



Impact of physical activity on longevity: A review of the literature

Flaka Hoti^{1*} 

¹ Nursing Department, Heimerer College, Pristina, Kosovo; flakahoti_1@hotmail.com

* Correspondence: Flaka Hoti; flakahoti_1@hotmail.com

ABSTRACT

Objectives: The aim of this review was to explain the literature about the association between physical activity and longevity.

Methods: The search was carried out in all databases of Web of Science and in all years (1900-2020), until December 31, 2020. The search term was “physical activity longevity” and the search was restricted to title. The inclusion criteria for papers were: 1. Type: Original papers. 2. Language: English. 3. Sample: Human participants. 4. Measures: Longevity and physical activity.

Findings: A total of 52 papers were found. After applying the inclusion and exclusion criteria, only 15 papers of these 52 papers were included in this review. The 15 studies found that physical activity have a positive impact on longevity.

Conclusions: Physical activity can extend longevity and delay mortality. Future studies should focus on explaining the influence of different types of physical activities on longevity and identifying potential mechanisms. Public health strategies should be implemented to increase the physical activity levels of the population.

KEYWORDS

Physical activity; longevity; older adults.

1. INTRODUCTION

Aging is a natural and complex physiological process influenced by many factors that can be broadly classified as intrinsic (related to genetic factors), extrinsic (related to psychosocial and environmental factors) and related to the effects of disease [1,2]. Biologically, the nature of this phenomenon and the mechanisms involved remain unknown. Rising life expectancy at birth, and in particular lower mortality at advanced ages, has led to a marked increase in the number and the proportion of centenarians, and to new records in longevity in low mortality countries [3]. Longevity

is defined as the capability to survive past the average age of death [4]. It is a shorthand term for a number of different actuarial constructs, the two most common of which are life expectancy, which is an empirical concept referring to the average age of death in a cohort, and life span (or maximum life span), which is a theoretical concept referring to the highest age attainable by any member of a population [5]. The rate of decline in mortality at advanced ages has not slowed in recent years, so this phenomenon can be expected to grow in scale over the coming century, with new records being set in terms of survival into extreme old age [6]. The swelling of the population of people aged 100 years and above has provided researchers with an opportunity to offer responses to one of the most fundamental questions about human health and longevity. The main questions that come into being for the secrets of longevity are what does it take to live a long life? How much do diet, exercise and other lifestyle factors matter compared with good ‘genes’? and one of the most crucial questions is what is the quality of life amongst the elderly population? When people grow old, do they actually become sicker, weak or fragile or they remain active, productive and social even after reaching their 100th birthday [7].

Unveiling the ‘secret’ of human longevity is undoubtedly one of the most intriguing challenges for the scientific community. Certainly, genetic factors are amongst the determinants of successful ageing, however, an active lifestyle, especially regular exercise, is also a positive contributor [8-11]. Physical activity (PA) is fundamental, in addition to a healthy diet and psychosocial wellbeing [3]. PA is defined as “any situation employing the skeletal muscles, whatever the aim, accompanied by an increase in energy expenditure compared with the resting state” [12]. It usually includes activities of daily living, leisure-time and recreational PA, as well as sport, this latter being defined as “a subset of PA, specialized and organized, in the form of exercises and/or competitions, facilitated by sports organizations” [12]. The World Health Organization (WHO) recommends that adults perform at least 150 minutes of moderate-intensity physical activity, or 75 minutes of vigorous-intensity PA, or an equivalent combination of moderate- and vigorous-intensity physical activity to achieve at least 600 MET-minutes per week (MET= metabolic equivalent of task, i.e., a caloric expenditure unit) [13]. Regular physical activities such as walking, cycling, doing the household work, etc., make an individual feel good and have significant benefits for health. PA also reduces the risk of cardiovascular disease, diabetes and some cancers, helps control weight, and contributes to mental well-being. Being daily active has multiple benefits for all ages and especially for the growing age, i.e., children and young individuals, and can make an extensive change to the health and welfare of senior population. On the contrary, physical inactivity and a sedentary lifestyle are among the leading risk factors for the

health of the population., being estimated to cause one million deaths per year in the WHO European Region [14].

PA plays a major and independent role in the prevention of cardiovascular disease and was found to reduce the mean relative risk by 33%, which is similar to the effects of PA in terms of stroke (31%) and hypertension (32%) when comparing high active and low active individuals [15]. Patients in cardiac rehabilitation also benefit from PA (here in form of exercise) as it improves the disease process and reduces the occurrence of premature death [16].

PA is an essential element of a healthy lifestyle, deciding about physical fitness, which undoubtedly determines the high quality of life and wellness. Regular physical exercises are crucial in the prevention of diseases related to cognitive function disorders and help to preserve the psychological well-being. One cannot ignore the positive impact of PA on the functioning of the body in older people and the phenomenon of the so-called successful aging. PA helps to improve the health of people suffering from mental disorders (including depression and anxiety disorders), supports coping with stress and reduces the risk of self-destructive behaviours. PA also allows to maintain proper cognitive functions, reduces the risk of neurodegenerative diseases and alleviates the symptoms of already diagnosed disorders, e.g. in the case of dementia. Findings related to neurogenesis induced by physical effort are directly connected with the improvement of psychological and cognitive functions [17]. PA also helps with diabetes. Type 2 diabetes is one of the strongest increasing chronic diseases globally [18] and can be demonstrably prevented with healthy lifestyles, incorporating aerobic and resistance activities, that are significantly more effective than Metformin treatment, a medication commonly given to people at risk [19].

If PA helps to prevent and treat these chronic diseases, we also expect PA to delay mortality and enhance longevity. There are several studies that report the important association between PA and longevity. Therefore, the aim of this review was to explain the literature about the association between PA and longevity.

2. METHODS

The search was carried out in all databases of Web of Science and in all years (1900-2020), until December 31, 2020. The search term was “physical activity longevity” and the search was restricted to title. A total of 52 papers were found. After applying the inclusion and exclusion criteria, only 15 papers of these 52 papers were included in this review.

The inclusion criteria for papers were:

1. Type: Original papers.
2. Language: English.
3. Sample: Human participants.
4. Measures: Longevity and physical activity.

The exclusion criteria for papers were:

1. Type: Review papers, conference papers, editorial papers, correspondence papers...
2. Language: Other languages.
3. Sample: Animal participants.
4. Measures: Longevity and/or physical activity not measured.

3. DOES PHYSICAL ACTIVITY INCREASE LONGEVITY?

The main characteristics of the 15 studies included in this review are reported in **Table 1**. All the studies found that physical activity have a positive impact on longevity. The first studies analyzing this issue were those of Paffenbarger et al. (1986 and 1994) [20-22]. These authors found that adopting a physically active lifeway, independently delayed all-cause mortality and extended longevity from one to more than two years. In 1996, Lissner et al. [23], showed that decreases in physical activity as well as low initial levels were strong risk factors for mortality in women. Lee & Paffenbarger (2000) [24] concluded that greater participation in moderate activities showed a trend toward lower mortality rates, while greater energy expended in vigorous activities clearly predicted lower mortality rates. The study of Mori et al. (2008) [25] also found that life activity score was significantly higher in a longevity district than in a non-longevity district. Furthermore, according to Stessman et al. (2009) [26], being physically active up to age 85 years was a strong predictor of survival. Lin et al. (2011) [27] reported that subjects who did not participate in leisure time physical activity had a higher mortality rate than those who were regular participants. In 2012, Buchman et al. [28] found that an individual with high total daily physical activity (90th percentile) had approximately one fourth the risk of death compared with an individual with low total daily physical activity (10th percentile). In addition, Ekblom-Bak et al. (2014) [29] indicated that a generally active daily life was associated with cardiovascular health and longevity in older adults. Also, Stessman & Jacobs (2014) [30] concluded that physical activity in older

adults with diabetes was associated with lower mortality from age 70 to 90. According to Keadle et al. (2015) [31], the lowest mortality risk was observed in those who were consistently active. Moreover, Rennemark et al. (2018) [32] indicated that being active 2 to 3 times a week or more was related to a 28% lower risk of not being alive at the follow-up measure. Brandts & Brandt (2018) [33] presented their results in men and women, showing that men who reported >90min of non-occupational physical activity per day were more likely to reach longevity compared with those who reported ≤ 30 min/day, while in the case of women, a significantly increased chance of reaching longevity was found for those who reported >30–60 min/day of non-occupational physical activity compared with those with 30 min/day of non-occupational physical activity or less. Finally, Stevens & Cruwys (2020) [34] concluded that not belonging to a sport or exercise group at baseline was associated with a significantly greater risk of earlier death.

Table 1. Impact of physical activity on longevity

Authors (years)	Design and duration	Participants	Assessment of physical activity	Assessment of longevity	Impact of physical activity on longevity
Paffenbarger et al. (1986) [20]	Longitudinal study. 16 years (1962-1978).	16,936 men, aged 35-74 years, USA.	Questionnaire about Physical Activity.	The number of deaths.	The most active alumni (39 % of the population) are estimated to have lived on average one and one quarter years longer than the least active ones.
Paffenbarger et al. (1986) [21]	Longitudinal study. 16 years (1962-1978).	16,936 men, aged 35-74 years, USA.	Questionnaire about Physical Activity.	The number of deaths.	Death rates declined steadily as energy expended on physical activity increased from less than 500 to 3500 kcal per week. By the age of 80, the amount of additional life attributable to adequate exercise, as compared with sedentariness, was from one to more than two years.
Paffenbarger et al. (1994) [22]	Cohort study. 11 years (1977-1988).	14,786 men aged 45-84 years, Harvard, USA.	Questionnaire about Physical Activity.	Reaching 90 years.	Adopting a physically active lifeway, independently delay all-cause mortality and extend longevity.
Lissner et al. (1996) [23]	Prospective study. 20 years (1968-1988).	1,405 Swedish women aged 38-60 years.	Questionnaire about Physical Activity.	20-year survival.	Decreases in physical activity as well as low initial levels are strong risk factors for mortality in women.

Lee & Paffenbarger (2000) [24]	Cohort study. 15 years (1977-1992).	13,485 men, mean age 57.5 years, USA.	Questionnaire about Physical Activity.	Death certificates.	Greater participation in moderate activities showed a trend toward lower mortality rates, while greater energy expended in vigorous activities clearly predicted lower mortality rates.
Mori et al. (2008) [25]	Cross sectional study.	202 participants in Japan: 133 (M/F 47/86, 67±1 years) in Kokufu and 69 (M/F 29/40, 62±1 years) in Miyama.	Questionnaire about Physical Activity.	Mean life span.	Life activity score was significantly higher in Kokufu (longevity district) than in Miyama (non-longevity district).
Stessman et al. (2009) [26]	Longitudinal cohort study. 18 years (1990-2008).	1861 Jerusalem residents born in 1920 and 1921, age 70 years at baseline.	4-item questionnaire, adapted from the Gothenburg population study of 70-year-olds.	Mortality data.	Being physically active up to age 85 years was a strong predictor of survival.
Lin et al. (2011) [27]	Prospective observational cohort study. 8 years (1996-2004).	876 Taiwanese people aged 65 years or over (477 men and 399 women).	Leisure time physical activity (LTPA) and non-leisure time physical activity (NLTPA) questionnaire.	Mortality follow-up.	Subjects who did not participate in LTPA (0 MET-hour/week) had a higher mortality rate than those who were regular LTPA participants.
Buchman et al. (2012) [28]	Cohort study. 4 years.	893 participants in USA, with a mean age of 82.0 ± 7.30 years. 76.3% were women and 11.8% had clinical dementia.	Total daily physical activity (exercise and non-exercise physical activity) was measured at baseline for up to 10 days with actigraphs (Actical; Philips Healthcare).	Number of deaths.	An individual with high total daily physical activity (90th percentile) had approximately one fourth the risk of death compared with an individual with low total daily physical activity (10th percentile).
Eklblom-Bak et al. (2014) [29]	Cohort study. 13 years (1997-2010).	3839 people in Sweden, 1816 men and 2023 women, 60 years old.	A NEPA (non-exercise physical activity) index was derived from a self-administered questionnaire.	Mortality during the follow up.	A generally active daily life, regardless of exercising regularly or not, was associated with cardiovascular health and longevity in older adults.
Stessman & Jacobs (2014) [30]	Cohort study. 20 years (1990-2010).	Individuals in Israel aged 70 in 1990 (n = 463), 78 in 1998 (n = 972), and 85 in 2005 (n = 1,181).	Leisure and non-leisure physical activity questionnaire.	Age of death.	Physical activity (PA) in individuals with Diabetes Mellitus (DM) was associated with lower all-cause mortality. PA in older adults with DM is associated with lower mortality from age 70 to 90.

Keadle et al. (2015) [31]	Prospective cohort study. 17 years (1994-2011).	165,087 adults in USA (aged 50–71 years).	In 1994–1996: Risk Factor Questionnaire. In 2004–2006: Follow-up Questionnaire.	Survival and mortality.	The lowest mortality risk was observed in those who were consistently active.
Rennemark et al. (2018) [32]	Follow-up study. 11 years (2004-2015).	8,462 people in Sweden, 5,049 women and 3,413 men, aged 60 to 96 years.	MPA (moderate physical activity) survey question.	Survivors and non-survivors at the follow-up.	Being active 2 to 3 times a week or more was related to a 28% lower risk of not being alive at the follow-up measure.
Brandts & Brandt (2018) [33]	Cohort study. 20 years (1986-2006).	7807 people in Netherlands, 3646 men and 4161 women, aged 68-70 years.	2 questions about non-occupational physical activity.	Reaching the age of 90 years.	Men who reported >90min of non-occupational physical activity per day were more likely to reach longevity compared with those who reported ≤30 min/day. In women, a significantly increased chance of reaching longevity was found for those who reported >30–60 min/day of non-occupational physical activity compared with those with 30 min/day of non-occupational physical activity or less.
Stevens & Cruwys (2020) [34]	Follow-up study. 14 years (2002-2016).	3896 people in England, age 50 years and over. 2015 members of sport or exercise groups (57.6% males, mean baseline age 60.68) and 1881 nonmember controls (54.8% males, mean baseline age 61.02).	Questionnaire of moderate and vigorous physical activity with a 4-point scale.	Mortality records over a 14-year follow-up.	Sport or exercise group members were less likely to have died at follow-up. Not belonging to a sport or exercise group at baseline was associated with a significantly greater risk of earlier death.

4. CONCLUSIONS

All the studies found that physical activity have a positive impact on longevity. Therefore, physical activity can extend longevity and delay mortality. Future studies should focus on explaining the influence of different types of physical activities on longevity and identifying potential mechanisms. Public health strategies should be implemented to increase the physical activity levels of the population.

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AUTHOR CONTRIBUTIONS

I have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

I declare no conflict of interest.

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