

## REVIEW

# Physical activity for health

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## Summary

*Physical activity plays a substantial role in maintaining people's good health and mental wellbeing, but that is not all: not only it positively affects the individuals' mental and physical health, but a lack of physical exercise exerts a negative impact also on the overall economy of a nation. In addition, physical inactivity not only increases the risk of non-communicable diseases (NCD), but also contributes significantly to the increased morbidity and mortality in patients suffering from these diseases. On the contrary, physical activity reduces the risk of NCDs – such as cardiovascular diseases, type 2 diabetes, and cancer – in a dose-dependent manner; regular exercise is also*

*associated with many health benefits and delayed mortality. However, understanding the role of physical activity in modern society and creating an awareness in the general population is one of the most important tasks of health and recreation promoters. Correspondingly, there is a dire need to enhance our knowledge, perception, and awareness of physical activity and its impacts on an individual's health, ultimately contributing to developing a healthy society. The current review will focus on the health benefits of the two most widely studied modifiable lifestyle risk factors, physical activity and diet, focusing particularly on the Mediterranean diet.*

## Introduction

The conventional Mediterranean diet (Med Diet) – which includes olive oil, fresh vegetables, fruits, legumes, nuts, fish, and red wine, and is characterized by minimal consumption of red/processed meats, fat-containing dairy products, and sweets – was proven to have several health benefits for humans, including a marked reduction in chronic diseases and improved health [1]. On the other hand, also physical activity (PA) has been proven a booster of healthy life. Accordingly, the synergistic effects of Med Diet and physical activity are apparent from several observational studies, as well as from personal experience of people belonging to different geographic area. Both Med Diet and physical activity have been reported to improve longevity and quality of life. For instance, several studies showed that Med Diet has an inverse relationship with total mortality [1-3]. Also, there are strong inverse associations between the consumption of foods following the principles of the Med Diet and cardiovascular mortality [3]. Correspondingly, synergizing physical activity with Med Diet reduces the risk for incidence and progression of cancer, mortality, and CVD. A recent study, which hypothesized the combined effect of Med Diet and physical activity on the reduction of total mortality, utilized data from the cohort of Seguimiento Universidad de Navarra (SUN), which

had 19,464 participants who were followed up between December 1999 and February 2016 [4]. The study reported that the synergistic effects of both PA and Med Diet reduced the hazard ratio (HR) and respective mortality. Furthermore, Med Diet alone lowers the mortality rate up to 95%, with multivariable adjusted HR 0.66. This effect is further enhanced when combined with high or moderate physical activity: in this case, the HR is reduced to 0.36 [2].

The positive impact of PA on health has been known for centuries. For instance, the ancient philosopher Plato emphasized the importance of PA by stating that “Lack of activity destroys the good condition of every human being, while movement and methodical physical exercise save it and preserve it”. In fact, this statement is as valid today as it was in ancient times. The modern lifestyle not only has led to decreased PA in doing the normal day-to-day chores, but also promoted human beings' dependency on machines: for instance, people do not need to walk to work or school, they depend on vehicles instead. This lifestyle has brought many comforts, of course, but at the expense of people's physical wellbeing: the reduced PA has raised great concerns about public health and wellbeing. In fact, decreased PA, also coupled with diet regimes rich in fast and fried foods, has increased the obesity rates to alarming levels more or less worldwide [5, 6]. In addition, this has resulted in an increased incidence of non-communicable diseases such as diabetes, cancer,

cardiovascular problems, inflammatory diseases, thus leading to increased morbidity and mortality [3-6]: lack of PA has become the fourth leading cause of mortality [7]. Not only this is an alarming situation, but it also has a huge socioeconomic impact on the healthcare system, with nations spending millions of dollars as maintenance cost of physically inactive citizens and in PA promotion programs. Therefore, it is direly needed to make the public realize the importance of physical activity, alone or in combination with healthy dietary regimes like the Med Diet, so that the full potential of both can be reaped for shaping a healthy and active lifestyle.

### Physical activity and health

Physical activity can be defined as ‘any bodily movement generated by skeletal muscles at the expense of energy utilization’: lifting, working out, playing, travelling, walking, cycling, dancing, gardening, housework are all examples of PA [7]. The compendium of PA is helpful in estimating the metabolic intensity of activity, as compared to a resting stage, in terms of metabolic equivalent tasks (METs) [8]. METs are used to categorize activities, for example sedentary or inactive (such as watching television, lying in supine position, desk work, light intensity or effortless behaviour grocery shopping, slow walk), moderate intensity (such as slow cycling, lawn mowing), and energetic activity (such as fast cycling, jogging, running) (Tab. I). Apart from PA levels, also the individual’s genetics influence PA results and the onset of several NCDs, among which obesity and cardiovascular diseases [9-13]. Several studies have reported that physical inactivity leads to an enhanced risk of all-cause mortality, overall poor health, and lower life expectancy, with high rates of morbidity and mortality in patients with underlying chronic diseases such as hypertension, diabetes, CVD, chronic obstructive pulmonary disease (COPD), especially when the patient’s BMI is above 30, indicating obesity [14-16]. These studies have also pointed out that a minimum increase in physical activity, such as adding an hour of walk weekly, could significantly improve the overall health and

reduce the risk of mortality. Furthermore, vigorous or high intensity physical activity not only stimulates the body systems, but also exerts positive effects on overall health condition. For instance, strong aerobic or endurance activities (like swimming or fast running/walking 150 minutes per week) not only reduce high blood pressure and type 2 diabetes, but also improve the lipid profile and decrease the risk of cardiovascular diseases (Tab. II) [17-19]. Additionally, weight endurance and weight-supporting exercises such as skipping, jumping, weight training, and using playground equipment, lead to the development of a healthy bone mass, bone health, muscular power, and musculoskeletal fitness [20].

### Effects of physical activity on cardiovascular diseases

Physical activity does wonders on heart health and circulation. This can be assessed by a simple fact: men are less prone to serious heart disease than women are, because generally they are more physically active. Physical activity, however, reduces 30-40% CVD risk in women [17, 24, 29, 31]. Regular exercise will attenuate chronic heart diseases by improving the cardiovascular system (the heart contraction and relaxation is refined with effective blood pumping and circulation) and by increasing lung capacity to facilitate oxygen intake and to improve dilation of blood vessels.

Additionally, altering blood lipid profiles by increasing ratio of protective high-density lipoprotein (HDL) to low density lipoprotein (LDL) and an enhanced usage of fat as fuel. This leads to a reduction of heart disease and stroke risk factors, such as high blood pressure and abnormal blood lipid profiles [32-34].

### Effects of Physical activity on Type 2 diabetes

Type 2 diabetes is mostly seen in adults over 40 years, but also in children and young people having a seden-

Tab. I. Classification of physical activity levels in terms of METs and their corresponding risk of mortality in case of underlying chronic diseases.

Metabolic equivalents (METs)	Classification of activity	Examples of activity	Risk of mortality in case of underlying chronic diseases and High Body mass Index (BMI) > 30*
1.0-1.5	Sedentary or inactive behaviour	Lying in supine position, meditating, desk work, watching TV, listening to music without any physical activity	High (risk rate: 2.0-2.5 on a 4 scale)
1.5-2.9	Light-intensity activity	Slow walk, cooking, gardening, washing, arts and crafts, playing an instrument, slow walking, fishing, light yoga	High (risk rate: 2.0-2.5 on a 4 scale)
3.0-5.9	Moderate-intensity activity	Slow dancing, cycling at a speed of less than 10 mph, vigorous cleaning, mowing the lawn, painting of walls, dancing, exercise class	Moderate (risk rate: 1.0-1.5 on a 4 scale)
> 6	Vigorous-intensity activity	Weightlifting, laborious jobs (such as carrying heavy loads or farming), fast dancing, cycling at more than 10 mph, running more than 4 mph	Low (risk rate: < 1.0 on a 4 scale)

\*Based on a study conducted by Myers et al., 2002 [14] and reviewed by Warbuton et al., 2006 [15].

**Tab. II.** Effects of physical activity on cardiovascular conditions.

Conditions	Subjects	Exercise/ physical activity	Results	Reference
Cardiovascular (CV) diseases and Cancer	10,224 men 3,120 women	Variables acquired from maxETT	Higher fitness level and decreased CV and cancer mortality were related to higher fitness levels	[17]
Cardiovascular diseases	4,276 men	Variables acquired from maxETT	Men with lower fitness levels had a higher risk rate (2.7) of dying from CV	[18]
Cardiovascular and all-cause mortality	1,960 men	Workout using bicycle ergometer	High fitness is linked to lower all-cause mortality and CV mortality	[19]
Chronic heart disease	12,138 men (MRFIT trial)	Self-informed physical activity during leisure time	63% reduction in fatal CHD observed because of moderate physical activity during leisure time as compared to lower leisure time PA	[21]
Cardiovascular (CV) diseases	12,516 men	Calories burned (kJ/week)	Burning more calories/week resulted in reduced risk of CVD in men	[22]
Cardiovascular (CV) diseases	10,269 men	> 4.5 METs Regular exercise	23% reduction CV and all-cause mortality with moderately vigorous PA, as self-reported by Harvard alumni	[23]
Risk of coronary events	72,488 women Nurses' Health Study	Total PA (walking, vigorous exercise)	Inverse relationship between total PA and coronary events: the higher the PA, the lower the risk of developing coronary events (even in women starting PA later in life)	[24]
Coronary heart disease	39,372 women	Total calories burnt by walking	Time spent on walking/week has an inverse effect on the risk rate of CHD	[25]
Coronary heart disease	9,758 men	Net energy expenditure during leisure-time	Lower risk of hard CHD events associated with high leisure time energy expenditure	[26]
Coronary heart disease	44,452 men	Various exercises such as walking, running, weight-training, rowing	Intense exercise, with a higher MET associated with reduced CHD risk	[27]
Cardiovascular (CV) diseases	6,213 men	Variables acquired from maxETT	In CVD patients, death risk in subjects having exercise capacity < 5 METs was approximately double than those who could exercise > 8 METs	[14]
Myocardial infarction	15,152 MI cases vs. 14,820 controls	Self-reported PA	Regular physical activity diminished the risk of myocardial infarction	[28]
All-cause premature death	9,777 men	Variables based on maxETT	Fit men had a lower risk rate of all cause and CVD death rate between follow up intervals than the unfit men	[29]
Diabetes mellitus and hypertension	2,478 men and women (18–30 yrs)	Walking duration on treadmill during ETT	Low fitness level associated with high risk of developing DM, HTN, and metabolic syndrome	[30]

tary lifestyle and obesity. Studies have shown that PA enhances blood glucose control and slows down the onset of type 2-diabetes [35] in both men and women [36]. Studies also show that, rather than sedentary activities, physical activity reduces the risk of type 2-diabetes in

both men and women. High risk individuals with obesity and inherited or impaired glucose tolerance, can reduce their risk of having type 2-diabetes risk by brisk exercises [37]. Physical activity reduces risk of diabetes by long-term and short-term improvements in insulin action

for better glucose control. In older men, exercise training for two months shows significant improvement in insulin sensitivity and fasting glycaemia [37].

### Effects of physical activity on weight management and obesity

Obesity has a strong correlation with physical inactivity. It's a common observation that people having sedentary lifestyle have a lower metabolic rate and tend to gain weight over time and become obese while those having regular exercise, walking or other forms of physical activity have a higher metabolic rate and are lean. In addition, less physical activity means less energy expenditure, which results in weight gain over time and vice versa [38]. Obesity has turned into an epidemic nowadays, with nearly half of the world population being obese [39]. For instance, nearly three-fourths of the adult population in the USA are obese. Similar trends exist in other westernised countries and, according to the EU, countries estimate that in 2008 23% women and 20% men are overweight or obese in the European countries [40]. In addition, a gradual increase in obesity has been observed also in children and adolescents in Europe [41]. These increasing trends in obesity and being overweight are largely dependent upon the physical inactivity as well as on dietary habits. Westernised food regime, with fried and fat-rich food coupled with high sugar and salt intakes, less vegetables and fruits more red meat are the contributory factors of high BMI in half of the western population. Besides that, inadequate physical activity with more sedentary lifestyle is the major cause for increased obesity and overweight in Europe. Physical activity coupled with proper food intake has an inverse effect on weight gain and obesity. High physical activity leads to high energy expenditure and, correspondingly reduction in stored fats (adiposity) and lower BMI. In addition, this helps to lower diabetes and high blood pressure, and also improves lipid profile that ultimately reduces the risk of developing NCDs [42-49].

### Effect of Physical activity on Cancer

Cancer has become a major concern because of the sedentary lifestyle of the European population. Cancer is a leading cause of death in Europe, existing health-care programs must be improved, and new initiatives must be developed to raise awareness of the role of PA in reducing cancer risk. Cancer is becoming the leading cause of death in Europe. Physical activity plays a significant influence in cancer risk reduction [50]: physically active men have a 30-40% lower risk of colon cancer, whereas physically active women have a 20-30% lower risk of breast cancer [50]. Physical activity lowers the risk of cancer through reducing long-term inflammation in the gut, which aids in the reduction of colon cancer, improves the immune system's ability to fight cancer, and improves hormone balance [44].

The effect of physical activity on various cancers is mentioned below:

- **Colon cancer:** Individuals who exercise regularly have a 40-50% lower risk of colon cancer than those who do not [51];
- **Breast cancer:** Women who are involved in vigorous physical activity can minimize up to 30-40% risk of breast cancer in both premenopausal and postmenopausal active women [52, 53, 54]. Also, if women increase physical activity after menopause, they are less prone to breast cancer [54, 55];
- **Bladder cancer:** People who participated in recreational activities had a 15% decreased risk of bladder cancer [56];
- **Lung cancer:** Physical activity can reduce the incidence of lung cancer in both smokers and non-smokers, according to meta-analysis research [57, 58];
- **Endometrial cancer:** Obesity is the leading cause of endometrial cancer, and it can be prevented with regular exercise. Endometrial cancer risk is reduced by 20% in highly active women [59];
- **Uterine cancer:** Uterine cancer risk was decreased in women who engaged in more physical activity. There is a lower risk of uterine cancer in more active women [60];
- **Oesophageal cancer:** Increased physical exercise lowers the risk of esophageal cancer by 21% [61];
- **Renal cell cancer:** Renal cell cancer risk is reduced by 12% in people who engage in vigorous physical activity [62];
- **Gastric cancer:** Individuals who were the most physically active had a 19% lower risk of stomach cancer than those who were the least active [63].

### Effects of Physical activity on Musculoskeletal health

Regular exercise promotes bone density, healthy joints, strong muscles, tendons and ligaments, as well as optimum growth and development. Additionally, it will develop functional ability for elderly individuals to lift, carry, climb stairs, etc. and lower the risk of osteoporosis and hip fracture [44, 64]. Physical activity can have beneficial effects on several musculoskeletal diseases (Tab. III)-

### Effects of Physical activity on Psychological health

Everyone's mental state can indeed be enhanced by exercise, which can lessen the effects of depression by elevating mood and sensations, it [80, 81]. Additionally, it can improve awareness of stress and sleep efficiency. Physical activity helps young people's cognitive, learning, and judgmental abilities, and their academic performance [82]. It will strengthen older people's cognitive abilities, including short-term memory, planning, and decision-making [83]. Mental health can

Tab. III. Effects of physical activity on musculoskeletal diseases.

Diseases	Condition	Symptoms	Treatment	References
Fibromyalgia	Ailment that causes pain throughout the body. Broad, diffuse, non-inflammatory, treatment-resistant joint and muscle aches, lasting at least three months	Reduced muscle strength, rapid fatigue	Aerobic training	[65-67]
Osteoarthritis	A degenerative condition that progresses over time and frequently causes severe discomfort	Discomfort, stiffness, sensitivity, loss of flexibility bone spurs, a grating sensation, and swelling	Physical exercises or aerobic exercises training, Non-Steroidal Anti-inflammatory Drugs (NSAID)	[68-72]
Osteoporosis	A condition where the quantity and thickness of bone tissue declines	Fractures resulting from fragility, loss of height, gum recession, stooped posture, lower back pain	Weight bearing exercises, walking, sunlight exposure for vitamin D production, bone and muscle strengthening exercises	[73-75]
Rheumatoid Arthritis	A chronic disorder that affects the joints and results in pain, swelling, and stiffness	Morning stiffness, joint discomfort, tenderness, and edema	Regular low intensity exercise	[71-74]

be enhanced by exercise, as reported by many studies: physical activity involves moving one's body and using their muscles, for example for walking, running, dancing, swimming, practicing yoga, or working in the garden [84]. The length of exercise regimens appears to mitigate the association between physical activity and psychological health, as lengthier programs regularly report. Mild to moderate mental health disorders, including depression and anxiety, may be effectively managed by engaging in physical activity. Increased aerobic exercise or strength training has been proven to dramatically improve depressive symptoms, even though people with depression often engage in less physical activity than those who do not suffer from it. Moreover, regular exercise appears to have benefits comparable to those of meditation or relaxation for anxiety symptoms and panic disorder [85].

### Current physical activity levels

Modern technologies are currently helping people in doing less physical labour; for example, using a private vehicle lessens the need for physical activity-based transportation, like walking or cycling. The introduction of television, computers, and other electronic leisure gradually made engaging in sedentary activities more appealing than exercising, particularly for young people. Accelerometers are the accepted methods of monitoring physical activity to evaluate people's transportation, household, and leisure activities. Low-income and middle-income countries are more active than high-income ones in terms of cycling and walking [86-88]. In the future, low- and middle-income countries will reduce their levels of physical activity because of technological changes [89].

The method used to estimate an activity's energy expenditure is called METs. According to MET hours, physi-

cal activity in the UK decreased by 20% between 1961 and 2005. Eurobarometer surveys are used to monitor the levels of sports and physical activity. The survey reveals that in Europe the physical activity falls with age and men are more enthusiastic than women. Correspondingly, well-educated individuals are more active than less educated ones. The Northern part of Europe is more active as compared to the Southern part, mostly engaging in activities like cycling, dancing, and gardening (particularly interesting to nations like the Netherlands and the Nordic region), while walking is more prevalent in Southern and Eastern Europe. According to the results of the overall survey, one in ten Europeans are unusually sedentary and unable to walk for 10 minutes each day [90].

The WHO public health recommendations for physical exercise are not being followed by about one third of Europeans [87, 90]. According to the "Health Behaviour in School-aged Children" (HBSC) research, an average of over 45% of girls and 2/3 of boys are unable to meet the recommended 60 minutes per day of moderate activity, with girls being less physically active than boys, according to reports (Tab. IV) [91]. Furthermore, accelerometers showed that 11-year-olds exercise more than 15-year-olds.

### Socioeconomic effects of physical activity as opposed to physical inactivity

Brain development, emotional and social health, job performance, and productivity are all enhanced by physical activity, resulting in the improvement of life skills like grit, self-control, punctuality, emotional regulation, decision-making, and goal-setting [94].

Physical activity-related risks typically involve the musculoskeletal system, such as straining a mus-

Tab. IV. Recommended PA for various age groups.

Age group	Recommended PA	Reference
Preschool children (3-5 years)	Physical activity throughout the day	[92]
Children and Adolescents (6-17 years)	Daily 60 minutes or more PA	[93]
Adults (18-64 years)	150 minutes moderate intensity PA weekly	[93]
Older adults (65 years and more)	At least 150 minutes of moderate-intensity aerobic PA weekly	[93]
Adults with chronic disabilities	150 minutes of moderate intense aerobic activity in a week	[92]
Pregnant and postpartum women	150 minutes of moderate intense aerobic activity (brisk walk)	[92]

cle or twisting a joint. These issues are brought on by performing too many activities without adequate warm-up or training. A person with heart disease runs a higher risk of having a heart attack if they participate in vigorous activity without warming up first. These hazards can be reduced simply by appropriately warming up before starting the more intensive exercises [95, 96]. To prepare the body for the increased demands on bones, muscles, the heart, and the lungs, muscle-strengthening exercises should be done gradually over time [97].

### Mediterranean diet and physical activity

One of the most important factors that affect health globally is the lack of physical activity [97]: physical inactivity is in fact a major risk factor for the development of chronic diseases and early death, as demonstrated by a wealth of research on the benefits of PA on health. The aging process will eventually be negatively impacted if PA or exercise is replaced with inactivity or sedentary behaviour [98]. The two most widely studied modifiable lifestyle risk factors, diet and PA, increase the risk of developing lifestyle diseases like CVDs, obesity, type 2 diabetes, and several malignancies, as well as their mortality and morbidity. In clinical practice, diet and PA are usually advised for promoting general health, weight loss or maintenance, preventing chronic diseases, and improving quality of life [99], being regarded as intricate variables that may interact [100]. When compared to the MedDiet or PA alone, there is already data to suggest that greater adherence to both is linked to improved health biomarkers, a lower risk of disease, and a lower mortality rate [100, 102]. If the person avoids smoking and alcohol abuse, the Med Diet may lower the risk of non-communicable illnesses, improve health status, and lower total lifetime healthcare expenses [103]. When combined with PA, these benefits may be even greater. This interaction of effects implies that lowering either element would also lower the likelihood that the other factor would result in a particular outcome. The presence of interaction demonstrates that the effect of the two exposures is different from the mere sum or multiplication of their individual effects, depending on the nature of the link between exposures and the anticipated scale (additive or multiplicative) for the interaction [104].

### Conclusion

It can be concluded that not only physical activity is beneficial for having a healthy life, but it is indeed essential to alleviate drastic consequences of various chronic non-communicable diseases. Recommended level of physical activity, coupled with a healthy diet such as Med Diet, can help to restore and maintain a healthy body and, correspondingly, an ecstatic life.

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### Conflicts of interest statement

Authors declare no conflict of interest.

### Author's contributions

MB: study conception, editing and critical revision of the manuscript; KD, ZN, MCM, FF, PC, MAP, SN, PM, SX, MB, DB, STC, KLH: literature search, editing and critical revision of the manuscript. All authors have read and approved the final manuscript.

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