amsterdam
- Random allocation or self-preference
- **Remission: 44.8% escitalopram v 43.3% running** (intent-to-treat analysis). **Adherence 82.2%% v 52.1%**
- Runners had significant improvement in weight, waist circumference, systolic and diastolic BP, heart rate and heart rate variability

Penninx BWJH. Journal of Affective Disorders 2023 May 15. doi:10.1016/j.jad.2023.02.064

Exercise Rx Major Depressive Disorder (slide 1 of 2)

A review of 41 randomized controlled trials found large effects (standardized mean difference=−0.946, 95% CI −1.18 to −0.71) favoring **exercise** in adults diagnosed with MDD, resulting in a **NNT** (number needed to treat) of only **2 adults**. (**NNT 4.3 for medications**).

- Heissel A, Heinen D, Brokmeier LL, et al. Exercise as medicine for depressive symptoms? A systematic review and meta-analysis with meta-regression. *Br J Sports Med*. 2023;57(16):1049-1057. <http://doi.org/10.1136/bjsports-2022-106282>
- Cipriani A, Furukawa TA, Salanti G, Chaimani A, Atkinson LZ, Ogawa Y, Leucht S, Ruhe HG, Turner EH, Higgins JP, Egger M. Comparative efficacy and acceptability of 21 antidepressant drugs for the acute treatment of adults with major depressive disorder: a systematic review and network metaanalysis. *Focus (Am Psychiatr Publ)* 16: 420–429. 2018

A systematic review of 15 cohort studies found that adults meeting recommended volumes of weekly physical activity (8.8 MET hours/week) had a 25% lower risk of MDD or depressive symptoms than those who were inactive, and even suboptimal levels of physical activity reduced risk by 18%. An **inverse curvilinear dose-response association between physical activity and depression** was observed, with **steeper association gradients at lower activity volumes**.

- Pearce M, Garcia L, Abbas A, et al. Association Between Physical Activity and Risk of Depression: A Systematic Review and Meta-analysis. *JAMA Psychiatry*. 2022;79(6):550–559. doi:10.1001/jamapsychiatry.2022.0609

A meta-analysis of 218 randomized trials of adults with MDD concluded that compared to usual care, **moderate, dose-dependent reductions in depression** were found for **walking, jogging, yoga, strength training, and tai chi or qigong.**

- Noetel M, Sanders T, Gallardo-Gómez D, et al. Effect of exercise for depression: systematic review and network meta-analysis of randomised controlled trials. *BMJ (Clinical research ed)*. 2024;384:e075847. <http://doi.org/10.1136/bmj-2023-075847>

Exercise has been recommended as an adjunct treatment for depression by the WHO

- World Health Organization: *WHO guidelines on physical activity and sedentary behaviour*. 2020

Exercise Types

Aerobic – Cardiorespiratory endurance

Strength

Flexibility

Balance

Combination of above

Combination with Mindfulness, Connectedness,
Competitiveness

Resistance Training and Depression/Anxiety

- “Resistance training is an effective intervention in reducing depression and anxiety symptoms in young people, delivered across a range of settings.”

- Marinelli R, Parker A, Levinger I, et al. Resistance training and combined resistance and aerobic training as a treatment of depression and anxiety symptoms in young people: A systematic review and meta-analysis. *Early intervention in psychiatry*. 2024 Jan 1.

- “Resistance combined aerobic training had a particularly significant effect on middle-aged and elderly patients with depression, as well as on those with moderate depression...moderate frequency (3–4 times per week), a total weekly duration of more than 180 min and supervised training displayed the best results.”

- Wang H, Liu Q, Pan Y. Impact of combiner aerobic and resistance training on depression: a systematic review and meta-analysis of randomized controlled trials. *BMC Sports Science, Medicine and Rehabilitation*. 2025 Jan 23;17(1):10.

- Patients with major depressive disorder (MDD) have an augmented risk of cardiovascular morbidity and mortality.
- Autonomic dysfunction (as measured by heart rate responses and heart rate variability) not only during resting conditions, but also during exercise as well as recovery from exercise.
- Reduced cardio-respiratory fitness (CRF)

Herbsleb M., Schumann A., Lehmann L., Gabriel H.H.W., Bar K.J. Cardio-respiratory fitness and autonomic function in patients with major depressive disorder. Front Psychiatry 2019;10:980.

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Physical activity to improve cognition

“Physical exercise can reduce global cognitive decline and lessen behavioural problems in people with MCI or dementia. Its benefits on cognitive function can be primarily attributed to its effects on working memory.”

Law, C. K., Lam, F. M., Chung, R. C., and Pang, M. Y. (2020). Physical exercise attenuates cognitive decline and reduces behavioural problems in people with mild cognitive impairment and dementia: A systematic review. J. Physiother. 66, 9–18. doi: 10.1016/j.jphys.2019.11.014

Possible mechanisms: Release of nitric oxide, enhancing arterial elasticity and reducing blood pressure. Amelioration of type 2 diabetes mellitus.

“It is hypothesized that aerobic exercise modulates the activation of microglia and astrocytes, cells crucial to brain inflammation and neurogenesis, respectively. It has also been suggested that aerobic exercise promotes the release of exercise factors such as irisin, cathepsin B, CLU, and GPLD1, which could enhance synaptic plasticity and neuroprotection.”

Huang B, Chen K, Li Y. Aerobic exercise, an effective prevention and treatment for mild cognitive impairment. Frontiers in aging neuroscience. 2023 Aug 8;15:1194559.

Multicomponent exercise programs (cognitive and physical) with sufficient intensity improve the activities of daily living skills, walking, balance and visual processing, “which can provide a more independent life for people with dementia and mild cognitive impairment”.

Begde A, Jain M, Hogervorst E, Wilcockson T. Does physical exercise improve the capacity for independent living in people with dementia or mild cognitive impairment: an overview of systematic reviews and meta-analyses. Aging & mental health. 2022 Dec 2;26(12):2317-27.

Age is not a barrier to supervised physical activity programs!

Fall prevention – *Balance and Strength Training*

Community-dwelling women over age 80 in Dunedin, New Zealand

Balance, Lower Limbs Strength (0.5 – 1 kg ankle weights) training program, 30 minutes

Taught by four one-hour home visits by physical therapist in the first 2 months

Hip extensor and abductor muscles, knee flexor and extensor muscles, inner range quadriceps, and ankle plantar and dorsiflexor muscles. Standing with one foot directly in front of the other; walking placing one foot directly in front of the other; walking on the toes and walking on the heels; walking backwards, sideways, and turning around; stepping over an object; bending and picking up an object; stair climbing in the home; rising from a sitting position to a standing one; knee squat; and “active range of movement” exercises (for example, neck rotations and hip and knee extensions).

Advised to do 3 times a week, and take walks outside home 3 times a week

In one year, 88 falls in the exercise group (116 subjects), 152 falls in the control group (117 subjects). Relative hazard for a first fall with injury in the exercise group compared with the control group 0.61.

Best Predictor of Falls: *Prior Falls*

Campbell AJ, Robertson MC, Gardner MM, Norton RN, Tilyard MW, Buchner DM. Randomised controlled trial of a general practice programme of home based exercise to prevent falls in elderly women. BMJ 1997;315:1065-9

Fall prevention – *Exercise Programs Meta-analysis*

17 trials involving 4305 participants

Exercise (multi-component, emphasize balance training) showed significant risk-reducing effect, with pooled estimates of the rate ratios of:

0.63 for all injurious falls

0.70 for falls resulting in medical care

0.57 for severe injurious falls

0.39 for falls resulting in fractures

El-Khoury F, Cassou B, Charles M, Dargent-Molina P. The effect of fall prevention exercise programmes on fall induced injuries in community dwelling older adults: systematic review and meta-analysis of randomised controlled trials BMJ 2013; 347 :f6234

Physical Activity and Longevity

Physical activity is associated with **reduced all-cause mortality, and cardiovascular and cancer-related mortality.**

Kraus WE, et al. Physical activity, all-cause and cardiovascular mortality, and cardiovascular disease. Med. Sci. Sports Exerc. 2019;51:1270–1281.

Rezende LFMD, et al. Physical activity and cancer: an umbrella review of the literature including 22 major anatomical sites and 770 000 cancer cases. Br. J. Sports Med. 2018;52:826–833.

Recent guidelines recommend 150–300 minutes of moderate-intensity activity or 75–150 min of vigorous-intensity physical activity (≥ 6 metabolic equivalents) per week. (20% mortality reduction)

Bull FC, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br. J. Sports Med. 2020;54:1451–1462.

Piercy KL, et al. The physical activity guidelines for Americans. JAMA. 2018;320:2020–2028.

Higher the physical activity, the **more** the longevity **benefit** (but diminishing returns) till 600 minutes of moderate activity or 300 minutes of vigorous activity per week **after which no further reduction in mortality.**

Lee DH, Rezende LFM, Joh H-K, et al: Long-term leisure-time physical activity intensity and all-cause and cause-specific mortality: a prospective cohort of US adults. Circulation 146:523–534, 2022

Brief Bursts of Intense Activity in Daily Life

Brief bursts of vigorous intermittent lifestyle physical activity (VILPA) that is embedded into everyday life, typically 1-2 min long, such as bursts of very fast walking while commuting to work, or stair climbing.

“Compared with participants who engaged in no VILPA, participants who engaged in VILPA at the sample median VILPA frequency of **3 length-standardized bouts per day (lasting 1 or 2 min each) showed a 38%–40% reduction in all-cause and cancer mortality risk and a 48%–49% reduction in CVD mortality risk.**” ... similar results when repeating the above analyses for vigorous physical activity (VPA) in 62,344 UK Biobank participants who exercised (1,552 deaths, 35,290 women/27,054 men). These results indicate that **small amounts of vigorous nonexercise physical activity are associated with substantially lower mortality.** VILPA in nonexercisers appears to elicit similar effects to VPA in exercisers, suggesting that VILPA may be a suitable physical activity target.

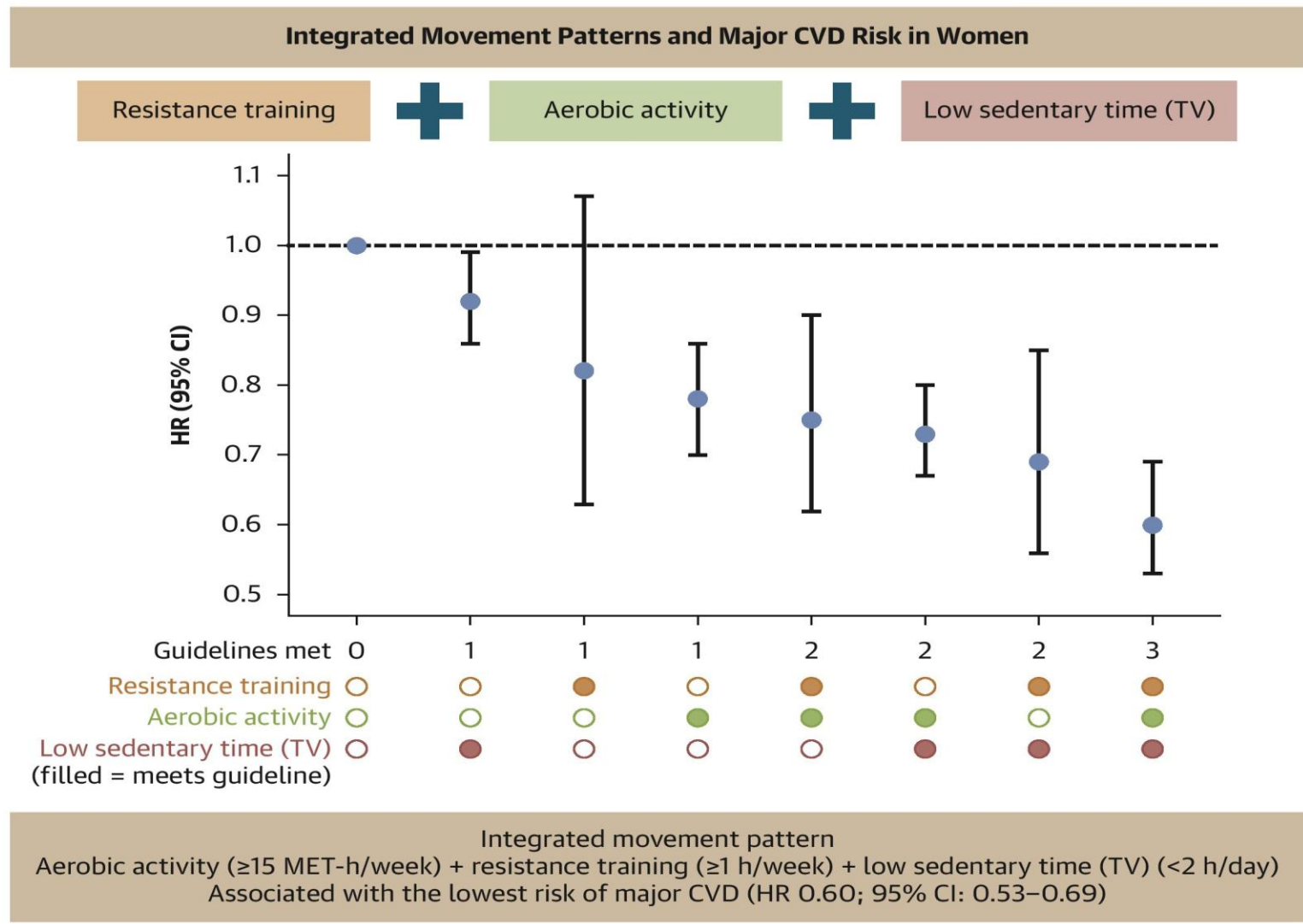
Stamatakis E, Ahmadi MN, Gill JMR, et al: Association of wearable device-measured vigorous intermittent lifestyle physical activity with mortality. Nat Med 28(12):2521–2529, 2022 36482104

CVD risk Lowered by Resistance Training in addition to Aerobics

- 117,025 women Nurses' Health Studies, "...over a mean of 14.5 years of follow-up 5,459 incident major CVD events occurred. Compared with no resistance training, women performing ≥ 2 h/wk had a **20% lower risk of major CVD** (HR: 0.80; 95% CI: 0.69-0.92; P for trend = 0.007), and each additional 1 h/wk was associated with a 5% lower risk (HR per 1 h/wk: 0.95; 95% CI: 0.92-0.99). The inverse association was stronger for MI (HR for ≥ 2 h/wk vs none: 0.56; 95% CI: 0.41-0.76) but not evident for stroke (HR: 0.99; 95% CI: 0.80-1.23). **Women who met recommendations for aerobic activity (≥ 15 metabolic equivalent of task hours per week), resistance training (≥ 1 h/wk), and low sedentary television viewing (< 2 h/d) had a lower risk of major CVD (HR: 0.60; 95% CI: 0.53-0.69), than those meeting aerobic and low sedentary television viewing recommendations but not resistance training (HR: 0.73; 95% CI: 0.67-0.80). Greater consistency in maintaining resistance training ($\geq 75\%$ of follow-up) and engaging in both upper and lower limb training were associated with stronger inverse associations."**

Tianyue Zhang et al. Resistance Training, Aerobic Activity, Television Viewing, and Risk of Major Cardiovascular Events in U.S. Women, JACC, 2026,

CENTRAL ILLUSTRATION: Joint Associations of Meeting Guidelines for Aerobic Activity, Resistance Training, and Low Sedentary Television Viewing Time With Risk of Major CVD, Myocardial Infarction, and Stroke in Women (Pooled Nurses' Health Study and Nurses' Health Study II)



Metabolic equivalent of Task (met)

Ratio of metabolic rate (oxygen consumed) during a task compared to **resting metabolic rate (1 MET, 3.5 milliliters of oxygen per kilogram of body weight per minute)** during quiet rest or sitting. Some examples (can vary among individuals based on fitness):

Sleeping = 0.9 METs

Walking 3 miles (4.8 km) per hour = 3 METs

Climbing two flights of stairs = 5 METs

Running at 10.9 miles (17.5 km) per hour = 18 METs

MET hour = Metabolic equivalence of activity for one hour

MET hours per week = MET hour multiplied by Number of hours per week the activity is engaged in.

Mendes MD, Da Silva I, Ramires V, Reichert F, Martins R, Ferreira R, Tomasi E. Metabolic equivalent of task (METs) thresholds as an indicator of physical activity intensity. PloS one. 2018 Jul 19;13(7):e0200701.

Exertion Intensity: Zones, Perceived Exertion, Talk test

Zone	Intensity	Talk Test	Metabolic Underpinning (Individual Variations in Measures)
1	Very Light PE (Perceived Exertion) = 1-2	Can Sing or speak in long, fluid paragraphs without any interruption to breathing.	Warm-up/Recovery. Heart Rate 50-60% of MHR (Maximal Heart Rate, 220-Age years). < 3 METs. Primary Fuel: Fat 90%+.
2	Light/Moderate PE = 3-4	Can speak in full sentences and carry on a normal conversation, but breathing is audible.	Around Aerobic Threshold (VT1) . 60-70% of MHR. 3-4.5 METs. Fat 70-85%. Much exercise needs to be in Zones 2-3.
3	Moderate/Hard PE = 5-6	Can only speak in short, choppy phrases . Continuous conversation becomes "comfortably hard".	Aerobic/Anaerobic Mix. 70-80% of MHR; 4.5-6 METs. Fat 50%, Carbohydrate 50%.
4	Hard/Vigorous PE = 7-8	Can only manage one or two words at a time before needing to gasp for air. (Ventilatory Threshold 2, Lactate accumulates rapidly, fatigue 30-60 minutes).	Lactate Threshold (VT2) . 80-90% of MHR. 6-9 METs. Carbohydrate 70-85%. Interval Training improves body's ability to buffer lactate, allowing to maintain a faster pace for longer.
5	Maximal PE = 9-10	Speaking is impossible . Gasping for air and focused entirely on breathing.	Anaerobic Peak. 90-100% of MHR. > 9 METs. Carbohydrate 100%.

References for talk test, zone training

Jeans EA, Foster C, Porcari JP, Gibson M, Doberstein S. Translation of exercise testing to exercise prescription using the talk test. The Journal of Strength & Conditioning Research. 2011;25:590-6

Woltmann ML, Foster C, Porcari JP, Camic CL, Dodge C, Haible S, Mikat RP. Evidence that the talk test can be used to regulate exercise intensity. The Journal of Strength & Conditioning Research. 2015;29:1248-54.

Bayles, M.P. ACSM's Exercise Testing and Prescription; Lippincott Williams & Wilkins: Philadelphia, PA, USA, 2023

Franklin BA et al. Physical activity, cardiorespiratory fitness, and cardiovascular health: A clinical practice statement of the ASPC Part I: Bioenergetics, contemporary physical activity recommendations, benefits, risks, extreme exercise regimens, potential maladaptations. Am J Prev Cardiol. 2022 Oct 13;12:100424

Physical activity – *Treat as A Vital Sign* in Clinical Assessments

Days/week of aerobic activity x Minutes of
aerobic activity/Day = **Minutes of aerobic
physical activity/ week**

Coleman KJ, Ngor E, Reynolds K, et al. Initial validation of an exercise “vital sign” in electronic medical records. Med Sci Sports Exerc. 2012;44:2071 – 2076

ICD 10: Z72.3 Lack of physical exercise.

Assessment of physical activity and fitness without sophisticated equipment – slide 1/4

- History: Physical activity vital sign, Types, duration, frequency of aerobics including sports, strength training, balance and flexibility exercises, Falls, medical impairments, enjoyments. Initial assessment measures can also be used for targets of improvement.
- Timed Up and Go (TUG) test: On the word "GO," stand up (using armrests if necessary), walk at a comfortable, safe pace 10 feet (3 meters) (indicated by a mark), turn around, walk back, and sit down.

< 10 seconds: Independent, low fall risk.

< 20 seconds: Mostly independent, low to moderate risk.

➤ **30 seconds: Indicates a high risk of falling and limited mobility.**

Ascencio EJ, Cieza-Gomez GD, Carrillo-Larco RM, Ortiz PJ. Timed up and go test predicts mortality in older adults in Peru: a population-based cohort study. BMC geriatrics. 2022 Jan 18;22(1):61.

Furlanetto KC, Correia NS, Mesquita R, Morita AA, do Amaral DP, Mont'Alverne DG, Pereira DM, Pitta F, Dal Corso S. Reference values for 7 different protocols of simple functional tests: a multicenter study. Archives of physical medicine and rehabilitation. 2022 Jan 1;103(1):20-8.

Assessment of physical activity and fitness without sophisticated equipment – slide 2/4

Balance tests - Stand one foot in front of the other for 30 seconds. Stand on one leg for 30 seconds.

2-minute walk test – How far can a person walk on a flat, level surface in 2 minutes. Mean 181 meters (189 for men, 176 for women; influenced by gender and age).

Selman JP, de Camargo AA, Santos J, Lanza FC, Dal Corso S. Reference equation for the 2-minute walk test in adults and the elderly. Respiratory care. 2014 Apr;59(4):525-30.

Bohannon RW, Wang YC, Gershon RC. Two-minute walk test performance by adults 18 to 85 years: normative values, reliability, and responsiveness. Archives of physical medicine and rehabilitation. 2015 Mar 1;96(3):472-7.

Nguyen DT, Penta M, Chinh NV, Sauvage C. Comparison of walking performance with the 6-minute and the 2-minute walk tests in elderly living in the community and in a nursing home. J Rehabil Res Pract. 2025;6(1):9-16.

6-minute walk test (often done in cardio-pulmonary offices with measurements of SpO₂, pulse rate, respiratory rate, breathlessness perception. Considerable research evidence in predicting mortality risk in CHF, COPD), correlated with exercise test on treadmill. Can be done with smart watches. Kervio G, Carre F, Ville NS. Reliability and intensity of the six-minute walk test in healthy elderly subjects. Med Sci Sports Exerc. 2003 Jan;35(1):169-74

Mean 593 meters for women, 638 for men.

Chetta A, Zanini A, Pisi G, Aiello M, Tzani P, Neri M, Olivieri D. Reference values for the 6-min walk test in healthy subjects 20-50 years old. Respir Med. 2006 Sep;100(9):1573-8. doi: 10.1016/j.rmed.2006.01.001. Epub 2006 Feb 7. PMID: 16466676.

- Cooper 12-minute run (maximal aerobic fitness test) – maximum distance a person can walk or run in a flat measured surface such as a track in 12 minutes. $VO_2 \text{ max} = (22.351 \times \text{kilometers}) - 11.288$ or $(35.97 \times \text{miles}) - 11.291$.

Anstrén L. The Reliability of Cooper's Test in Subjects Between 28-60 Years of Age. 2015, diva-portal.org

- VO_2 max estimates and other measures by smart watches and wearable technology.

Assessment of physical activity and fitness without sophisticated equipment – slide 4/4

Muscular strength – Get up from chair without holding onto anything.

Maximum weight one can lift and hold.

Grip Strength (proxy for overall health/frailty, many studies as risk factor for mortality)

López-Bueno R, Andersen LL, Calatayud J, Casaña J, Grabovac I, Oberndorfer M, del Pozo Cruz B. Associations of handgrip strength with all-cause and cancer mortality in older adults: a prospective cohort study in 28 countries. Age and Ageing. 2022 May 4;51(5):afac117.

Muscular Endurance: Maximum number of correctly performed squats or getting up from chairs and sitting down repeatedly without rest, push ups without rest.

Flexibility: Sit and Reach test.

VO₂ max

- **VO₂ max is the gold-standard measure of one's aerobic fitness — essentially how much (V=volume) oxygen one's body can use during intense exercise, expressed in mL/kg/min. Reflects how efficiently one's heart, lungs, blood, and muscles work together.**
- **Higher VO₂max is strongly linked to better endurance, faster recovery, better cardiovascular health and longevity.**
- When age of 30 years is reached, VO₂max starts to decline with 9-10 percent per decade but the decline can be reduced by different forms of exercise. With exercise of moderate to high intensity the decline can be reduced by almost 50 percent.

Strength Exercise Principles

Major muscle groups of functional relevance, 2 to 3 times a week with at least one day rest in-between, 1.5 days for elderly. Exercise in a safe manner. Keep your breath flowing. Warm up. Has to be challenging in weight (resistance if using bands) and duration, without being too stressful that can cause injury. Make progression gradually in increasing weights/resistance over sessions. Generally 7-12 repetitions with 70% of maximum weight one can lift once, 3 sets, with 30-120 seconds recovery between sets. (30 seconds for endurance, 120 seconds for maximal muscle growth). Quick smooth concentric contraction (forceful lifting), slow eccentric contraction (gradual lowering). 50% of potential improvement from one set, 75% from 2 sets, 90% from 3 sets.

Good nutrition with adequate protein intake. Current US guidelines 1.2 to 1.6 grams per Kg body weight/day, (For 70 Kg, 154 lb man, 84 to 112 g daily). Pre-2025 guidelines recommended 0.8 g/Kg. Spread intake through the day (3 hours apart) as muscle synthesis cannot use more than 40 g of protein per meal. Mixture of plant proteins makes up for deficiencies of amino acids in a particular plant.

Protein alone does not build muscle, stimulus to muscle growth via load is important.

Why Strength training is important

From age 30 onwards, progressive loss of bone, muscle strength, muscle mass. Progressive decline in exercise capacity, VO2 max. This can be decelerated by regular weight-bearing physical activity. In modern world, for many it requires regular, planned exercises with load.

Both lower and upper body strength are important.

Once a person loses the ability to get up from the chair and walk, there is rapid deterioration of general health, resulting in institutionalization and premature death.

Lack of lower limb strength, flexibility and balance result in falls, sometimes with fractures or other serious injuries producing functional disability and death.

Grip strength and other tests of strength are correlated with frailty, increased risk of death, dementia, falls.

Strength and mobility help one access social and material rewards and thus keep mood good, reduce depression, increase social support.

Dehi M, Aghajari P, Shahshahani M, Takfallah L, Jahangiri L. The effect of stationary walking on the quality of life of the elderly women: a randomized controlled trial. J Caring Sci. 2014 Jun 1;3(2):103-11.

Strength training in the age of GLP-1 receptor agonists

When one loses weight by any method (such as taking glucagon-like peptide receptor agonists [GLP-1 RA], calorie restriction, intermittent fasting, bariatric surgery), one has to make extra effort to guard against muscle and bone loss by strength training and adequate protein intake.

Jensen SB, Sørensen V, Sandsdal RM, Lehmann EW, Lundgren JR, Juhl CR, Janus C, Ternhamar T, Stallknecht BM, Holst JJ, Jørgensen NR. Bone health after exercise alone, GLP-1 receptor agonist treatment, or combination treatment: a secondary analysis of a randomized clinical trial. *JAMA Network Open*. 2024 Jun 25;7(6):e2416775.

Rossi G, Bucciarelli L, Mananguite CL, Giovarelli M, Fiorina P. Muscle loss and GLP-1R agonists use. *Acta Diabetologica*. 2025 Nov 7:1-0.

Approximately 25% of total weight loss is generally thought to be from fat-free mass, with skeletal muscle loss contributing to about half of this component.

Heymsfield SB, Gonzalez MC, Shen W, Redman L, Thomas D (2014) Weight loss composition is one-fourth fat-free mass: a critical review and critique of this widely cited rule. *Obes Rev* 15(4):310–32

A daily protein intake of 1.2–1.6 g/kg body weight is recommended for strength training , and for people undergoing weight loss. There is no extra benefit beyond the 1.6/kg level.

Mozaffarian D, Agarwal M, Aggarwal M, Alexander L, Apovian CM, Bindlish S et al (2025) Nutritional priorities to support GLP-1 therapy for obesity: A joint advisory from the American college of lifestyle medicine, the American society for Nutrition, the obesity medicine Association, and the obesity society. *Obes Pillars* 15:100181

Morton RW, Murphy KT, McKellar SR, Schoenfeld BJ, Henselmans M, Helms E, Aragon AA, Devries MC, Banfield L, Krieger JW, Phillips SM. A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength in healthy adults. *British journal of sports medicine*. 2018 Mar 1;52(6):376-84.

Occupying one's Mind during Exercises

Listening to podcasts including journal articles, audiobooks. Helpful for time-pressured, and helps you keep abreast of the literature.

Music

Mindfulness or enjoying surroundings

Conversations in group exercises or by phone

Some Helpful Tips to aid Exercising

Establish a Routine. Habit. Cues are powerful. To overcome inertia, remind yourself that within a few minutes of beginning exercise you are likely to feel good.

Focus on small gradual gains.

Anticipate obstacles such as weather, time, and build systems to overcome them.

Exercise with a partner.

Variety is important.

Multitasking.

Do things you enjoy and are easy to implement.

Set up systems to promote physical activity

Founded in 2014 Brooklyn Psychiatric Society's Annual 5 K Run.



Papua New Guinea Lecture - 2024

 **Massachusetts General Hospital**
Founding Member, Mass General Brigham
Psychiatry Academy



Thank You !

Ramaswamy.Viswanathan@downstate.edu

