



THE IMPACT AND IMPORTANCE OF HEALTH-RELATED INTERVENTIONS DURING MIDLIFE ON OLD AGE

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Abstract

The relationship between lifestyle factors and physical function in later life is a growing area of research, with multiple studies examining how midlife behaviors affect health outcomes in older adulthood. This study also focuses on a survey of 100 people about their experiences with age-related problems and the impact of lifestyle changes. According to a study utilizing data from the Baltimore Longitudinal Study of Aging highlights the positive impact of improved dietary patterns on physical function, with those adhering to the Alternative Healthy Eating Index (AHEI) showing better scores on the Short Physical Performance Battery (SPPB). Similarly, research on community-dwelling adults underscores the importance of combined mental and physical activity, with "Active PA and MA" participants demonstrating superior grip strength and gait speed compared to inactive peers. Physical activity patterns over time have also been linked to health-related quality of life (HRQoL), as evidenced by the Korea Health Panel Survey, which found that individuals who remained inactive over eight years had nearly double the odds of low HRQoL. Meta-analyses further support the benefits of long-term physical exercise interventions, which lower the risk of falls, injuries, and mortality while improving cognition and physical function in older adults. Lastly, an objective measure of physical activity from the Helsinki Birth Cohort Study reveals a positive association between physical performance and light to vigorous physical activity. Collectively, these studies highlight the critical role of sustained healthy behaviors, including diet and physical activity, in maintaining physical function in later life. The findings point toward a common goal of promoting lifestyle interventions in midlife to support independence and quality of life in aging populations.

Keywords: Nutrition, Physical Function, Middle Age, Old-age, Fitness Patterns, Dietary Trajectory.

1. INTRODUCTION

Perhaps the most critical area of investigation is how the behaviors amassed in middle life actually correlate with physical functioning over the remainder of the life course: Here again, there is substantial evidence that lifestyle choices made midlife have a very significant impact on health and functional independence into old age [1-5]. Given the speedy ageing of populations worldwide, there has been a growing need for public health professionals, clinicians, and policymakers to explore the impact factors of diet, physical activity, mental engagement, and social interaction on long-term health outcomes. Whereas survival becomes necessary, it is just as important that the quality of life be maintained so that older adults remain physically active, independent, and

self-sufficient. The common objective among the research papers reviewed here is to identify how aspects of lifestyle—particularly diet and physical activity—impact the physical function of older adults, leading toward the identification of interventions that might improve health outcomes and reduce the burden of age-related physical decline.

1.1 Importance of Physical Function in Life

Physical functioning is one of the significant determinants of quality of life in older adults. This includes activities like the execution of everyday tasks such as walking, the ability to lift

things, and balancing-losing the capacity to pose a danger of falling or suffering an injury. Deprecation of physical function among the elderly leads to more reliance on others, dangers of falls and injuries, and the loss of independence, which can in some way be related with impairments in mental health and social well-being. Therefore, it is very important that aging populations be able to maintain physical function into older adulthood in order to keep them independent, healthy, and socially active. Physical function, however, does not decline uniformly across the population, and the variability has been associated with differences in lifestyle behaviors earlier in life.

A common underlying thread among these studies is the recognition that physical function in old age does not have an entirely genetic or inexorable, physiologically determined basis but instead also has modifiable dimensions such as diet, physical activity, and mental and social activity patterns. The present body of findings extends the increasing volume of research based on the notion that interventions initiated during midlife influences the outcome of health in later life.

1.2 Midlife as a Crucial Window for Intervention

Midlife can typically be defined as the years between 40 and 65. This period is characteristically marked by critical interventions. The body during this stage begins to experience changes that will occur in the aging process, even as health behaviours may either hasten or retard physical deterioration. For example, a healthier diet and increased physical activity during this life stage help to prevent or delay chronic diseases related to impaired physical function in old age, such as cardiovascular disease, diabetes, and osteoporosis.

Baltimore Longitudinal Study of Aging [1] is a study that aimed to explore the impact that the diet patterns adopted during midlife may have on physical function later in life. Diet quality, measured by the Alternate Healthy Eating Index, assesses the degree of change in their adherence to healthier eating patterns as "greatly improved" or "moderately improved" diet trajectories. The findings in this study suggest that individuals whose diets improved from poor to good diet categories have improved physical function with age as measured by SPPB. In contrast, moderate improvements are related to lower physical function scores. This therefore presents a platform for the intermediate lifespan dietary interventions with the potential to positively impact later life physical function, hence further reiterating that lifestyle interventions with an intention to improve long-term health results occur at this critical point in midlife.

1.3 Physical Activity and Its Long-Term Benefits

Perhaps the most widely studied modifiable risk factor related to physical function and aging is physical activity. Studies have shown that chronic levels of physical activity are linked

to greater muscle strength, balance, cardiovascular fitness, and cognitive ability--key contributors to physical independence later in life. Declines in physical activity have been linked to other conditions related to the aging process, for example, sarcopenia which is the loss of muscle mass and frailty, either of which can compromise physical functions seriously and predispose the older adult to falling and injury.

Here, changes in physical activity levels and their association with health-related quality of life among older adults are tracked over eight years with the Korea Health Panel Survey [3]. Participants are categorized into one of four groups: persistently inactive, newly becoming inactive, newly becoming active, or persistently active. The findings establish that staying inactive throughout the study period was nearly twice as likely to report low health related quality of life, while maintaining activity levels allowed for higher quality of life. Therefore, it appears that staying active during older adulthood is important for maintaining a good quality of life and physical function.

More importantly, proof of value through maintaining or embracing physical activity later in life can be allowed because benefits were seen not only in the always active but also in the late lifers using the data from the Korea Health Panel Survey. The best thing about this is that public health initiatives can take both middle-aged and older adults, making them continue their activity and some taking up the practice for better health in the future.

1.4 The Role of Combined Activity Engagement

It is clear that physical activity is known as a determinant of physical function, mental and social engagement also play a role in healthy ageing. Mental and social activity positively impact cognitive function, mental health, and social connectedness, which are all related to better physical health outcomes during old age. The relationship of combined mental, physical, and social activity engagement to physical function among community-dwelling adults based on grip strength and gait speed as primary indicators of physical health are examined.

It identifies four clearly distinct classes of engagement: "Active PA and MA," "Active MA," "Active PA," and "Inactive." Interestingly, social activity did not vary significantly across these groups, though the best physical function was observed in those belonging to the class "Active PA and MA" and compared with others from the "Active MA" and "Inactive" groups. That suggests the total effect of physical and mental activity is more important to maintain physical function, with maximum activity resulting in optimal performance.

The findings highlight the need to foster engagement in physical and mental activities among the elderly because it seems to have a synergistic effect on physical health. Such results render policymakers and public health professionals to require holistic interventions transcending just one area, such as being solely the cognitive domain.

1.5 Long-Term Benefits of Exercise Interventions

Another included review is a meta-analysis of RCTs, reviewing the long-term effects of physical exercise interventions on older adults. Secondary outcomes evaluated were dropout rates for causes that were health-related and mortality, as well as falls, injuries, fractures, physical functioning, and cognition. The results indicate that physical exercise interventions reduced the risk of falls and associated injuries, improved both physical and cognitive function, and in the case of clinical populations, also reduced mortality risk. Baseline participants' age, cognitive status, and physical function appears to be unrelated to the benefits from physical exercise. This implies that exercise interventions are possibly effective in all older adults, irrespective of how healthy they may be. Furthermore, that the longer that exercise interventions are done, the greater the reduction in the risk of falling: a major cause of morbidity and mortality for older adults, suggests that physical activity might play a vital role in protecting both physical health and safety in old age.

This meta-analysis supports the findings of other studies that are discussed in this report, including the Korea Health Panel Survey [3] and the community-dwelling adults study [2], which demonstrate the extensive long-term benefits of physical activity. Regular physical activity, regardless of whether it is initiated during middle age or continued into later life, was consistently essential to protecting against age-related decline and maintaining physical function.

A minor percentage of the reviewed studies applied objective measures of physical activity, applied in one study. This study is based on the gathered data from the Helsinki Birth Cohort Study. It applies physical activity monitoring by the Sense Wear Pro 3 Armband, which tracks participants' levels of physical activity, and utilizes the Senior Fitness Test (SFT) to assess physical performance.

There was a positive association between light to vigorous levels of physical activity and high overall scores for SFTs, where sedentary time shows a negative correlation with physical performance. Most importantly, there were no sex differences between the results of this study, hence indicating that the benefits of physical activity apply across sexes equally well. The aim is to find lifestyle factors that impact physical function in the elderly and to suggest evidence-based recommendations for improving the health outcomes of aging populations. Whether through diet, physical activity, mental engagement, or the combination of the above, it remains the same inasmuch as to encourage possible interventions that can help support a person's maintenance of physical function as they age and remain independent.

The conclusions drawn from these studies are that indeed midlife is a critical phase of adopting health-related behavior because the decisions made during middle age have lifelong consequences for physical function in old age. Public health programs seeking to improve diet, facilitate physical activity,

and maintain mental and social activity should, therefore, target intervention in middle age and old age.

Ultimately, therefore, allowing people to make the lifestyle adjustments of midlife might increase the quality of life for individuals older adults, reduce as much as possible the burden of age-related physical decline, and enable successful ageing to continue into later life.

2. BACKGROUND

Aging is an inevitable biological process, but it remains true that health interventions at middle age can significantly influence the aging trajectories. Middle age extends from 40 to 65 years and is so far considered a most critical point for making lifestyle alterations that make perfect sense for mitigating age-related decline in physical, mental, and cognitive health. Considerable amounts of research have proven that certain exercises which are physical exercise, mindfulness practices, or diet alteration are important for healthy aging.

The rise in life expectancy due to medical and technological progress, along with falling fertility rates, has added to a prominent rise in the population of older individuals, globally [6]. This is a cause for attention due to the increased need for more focus and methods for improving the health and lifestyle of these older adults to facilitate healthy aging processes. According to the population projections from World Population Prospects 2022, the percentage of individuals aged 65 and older is expected to increase from 10% in 2022 to 16% by 2050 [7].

2.1 Cognitive Function and Physical Activity

Numerous researches supported that physical activity during middle age prevents cognitive decline early in life. According to the NIH, most meta-analyses concluded that participating regularly in physical exercises, especially aerobic exercise such as walking, jogging, and swimming, could decrease the chances of progression towards dementia in older adults by up to 35% [8]. Middle-aged adults who had habitual physical activity showed a larger hippocampal volume, important in the processes of memory, while providing evidence of the protection against cognitive aging [9]. The evidence therefore supports that physical activity is one of the best non-pharmacological interventions for the preservation of cognition with aging.

2.2 Reduction of Disease Risk

Evidence also points towards the risk reduction for chronic diseases like cardiovascular disease and osteoporosis by doing physical activity. In a review published in the Journal of Aging Research, in 2020, maintenance of an active lifestyle in the middle years considerably reduces the chances of getting cardiovascular diseases, which account for the largest proportion of deaths globally [10]. Exercise helps

keep the blood vessels healthy, control and maintain healthy blood pressure, and proper body weight. According to the American Heart Association, at least 150 minutes of moderate intensity aerobic exercise per week reduces cardiovascular risks while aging (AHA, 2021).

2.3 Role of Sleep in Aging

Another area of interest that is being looked at is sleep in healthy aging. Poor quality of sleep during the middle years has been correlated to many health problems, including impairment in cognitive function, high risk of cardiovascular diseases, and suppression of the immune response [16]. Shorter and longer sleep durations are associated with generally lower cognition scores with age, but fair and poor quality of sleep are associated with generally lower levels of cognition. Tests of interactions between sleep duration and quality indicated that subjects who reported long durations of sleep with poor quality of sleep had the lowest overall cognitive scores [17].

2.4 Dietary Patterns and Aging

Yet research studies on dietary patterns during midlife have also explored advancing healthy aging. According to NCBI, it will be important to eat a nutrient-rich diet in middle age that works to ameliorate oxidative stress, inflammation, and cellular aging [11]. Calorie restriction is a dietary intervention. It aims at reducing calorie intake without causing malnutrition and has gained a lot of attention as it extends life and delays the onset of age-related diseases [12]. With this, high intake of a diet rich in antioxidants, such as the Mediterranean diet, high in fruits, vegetables, whole grains, and healthier fats, has been associated with a decreased rate of decline in cognitive functions as well as better heart health during middle age [13-40]

2.5 Mental Health Related Activities

Mental health interventions, including mindfulness and meditation, have also been suggested as contributing to healthy ageing. Adopting mindfulness practices in middle age decreases the levels of stress in people, thereby lowering the risk for age-related mental health disorders such as anxiety and depression [14]. There are mental benefits and also some physical ones in mindfulness, where patients tend to have less inflammation and lower levels of cortisol, which are all connected with aging processes [15].

3. LITERATURE REVIEW

In a study that examines the long-term trajectories of midlife dietary patterns in relation to physical functions in later life [1]. Ways in which dietary quality improvements can have meaningful impacts on functional outcomes in later life. The study aims to examine the relationship between dietary changes in middle age are illustrated. Diet being a modifiable behavior plays a crucial role in overall health

through the course of life. It has an impact on mortality, chronic diseases (cardiovascular disease, diabetes, and cancer), along with physical and cognitive function. According to a study in Whitehall II cohort, better diet quality in middle age is linked to lower risks of cardiovascular disease, diabetes, and mortality later in life. Dietary patterns can vary throughout adulthood as responses to factors like illness, social influences, or new nutritional information. This makes it essential to assess the way diet varies over time and its impact on health outcomes in older age.

Previous studies have some limitations, like solely focusing on diet at one point of time without considering how much diets can change over time with life events or updated nutritional information and dietary guidelines. Instead, investigating changes in dietary patterns over the the course of life might provide a more insightful and improved understanding into how diet affects health outcomes. It was hypothesized that those who improved their diet during middle age, had better physical function when they were older. The study was conducted by taking 851 participants who were white, non - hispanic men and women. It was approved by the Institutional Review Board (IRB) and participants gave their informed consent. From 1961 to 2008 dietary data was collected using diet records, with participants logging their food intake daily. They were trained on how to record portion sizes using food pictures and portable scales. The quality of diet was measured using Alternative Healthy Eating Index-2010 (AHEI) score.

It was calculated for each participant based on 11 food and nutrient components linked to chronic disease risk. Scores ranged from 0 (worst quality) to 110 (best quality). Eating higher amounts of healthy foods (like vegetables, fruits, whole grains, etc.) and less of unhealthy foods (like sugar-sweetened beverages, red/processed meats, etc.) contributed to higher scores.

The physical function was measured using Short Physical Performance Battery (SPPB) that included three tests which were repeated chair stands, standing balance, and usual gait speed. These components were scored from 0 (worst) to 4 (best) and total scores ranged from 0 to 12. The covariates included age, sex, race/ethnicity, education level, smoking status, physical activity, and medical conditions. The physical activity was categorized into four levels, being sedentary, low, moderate, and high. Body Mass Index (BMI) was also calculated, with overweight defined as a BMI equal to or more than 25 kg/m².

Finally, the observations were analyzed using Latent Class Analysis. The participants were grouped and categorized in latent classes being greatly improved which were those whose diet quality moved from poor/intermediate to good over time, and moderately improved which were those whose diet quality moved from from poor to intermediate, with very less participants achieving good diet status. , this study then concluded that participants whose diet improved more significantly (greatly improved class) tended to have better

physical function in older age compared to those with less improvement (moderately improved class).

This study had limitations as well, those being generalizability since the participants were largely non-Hispanic White and highly educated. Co-founding factors like physical activity, smoking, and sedentary behavior have an impact, though they were partly considered, some unmeasured variables may affect the results.

A study [2] examined the link of activity engagement with physical function in older adults and further illustrated how combined mental and physical activities enhance functional performance in aging populations. This study looks at how engaging in different activities can help older adults maintain physical function, which is key to staying independent and avoiding health issues like falls and hospitalizations. Physical function includes basic abilities like mobility, strength, and endurance, which tend to decline with age. Older adults are encouraged to stay active physically, mentally, and socially to prevent such decline. Physical activity (PA) is supported with the most research in overall improvement. Mental activities (MA), like cognitive exercises, and social activities (SA), like socializing also show potential to help but less research exists on these. What's unclear is whether doing a combination of these activities could lead to better results than doing any single activity alone. Some studies suggest that combining activities, like PA and MA or MA and SA, leads to better cognitive improvements. However, it's unknown if this combination also improves physical function in older adults.

This study aims to explore that. It looks at patterns of activity engagement in PA, MA, and SA, identifies groups with similar activity behaviors, and examines how these activities relate to physical function. It was hypothesized that engaging in a combination of activities would lead to better physical function than just engaging in one type. A cross-sectional design was used, which analyzed data from the second wave of the Survey of Midlife Development in the United States (MIDUS II), which had followed up with participants from MIDUS I after 10 years. It included 466 individuals, aged 55 or older. Physical function was assessed through grip strength using a dynamometer and by gait speed which was done by timing how quickly participants walked 50 feet. Three types of activities were measured; Physical (PA), Mental (MA) and Social (SA); frequency of attending social gatherings or meetings. MA and SA were moderately correlated however, PA did not correlate with either. Data on variables like age, sex, education, medications, smoking habits, and waist circumference, education, medication use and smoking status was collected.

For analysis, Pearson's correlation was used to explore the relationship between activity engagement (PA, MA, SA) and physical function (grip strength and gait speed). It was followed by Latent Class Analysis (LCA) to identify groups that had similar patterns of activity engagement. Next was the analysis of variance (ANCOVA) that examined differences in physical function across the four latent classes. Four groups, based on engagement in PA and MA were classified. These

were, Active PA and MA, Active PA, Active MA and Inactive in both. Social activity did not differ much.

The groups, Active PA and MA, Active PA, and Active MA had similar grip strength, superior to the "Inactive" group. Active PA and MA group had better gait speed compared to the Active MA and Inactive groups. Differences in physical function were not due to health disparities, as all four groups had similar health status. Previous studies have focused on the effects of combined physical activity (PA) and mental activity (MA) on cognitive function. According to the study, engaging in both PA and MA improves physical function particularly gait speed. While grip strength differences were significant, but fell short of clinical significance. Unlike previous findings that favored PA alone, this research indicates that combined PA and MA are equally effective.

The study has limitations. Cross-sectional design restricts establishing causal relationships between activity engagement and physical function, self-reported measures of activity engagement focused on frequency, not duration or intensity, minimal variation in social activity (SA) among groups, findings may not be generalizable to other populations, including men, lower-educated individuals, or ethnic minorities.

Another study [3] surveyed sustained physical activity from middle age to early old age and demonstrated the benefit of keeping up one's active lifestyle in quality of life during early old age.

This study analyzes changes in Physical Activity from middle to early old age and how these impact Health Related Quality of Life. In South Korea, older adults are the fastest-growing segment of their population. A concern for healthy aging and quality of life (QoL) is the gap between their average life expectancy (83.3 years) and the years people live in good health (73.1 years). The problem, lowering the QoL of the elderly, is Frailty. Increased physical activity has been proven to prevent frailty and bring healthier outputs like increase in metabolism, reduced depression, better cognitive function, and prevention of dementia. Middle-aged people who have lived a life of activity have lower mortality and good QoL as they age and many continue their active lifestyles into old age, and benefit from better health and QoL. Secondary data analysis evaluated the change in the level of physical activity over a certain period of time and furthered the impact of such change on the quality of life of middle-aged and older adults. Using a two-time-point data from the same respondents in 2009 and 2017 when the subjects were at middle-aged and early old age respectively. The data was drawn from the Korea Health Panel Survey (KHPS). 2009 was used as the baseline for this study since PA data was included from that year onwards. 994 participants, between 52-59 years were followed in 2009 and those between 60 and 67 years in 2017. Very severely ill participants and those with missing data on quality of life were excluded. PA was measured using the International Physical Activity Questionnaire (IPAQ) categorized into three groups, low, moderate, and high. Participants were divided into 4 groups, 'remained inactive',

'became inactive', 'became active' and 'remained active'. HRQoL was measured by the EuroQol 5-dimension-3-level version, assessing mobility, self-care, usual activities, pain, and anxiety. Every category is rated, and the overall score (1 being best) is used as a measurement of QoL. Other variables included gender, marital status, education, employment, chronic diseases, BMI, smoking, and alcohol consumption. There were statistical analyses of the relationship of PA levels and HRQoL in 2009 and between 2009 and 2017. Logistic regression evaluated factors related to lower quality of life in 2017.

Women showed a higher HRQoL than men, divorced or separated participants had the highest poor HRQoL rate, Middle school graduates were more likely to be in the lower category, showing a significant difference from those with higher education, Participants with chronic illnesses had a higher poor HRQoL rate than those without, underweight participants had the highest HRQoL. The inactive participants were about twice as likely to be in the worst 10% of HRQoL. Frail participants for 8 years had poorer HRQoL. PA improved HRQoL and reduced risks of chronic diseases like obesity. A significant strength of this study was its longitudinal approach in examining PA changes from middle age to early old age, 52–59 to 60–67 years. This contrasts with the earlier studies targeted to particular age groups since it affirms that staying or becoming active supports healthier aging. However, sustaining PA is difficult due to ingrained habits needing motivation. Lower socioeconomic status, particularly lower education, is also associated with lower PA and reduced HRQoL, thus targeted interventions are needed to reduce health inequalities.

This study has limitations. The sampling in the survey might not have included participants with serious illnesses and a low HRQoL, hence reporting bias, the present study estimated only the cumulative effect of PA on HRQoL and excluded changes in individual characteristics over a period of 8 years, such factors should also be considered in future research.

A systematic review and meta-analysis [4] with randomized controlled trials, determined the safety and efficacy of long-term exercise interventions in older adults, thereby underlining their considerable potential for improving physical function and diminishing health risks. Decreasing physical activity among the aging population is a huge public health concern for modern populations. A host of anti-aging benefits are derived from regular exercise, including the reduced risk of frailty, cognitive decline, poor muscle function, and falls in older adults. No study has assessed whether health problems contribute to an exit from exercise programs among older adults or whether exercise programs affect the risk of death. In informing the design and safety of exercise programs for older adults, this knowledge is important. This study aimed to systematically review and evaluate the relationship between long-term exercise programs-one-year or longer-that impact dropout rates for health issues and all-cause mortality in the elderly.

It also reviews on how these programs are key factors that influence health outcomes among older adults such as physical function, cognition, quality of life, hospitalizations, falls, and fractures. It is registered in PROSPERO and follows the PRISMA guidelines. Participants were adults aged 65 and older. It designed to be an RCT and consisted of a control group that did not have such systematic exercise. The trial measured the dropouts from health causes and mortality, with exercise intervention lasting at least one year. Researchers excluded studies that didn't define the exercise intervention, involved participants under 65, or lacked a control group. Primary outcomes were health-related dropout and mortality. Secondary outcomes were physical function, cognitive status, quality of life, hospitalization, falls, injuries, and fractures.

Data for 49 studies with 21,292 participants indicated that 16.9% of those in the exercise group and 19.0% in the control group dropped out for health reasons. No significant difference in dropouts between the exercise and control groups implies that exercise did not enhance health-related dropouts. Results were generalizable across different settings, exercise types, and levels of study quality. There was no publication bias. Data from 56 studies involving 26,017 participants have demonstrated that exercise has little effect on rates of death in general. However, in clinical populations, risk of death was significantly decreased with exercise. No publication bias was found for mortality results. Exercise increased balance, gait speed, strength, and cognitive function. It reduced the occurrence of falls and fall-related injuries compared with control groups. Exercise also improved health-related quality of life. Long-term exercise programs show beneficial implications regarding reduced fall risk and physical and cognitive functioning capability as well as general health in older adults. It thereby supports the role of regular physical activity in promoting healthy aging, especially in chronic conditions.

The study has limitations. It is unknown if health-related dropouts were due to exercise. There were mixed protocols for exercise and types of populations- healthy vs. clinical, although subgroup analyses were performed. Most researches were done on community-living older adults, which restricted the analysis of the institutionalized elderly.

The strengths of this study are that it is the first meta-analysis to evaluate the safety and effectiveness of long-term exercise interventions in older adults, comprising more studies and health outcomes compared with earlier reviews. It minimized publication bias while still retaining statistical power by including only outcomes from at least 10 studies.

A study [5] examined the relation of objectively measured physical activity to physical performance in older adults, and indeed, there does appear to be a relation where higher activity levels are associated with better physical function later in life. Life expectancy is increasing, thus resulting in a greater population over 65. Physical function enables quality of life and independence in old age. According to the WHO, physical inactivity is the fourth leading risk factor for global

death. Inactivity heightens the risk of chronic diseases such as heart disease, type 2 diabetes, cancer, and cognitive disorders. Healthy aging involves three key factors: low disease risk, good cognitive and physical function, and active engagement in life. The Senior Fitness Test (SFT) was developed to measure fitness in older adults. Studies often use questionnaires rather than objective measurements to measure PA, and most link PA with physical abilities. So, an advanced PA monitor that tracks the levels of PA was utilized in this study among older adults using the SFT. This examination is a part of the Helsinki Birth Cohort Study, HBCS, of those born in Helsinki between 1934 and 1944. Out of 1,404 subjects invited in 2011, for reexamination, 695 subjects (316 men and 379 women) gave sufficient information on PA and performance. The Ethics Committee of Epidemiology and Public Health in Helsinki approved the study, and all participants gave written consent.

PA was captured for 10 days by the Sense Wear Pro 3 Armband using valid data from four weekdays and one weekend day. The intensity was classified as sedentary, lightly active, or moderately and vigorously active. Evaluations of physical performance included a modified Senior Fitness Test that assesses strength, flexibility, endurance, and fitness. Covariates were BMI, lean mass, age, sex, smoking and education. Mean age of participants was 70.7 years (range 66.9-79.1) at the time of SFT. Scores from the SFT, chair stand, arm curl, and chair sit-and-reach tests were higher among women than men, whereas no gender differences existed for the back scratch or six-minute walk tests. Women reported higher amounts of light physical activity (PA) than men, who reported higher amounts of moderate-to-vigorous physical activity (MVPA).

Previous studies indicate that slower gait speed predicts premature death and higher disability, falls, and hospitalizations in older adults. This study establishes that both light and moderate-to-vigorous physical activity improve physical performance, and sedentary time worsens it, thereby emphasizing the value of light PA for improved health outcomes. Physical decline can be slowed or even reversed by encouraging PA. Older adults who start PA later in life can experience significant health benefits. PA influences physical performance by improving aerobic fitness, muscle strength, flexibility, and reducing body fat. It also reduces the risk of diseases like cardiovascular disease, type 2 diabetes, cancers, and functional decline. Additionally, PA improves neurotransmitter function, brain health, and mental well-being, which can help older adults stay active and socially engaged.

The merits of this study are the large well-characterized cohort of men and women examining general physical performance, using the SFT for continuous observations. It also objectively measured PA by employing the validated SenseWear Armband with accuracy in estimating energy expenditure of PA and detailed information regarding frequency, intensity, and time of activities, thus not suffering from recall biases characteristic of questionnaires.

The study has limitations. The Finnish population might not generalize to larger populations. The patients were healthier and more educated, creating selection bias. Finally, the research excluded people with extreme physical disabilities and, therefore, was limited in applying generalizations.

4. PROBLEM DEFINITION

A global increase in life expectancy has resulted in a higher population of adults over the ages of 65. This situation emphasizes on the importance of maintaining, if not uplifting quality of life. It further highlights the significance of physical function and nutrition. Despite the wide evidence on the positive effects of physical activity and healthy dietary behaviors separately, the long-term impact of both lifestyle factors, going hand in hand, and the effect they have on later-life functional health has not been explored as much. Along with that, people in their middle-ages need to be more aware of the significance of these to start or improve their right diet and physical activity according to their nutritional and fitness needs. More customized approaches need to be taken instead of following what the masses are doing. This requires studying one's health and fitness patterns to curate the suitable and beneficial routine catering to their specific needs, helping them improve their quality of life in the future. Some, but still not a lot of people are aware and of those who are, a lot do not want to invest the time and effort in preparing their body for the future and often opt for instant gratification.

5. OBJECTIVES

- To promote improvement in nutrition and physical functioning for adults nearing middle and old age.
- To study the long-term effects of combined, sustained physical activity along with a nutrition rich diet during middle age.

6. PROPOSED SOLUTIONS

The problems outlined above require long-term multi-faceted interventions in physical activity and diet beginning in the middle age and extending into early old age. These interventions can be through accessible and prominent sources. Useful actions would be raising awareness, curating programs and building communities. There is a major need for adults to understand why they need to improve their quality of life. This can only be done by educating them about the physiological changes occurring in their bodies as they age.

6.1 Community Based Activity Programs

These can help form like-minded thinking within a certain group of people. This creates a lasting effect, that does not let the momentum of constant encouragement and motivation die down. They should target strength, balance, and aerobic activity to enhance physical function, prevent

falls and fractures, and promote continued participation by health professionals. These can be done by collaborating with community centres in neighbourhoods. Workplaces can also introduce midlife-wellness programs. These can help create awareness among the employees as a part of workplace modules. Their canteens can have healthier and nutritious options along with education about the benefits of different food groups being served.

6.2 Detailed and Elaborate Mobile Applications

Applications that have an interface that is specifically designed to be comfortable for older age groups can be introduced. These applications can help them log their daily progress while also personalizing suggestions and diet and exercise plans. This will help them get an accessible source of information and assistance. These applications can be linked to the already existing wearable devices for gathering accurate data for every individual. Receiving feedbacks that are extremely personalized can help individuals change/adjust their diet and physical activity. This helps foster long-term adherence to their wellness goals and improves functional outcomes.

6.3 Awareness About Reading the Labels of Food Products.

Awareness can be spread through posters and campaigns on the streets can be a good way of reaching those who are not active on social media. Grocery stores should be mandated to put up signages that encourage customers to do so as well. Being encouraged to read and analyze labels at grocery stores will help people get insight into the ingredients used in the product, make informed decisions for their dietary needs and avoid products that have negative impacts on their health and find those that will benefit them.

7. HYPOTHESIS RESULT

The engagement of healthy activities, including well-placed, balanced diets, exercise, and mental engagement during middle age has a positive impact on overall physical function, cognitive performance, and later life's quality of life. This impact is stronger when the activity habits are matched with an intervention through mobile applications or community-based programs that are individualized.

7.1 Secondary Research

The five studies combined provide strong evidence for the importance of health-related activities in middle age, if this ultimately leads to good impacts later in life. According to Talegawkar et al. (2021), adults whose diets improved significantly, particularly by improvements in the Alternative Healthy Eating Index, had better physical function in old age when the improvement was significant. Shah et al. (2017)

reported the positive impact of both physical and mental activity. More active participants in both streams performed better in physical performance, specially gait speed, than non-active stream participants. Adding to that, Lee et al. (2022) illustrated that long-term physical activity from middle age until early old age was associated with maintaining a better quality of life in elderly years-the significance of long-term physical activity. García-Hermoso et al. (2020) went on to define further the above determinations wherein long-term exercise-based interventions were found to decrease the risk of mortality, enhance physical abilities, and also decrease the occurrence of falls and injury amongst the elderly population. Finally, Jantunen et al. 2017 demonstrated that objectively measured physical activity across a range of intensities was positively associated with physical performance later in life, whereas sedentary behavior had the opposite effect. In total, these studies emphasize on the crucial participation of diet, physical activity and mental engagement in the maintenance of physical function, diminishment of health risks, and improvement of quality of life upon aging.

7.2 Primary Research

A cross-sectional survey of 100 adults aged 40-60 years was conducted to measure their level of activity in health-related practice and perceptions of how these activities might have an impact on aging. Participants were asked questions relating to diet, physical activity, mental engagement, and whether technology is used to monitor health-related habits.

The survey brought forth several important findings concerning the types of activities and attitudes by the participants toward health and aging. For example, 60% of the participants were said to have healthy diets; meanwhile, the other 40% did not have any well-planned diet. Physical activities differed between the groups, given that 55% of them undergo regular exercise, which is at least three to five times every week, while 45% were categorized either as sedentary or as having minimal activity. In mental engagement, half of the respondents reported to usually participate in such activities like puzzles, reading, or learning new skills. However, not more than 30% track their health through mobile applications and wearable devices, while 70% of them use traditional methods or rely on nothing for health management.

As far as attitudes towards aging are concerned, 65 percent of the respondents replied that preserving health-directed activities in midlife would contribute positively to their aging process. However, 25 percent reported that they neither disagreed nor were sure about any association between the events of midlife and the outcomes related to aging, while 10 percent did not think that the activities in midlife would have a salutary effect on aging.

Participants who often engaged in behaviors like healthy diet, exercise, and mental challenge reportedly found their aging health to be confident and capable of maintaining their physical capabilities. Those participants who were less or inactive were bothered by aging, and many stated that

perceived barriers such as not being motivated and lack of time forbade them from acting towards healthier behaviors.

8. Limitations

8.1 Shortcomings of Community Based Activity Programmes

The proposed solutions have some limitations as well. Community-based activity programs require mutual consistency from the organizers and participants, which is usually absent. The organizers may conduct workshops and programs only to satisfy the policy requirements but not because they are interested in the participants' welfare. As a result, disengaged participants may lose motivation, which would further lead to the gradual fall in participation rates. From the participant's side, middle age would present a challenge to retaining them since one is usually occupied and the extra exertion would be very demanding. Additionally, lack of self-drive contributes to decreased participation and thus a low ability to maintain long-term benefits intended for these programs.

8.2 Digital Literacy Gap

Although beneficial, mobile applications have certain limitations too. One of the major issues is that of the digital literacy gap because many of the aged people might not be able to handle complex interfaces or use technology very effectively despite much effort to make the applications much easier to use. This also assumes an access to such technology that not everyone in this age range will have or be able to afford. In addition, personalized advice or recommendations based on logged data may not accurately take into account the particular health conditions or limitations of an individual, thus inaccurately advising someone. Lastly, using the application for a long time might be tough as this gets easier with age, but older adults lose interest or have declining motivation over time in the absence of pertinent external support or encouragement.

8.3 Problems Faced in Spreading Public Awareness

While promoting awareness about reading food labels through street posters and campaigns can be effective, there are several limitations to this approach. First, not everyone may engage with or notice these campaigns, especially if they are placed in areas with low foot traffic or if people are simply not paying attention. Additionally, posters and signage alone may not provide enough education for individuals who are unfamiliar with how to interpret nutritional information or ingredient lists. Grocery store signage, though helpful, might be ignored or seen as clutter by busy shoppers. Moreover, while these efforts target those not active on social media, they may still miss certain segments of the population, such

as those with limited literacy or vision impairments. Lastly, reliance on self-motivation to read and analyze labels may not lead to significant behavior change without broader educational efforts or incentives.

8.4 Limitations of This Study

This study had salient limitations as well, that would have to be considered when interpreting the findings. Sample size and geographic scope is limited for it only focuses on one target group of subjects which might affect the generalizability and universal accuracy of findings. In view of the geographical restriction on coverage, the results may not represent a broader population fully, making the conclusions less applicable to other regions or demographic groups. Moreover, it is a one-time assessment rather than a longitudinal study that constrains one from examining trends and changes over time. This means that without follow-up assessments, long-term outcomes cannot be aspired to or, for that matter, the progression of factors under study, and thus, the study can only establish a point in time. Moreover, it used much question-and-answer approaches with several brainstorming techniques for analysis. This method presents very good insights while, in fact, narrowing the perspective because the issue was primarily explored through subjective self-reporting and discussion-based approaches. Lacking diversity in methods affects the view of the problem by being perceived from various angles or accounting for other factors influencing outcomes, such as objective data, longitudinal observations, or experimental designs. Such limitations call for much broader, diversified, and longer studies so that this topic could be studied more profoundly as well as enhance the robustness of conclusions from such further research.

9. Future Work

- The study can be done in a more elaborate manner with a larger sample size. The mode and methodology can follow an approach with varying tests and surveys that give more holistic results covering a wide range of aspects.
- Large groups of people can be recruited to conduct studies that track their nutrition along with their physical activity from time to time. They should track dietary intake and levels and forms of their physical activity. Health markers like BMI, blood pressure, cholesterol levels, and mental health should also be taken into account. Effects on physical functionality due to change in diets can be assessed by giving these people specific instructions on what and how much to eat. Regular follow ups can help determine the effects.
- The use of Artificial Intelligence can be incorporated in the analysis methods as a tool to get even accurate, yet quick results and conclusions.

- Further specifying research based on urban and rural populations and analyzing the needs and differences in both groups can help find solutions that are more universal or even separate solutions to cater to a wider population. This can be done to see the dietary patterns, lifestyle and resources of each group, how they differ from each other and customizing solutions based on the findings. These two groups can be treated as broad divisions and which can be delved into further in order to get improved research directions leading to appropriate solutions.
- This research can also take the course of an entire lifetime instead of just middle age interventions. It can focus on the cause and effect of all the choices that are made throughout one's lifetime and how they affect the human body as they age. These can be very specific terms like physical fitness, mental wellness, internal health and skin health. It can be a way to point out the ideal lifestyle choices that one can make according to their personal goals. It is also a great way to study the long-term effects of certain habits, lifestyle and living situations.
- The above methodology of research can also go in the direction of the identifying the causes of illnesses and diseases. It can help find ways to identify the root cause of illnesses that develop over a long period of time. It can be done by pointing out habits that might add up over a long period of time to be the cause of these problems.
- The study can take the path of genetic testing as part of the testing process into how individual genetic predispositions may affect the effectiveness of health interventions. When put together with the genetic profile, lifestyle factors like diet and physical activity provide comprehensive information about what the final personalized health outcomes are going to be. Such a type of approach-by combining nutritional sciences and genomics-is widely referred to as nutrigenomics. This makes it possible to tailor interventions to the individual based on the genetic makeup that would make recommendations more targeted at better health and higher physical function in later life.
- Future studies can include cross-sectional and longitudinal studies of populations from various countries or ethnic groups. Then the researchers will be able to see whether differences in diet, lifestyle, and health practices among cultures can contribute to differences in aging outcomes. In this way, it will show the role of socio-cultural factors in shaping the effectiveness of health interventions while gaining valuable knowledge from globally applicable solutions with respect for variation of culture.

10. Conclusion

The intervention of healthier habits and lifestyle changes during middle age is extremely essential to maintain a healthy and active lifestyle during later ages. These factors include mental activity, physical activity along with lifestyle factors like food intake and sleep. Findings of the study point towards taking the right steps at the midlife stage regarding healthy consumption and engagement in physical and mental activities-healthy eating, physical activity, and mental engagement-as one of the crucial steps toward an improved quality of life in older years. Accordingly, participants that engaged more in such behaviors had greater confidence about their aging process, while those who were less engaged perceived the barrier as not having enough time or motivation to age properly. Findings pointed out that most people realized that healthy lifestyle behaviors during aging are needed, but a large percentage was still uncertain or uninformed about the long-term effects of these behaviors. In most cases, use of technology in health tracking is quite low, thus implying much room for change with regard to healthy management practices during middle age, which may subsequently lead to better aging later in life.

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