The Association between Regular Exercise and Health Life Expectancy

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ABSTRACT

This study aims to explore whether regular exercise may prolong life expectancy of the elderly and increase the proportion of active life expectancy. We used longitudinal data from the Taiwan Elderly Study on Aging to compute years of active life expectancy among Taiwan elderly. Multistate life table method was applied to estimate health life expectancies and probability of transitions. The results showed that regular exercisers have longer life expectancy and higher proportion of active life expectancy, but the inactive life expectancy was not significantly lower. It suggests that exercise even at older age can prolong life and help the elderly retain in active state.

INTRODUCTION

Taiwan is one among the many countries that face rapid transition of population aging and fertility decline. Elderly population in Taiwan has been increasing significantly in both its number and proportion during the past decade. The number of the disabled has been growing as a result of population aging. The expenditure for medical and long term care could be tremendous. However, the disability prior to the end of life is not an inevitable part of longevity(Freedman, Martin, & Schoeni, 2002; Leveille, Guralnik, Ferrucci, & Langlois, 1999). Prolongation of active life expectancy (ALE), which defined as the number of years an individual can expect to live without functional limitations is an important issue in aging society(Katz, et al., 1983).

Exercise has many beneficial effects on health. It can help control body weight, reduce risk of chronic disease, improve mental health and increase chance of living longer. Early in 1970s, the American College of Sports Medicine (ACSM) followed the theory of exercise science and recommended people to exercise for their health. Numerous studies have investigated the health benefits of regular exercise in the elderly, which included both physiological and psychological aspects(Yasunaga & Tokunaga, 2001). It is documented that regular exercise has significant and advantageous effects on body composition, cardiopulmonary functioning, increasing muscle strength and bone density(Lemura, Von Duvillard, & Mookerjee, 2000). Additionally, many epidemiological or experimental research demonstrated that regular physical activity can extend life and decreases risk of chronic diseases of aging(e.g., cardiovascular disease, diabetes, colon cancer)(Blair, et al., 1995; Haskell & Phillips, 1995; Penedo & Dahn, 2005; Wang, Pratt, Macera, Zheng, & Heath, 2004). Prospective data also showed that increasing regular physical activities is associated with decreasing depressive symptom in middle-age women, independent of pre-existing health problems(Brown, Ford, Burton, Marshall, & Dobson, 2005).There

is also evidence that regular physical activity can help elderly maintain independence, preventing disability, and enhance self-efficacy and their quality of life(DiPietro, 2001; Martin, Velente, & Antlitz, 1989). Even in the elderly with chronic diseases, studies also demonstrate that physical activity may reduce the risk of death from the disease(Diabetes Prevention Program Research Group, 2002; Holmes, Chen, Feskanich, Kroenke, & Colditz, 2005; Thompson, et al., 2003). However, few studies have examined the impact of regular exercise on healthy life expectancy among the elderly.

Healthy life expectancy, also known as health expectancy, active life expectancy, disease-free life expectancy or disability-free life expectancy, is a indicator that derives from the information of mortality and morbidity and/or disability. The concept was first introduced by Sanders(Sanders, 1964), later developed by Sullivan(Sullivan, 1971) and has been widely used to monitor population health and its long-term transition. It is a general term that estimates the average years of health state a person may expect to live in. This indicator is helpful in determining whether health interventions are improving the general level of population health or merely preventing severely ill people from dying. The selection of health measure could be arbitrary to fit the purpose of the analysis,

The aim of this study is to explore whether regular exercise may prolong life expectancy and increase the proportion of active life expectancy of the elderly. We used active life expectancy as our measurement of health expectancy and get the estimates by computing the average number of years in which older adults were expected to live without being restricted to activities of daily living (ADLs). Regular exercise was defined as our predictor that had beneficial effects on health expectancy. We then calculated LE(life expectancy), ALE(active life expectancy) and compare their differences between regular exercisers and non-exercisers.

METHOD

Data

The Taiwan Longitudinal Study on Aging (TLSA) was initiated in 1989, with follow-up surveys conducted in 1993, 1996, 1999, 2003 and 2007. This longitudinal study was designed to investigate health and living status of the elder and middle aged in Taiwan. A multi-stage, equal probability sampling was applied to obtain a national representative sample of the non-aboriginal townships. Both community-dwelling and institution were covered in the sampling frame. In the first stage, 56 townships were selected from 331 non-aboriginal administrative units. Secondly, blocks (lins) were

sampled within each selected townships. In the final stage residents aged 60 years or older were selected from the sampled blocks. A total of 4,049 sampled individuals were completed in 1989. Two refresh samples were selected in 1996 and 2003 to maintain representativeness of the younger age strata. Data were collected by community-based face-to-face interviews. Survival status of the respondents was obtained annually through data linkage with death registration of the Ministry of Interior and death certification of the Department of Health.
Three waves of data including 1996, 1999 and 2003 were used for this study. The response rates of these three waves of survey were 89%, 90%, 91% respectively.

Measures

We categorized regular exercise by using the following question: “Do you exercise regularly?” The original response categories were “No”, “Less than 2 times a week”, “3-5 times a week”, and “over 6 times a week”. We considered those who responded “No” or “Less than 2 times a week” to be no regular exercise, whereas those who responded “3-5 times a week” or “over 6 times a week” to be regular exercise.

We assessed health status of the respondents by using 6 ADLs: bathing, dressing and undressing, eating, getting out of bed/chair (standing up, sitting in a chair), moving about the house, going to the toilet. The response categories were ”no problem”, “some difficulty”, “very difficult” and ”can’t do it” for each item. We considered those who presented ‘‘no problem’’ or ‘‘some difficulty’’ in all of the 6 items to be active and anyone with the answers of “very difficult”, or “can’t do it” as inactive. We further defined respondents in health state as those who were active, and in unhealthy state as those who were inactive.

Analytic Strategy

The central hypothesis of this study specifies that regular exercise may prolong life expectancy and active life expectancy. We used multistate life table model to estimate healthy and active life expectancy between exercisers and non-exercisers. The three states in this study were healthy state, unhealthy state and death. The first two states were transient and responses might therefore move from one health state to the other across the three wave surveys. But once responses moved form the first two states to death state, it was impossible to move back to the original state. With the two non-absorbing states and one absorbing state, 4 transitions could be observed. (Figure 1)

We used IMaCh(Lievre, Brouard, & Heathcote, 2003), which was a public available software developed by INEDs to estimate probabilities of transitions from one state to

another. The input data included dates of birth and death, health statuses at each wave of data, and covariates that are considered key to the analysis.

RESULTS

The Table 1 showed the proportions of active and inactive life year by demographic characteristics of the subjects. Near 94.4% of the subjects were active at baseline survey of this analysis. The proportions of inactive were slightly higher in female, older, Fuchienese, or those with lower education attainment. Among the 3,037 subjects aged 65 and above who completed questionnaire interview in 1996, two were excluded because of missing data in exercise frequency. 1461 subjects (48.3%) who answered exercise less than two times a week were categorized as "non-exercisers" by definition of this study, 1,574 subjects who exercised three times or more weekly were categorized as "regular exercisers". In this wave, 2851 subjects were classified as active group, 184 subjects as inactive group. Subsequently in 1999, 2,254 subjects were classified as active, 218 inactive, 403 deceased, and another 160 subjects were lost to follow-up. In 2003, 1667 subjects were in the active group, 248 in the inactive group, 617 deceased and 503 were loss to follow-up. (Table 2)

If not taking exercise or health status into consideration, the length of life expectancy and proportion of active life time to total life expectancies declined in older age. Those who were 65 years old are expected to live for another 17 years, near 90% of the years is active. When 90 years old, they expected to live for another 4 years, but only 57.5% of the years were active. (Table3)

In comparison with the non-exerciser, life expectancies were significantly longer among the exerciser in all age groups. The proportions of active life year are consistently higher among the exerciser. On the Contrary, inactive life expectancies were slightly longer among the non-exerciser but the differences between exercisers and non-exercisers are not statistical significant. The protect effect of regular exercise on ALE increased with age. (Table 4)

Regardless of starting with active or inactive, exercisers had longer life expectancy than non-exercisers. (Figure 2) The proportions of their active life expectancy to total life expectancy were also higher than non-exercisers. (Table 5, Figure 2)

DISCUSSTION

This study reports the association between exercise behavior and health life expectancy in Taiwanese elders. The results showed Taiwanese elderly who took

regular exercise in 1999 had longer life expectancy during the follow period. Exercisers consistently have longer life expectancy and higher proportion of active life expectancy, but the inactive life expectancy is not significantly lower. This indicates that the prolongation of life expectancy on exercisers is mainly on the years of active life.

In this study, we used ADL as “health” measurements, because impaired ADL functioning implies serious decline in elder’s daily functions, needs support from the others and higher risk of hospitalization, nursing home admission and death rate. The policy implication upon this observational study is that exercise even at older age can prolong life and help them retain in active state for the rest of their life.

The strength of this study is we used a national representative sample that covers institutionalized respondents and treated exercise and health data in a temporal manner. The longitudinal study design also enabled incidence-based life expectancy estimation and to elucidate the causal role of exercise behavior in promoting health and prolonging life among the elderly.

There were still several limitations of this study. First, it’s not free from the reverse causality between exercise and ADLs. Unhealthy people are less likely to take exercise might due to their physical limitations. One solution is to further stratify subjects by their ability of taking exercise in previous wave (1993 survey). Here we made attempts to use the question “Can you walk for 200 to 300 meters?” to assess their ability of taking exercise, but this stratification resulted in insufficient sample size in inactive stratum. Nevertheless, if we look at the state-based results and make comparisons within those who started in active and those who started in inactive, exercisers still had longer life expectancy than non-exercisers regardless of their health state at the start point. The proportions of active life expectancy to total life expectancy were also higher among the exercisers. This implies that even confined by physical limitations, the exercisers could have better chance of returning to active status. The observation is consistent with many studies that concluded the benefits of rehabilitation exercise on the patients(Holmes, et al., 2005). On the other hand, it is controversial to define “regular exercise” just by information from one wave of survey because exercise behavior is likely to change overtime. Sensitive analysis would be recommended for further analysis

In summary, the results of this study suggest that exercise behavior could postpone the decline of daily functions in elders. The policy implications of this study would call

for of adequate programs to help elder people who are willing to exercise, and provide them with safety environments to exercise. Rehabilitation is also crucial to help elderly who are confined with physical limitations to return to active state.

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Figure 1 Conceptual framework of Health Transitions in this study

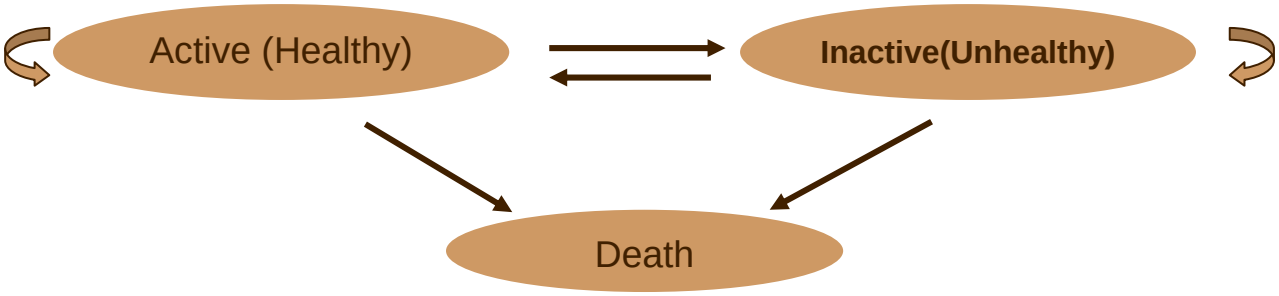

Figure 2 Life Expectancy and Active Life Expectancy between Exercisers and Non-exercisers

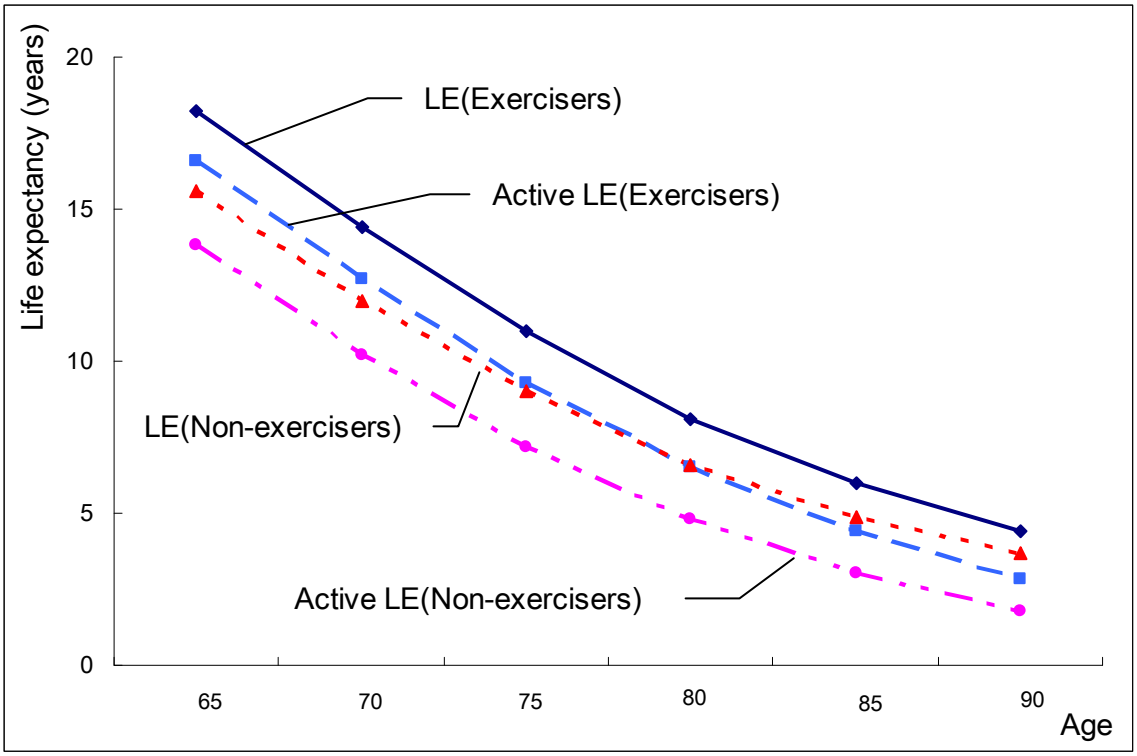

Table 1 The Proportion of Active and Inactive in 1996 by Demographic Characteristics of the sample

Sample Characteristics	Active at 1996		Inactive at 1996	
	No.	%	No.	%
Overall	2851	94.36	184	5.64
Age,y (n=3035)				
65-74	1887	96.22	79	3.78
75-84	853	91.43	80	8.57
85+	111	81.62	25	18.38
Gender(n=3035)				
Male	1607	95.13	90	4.87
Female	1244	93.39	94	6.61
Ethnicity(n=3026)				
Fuchien	1705	93.39	129	6.61
Hakka	443	94.57	27	5.43
Other	694	96.55	28	3.45
Education(n=3035)				
None	1288	92.44	112	7.56
1st-6th grade	963	95.26	49	4.74
6th-8th grade	268	96.82	11	3.18
9th grade or above	332	97.01	12	2.99

Table 2 Frequency of Health transition

	Survey year		
	1996	1999	2003
Active	2851	2254	1667
Inactive	184	218	248
Dead		403	617
Missing		160	503

Table 3 Life expectancy and proportion of active life expectancy

Age	LE	Active LE	Percentage of Active LE(%)
65	16.9	15.2	89.9
70	13.2	11.4	86.4
75	9.9	8.2	82.8
80	7.3	5.6	76.7
85	5.4	3.7	68.5
90	4.0	2.3	57.5

Table 4 Life Expectancy and Active Life Expectancy between Exercisers and Non-exercisers

Age	Exercisers			Non-exercisers		
	LE	Active LE	Percentage of Active LE(%)	LE	Active LE	Percentage of Active LE(%)
65	18.2	16.6	91.2	15.6	13.8	88.5
70	14.4	12.7	88.2	12.0	10.2	85.0
75	11.0	9.3	84.5	9.0	7.2	80.0
80	8.1	6.5	80.2	6.6	4.8	72.7
85	6.0	4.4	73.3	4.9	3.0	61.2
90	4.4	2.8	63.6	3.7	1.8	48.6

Table 5 State-based Life Expectancy and Active Life Expectancy

	LE	Active LE	Inactive LE	Percentage of Active LE(%)
Start with Active				
Overall	17.0	15.4	1.7	90.6
Exercisers	18.3	16.8	1.6	91.8
Non-exercisers	15.8	14.0	1.8	88.6
Start with Inactive				
Overall	10.9	6.0	4.9	55.0
Exercisers	13.1	8.5	4.6	64.9
Non-exercisers	10.0	5.0	5.0	50.0