

Original Article

The Effect of Regular Exercise, Hypertension, and Diabetes on Cognitive Function in Older Taiwanese Adults over a Two-year Period

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Purpose: To examine the effect of two chronic diseases and exercise regularity on the cognitive function of older Taiwanese adults over a two-year period.

Methods: In total, 199 community-dwelling older adults aged 60 years old and older at community centers volunteered to participate in this study. At baseline, all participants received face-to-face interviews to gather their history of chronic diseases, health related information, and exercise regularity. At the same time, cognitive functioning was assessed. They were assigned to no disease, hypertension only, diabetes only, and both hypertension and diabetes groups. At follow up two-years later, the participants were re-assessed for exercise regularity and cognitive function.

Results: There were no significant differences in age, sex, body mass index and levels of education among the four groups. A three-way split plot repeated measure analysis of variance showed a significant “time” main effect, a significant “exercise” main effect, and a significant “disease by time” interaction effect. Generally, cognitive function declined over the two-year period. Regardless of group assignment, those who exercised regularly had less of a decline in cognitive functioning than their counterparts. Older adults with both high blood pressure and diabetes declined more in cognitive function than those with one or neither of these chronic diseases.

Conclusions: The promotion of regular exercise among people over 60 can help prevent declines in cognitive functioning as well as reduce the amount of decline in this age group.

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Introduction

Hypertension and diabetes were among the top ten causes of death for women and diabetes was among the top ten causes of death for men in Taiwan in 2009 (Department of Health, Executive Yuan, 2009)^[1]. Hypertension and diabetes, commonly seen in older adults, are risk factors for a decline in cognitive functioning^[2-4]. Overweight and hypertension, both major risk factors for cardiovascular morbidity, have also been associated decline in cognitive performance^[5]. However, studies have suggested that cognitive decline can be prevented or slowed down by physical activity in people who are generally healthy as well as those with diabetes and hypertension^[6-14].

Most such studies have been conducted in Western countries among mostly Caucasians, not in Asia in populations that are generally Asian^[10]. This study examines the effects of these two chronic diseases individually and in combination on the cognitive function among elderly Taiwanese people over a two-year period. We further explored the effect of regular exercise on cognitive decline in these populations.

Methods

Study design

This is a prospective longitudinal two-year follow-up study.

Participants

Older adults participating in activities at community centers were approached by the research assistant to determine their eligibility to participate in this study. We included those who were 60 years old or older, living independently in their homes in the community, and able to follow instructions and complete the assessments used in this study. Prior to participation in this study, participants signed a written consent form. The protocol for this study was reviewed and approved by the institutional review board of Tzu-Chi general Hospital.

Procedure

At baseline, participants received a face-to-

face interview to record their demographic, health status, body mass index(BMI), self-perceived health status, exercise behavior, and cognitive function (assessed by the Chinese version of the Mini-Mental State Examination, C-MMSE)^[15, 16]. In the two-year follow-up, they were re-assessed for exercise behavior and cognitive function.

In the face-to-face interview, participants were asked to report demographic information (age, gender), self-perceived health status (healthier, same, or less healthy as compared to others at their age), and high blood pressure and diabetes as diagnosed by a physician. Body weight was measured with a calibrated digital scale to the nearest 0.1 kg, while body height was measured with a stadiometer to the nearest 0.1 cm. Older adults who reported exercising ≥ 3 days a week, ≥ 20 minutes per session, and for more than six months were grouped into the “regular” exercise group; all others were grouped into the “irregular” exercise group. Those who were in the “regular” exercise group at both the baseline and follow-up assessments were defined as a “regular” exercise group; all others were categorized into the “irregular” exercise group^[17]. Older adults also grouped into four subgroups based on their self-reported physician diagnosed diseases of high blood pressure and diabetes: those without both disease, those with high blood pressure only, those with diabetes only, and those with both high blood pressure and diabetes.

Statistical Analysis

Participant’s characteristics data were summarized descriptively. Among group differences were examined using analysis of variance (ANOVA) for continuous variables (age, BMI) and chi square tests for discrete variables (sex, education levels, self perceived health status, exercise behavior). A three-way, $2 \times 2 \times 2$, split plot repeated measure analysis of variance (ANOVA) was used to determine the effect time (a within factor), the effect of co-morbidity (a between factor), the effect of exercise regularity (a between factor) and the interactions effect. A p -value=0.05 was considered significant. All statistical operations were performed using SPSS 10.0 (SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606).

Table 1. Demographics and health related information for participants in co-morbidity subgroups.

		Neither (n=89)	HBP* only (n=75)	DM* only (n=11)	Both (n=24)
Age		71.7 (6.2)	72.7 (6.5)	71.9 (6.1)	73.5 (6.2)
Body mass index (BMI)		24.4 (2.9)	25.6 (3.1)	23.4 (2.9)	25.1 (3.0)
Sex					
	Men	45 (50.6%)	43 (57.3%)	6 (54.5%)	10 (41.7%)
	Women	44 (49.4%)	32 (42.7%)	5 (45.5%)	14 (58.3%)
Education					
	<6 years	70 (78.7%)	65 (86.7%)	8 (72.47%)	19 (79.2%)
	>=6 years	19 (21.3%)	10 (13.3%)	3 (27.3%)	5 (20.8%)
Self perceived health					
	Healthier	35 (39.3%)	31 (41.3%)	5 (45.5%)	5 (20.8%)
	Same	41 (46.1%)	33 (44.0%)	5 (45.5%)	12 (50.0%)
	Less healthier	13 (14.6%)	11 (14.7%)	1 (9.1%)	7 (29.2%)
Exercise regularity					
	Regular	60 (67.4%)	49 (65.3%)	8 (72.7%)	15 (62.5%)
	Irregular	29 (32.6%)	26 (34.7%)	3 (27.3%)	9 (37.5%)
MMSE					
	Baseline	26.1 (3.6)	26.8 (2.8)	25.5 (4.2)	26.7 (2.9)
	Two-year Follow up	25.5 (3.7)	26.0 (3.2)	24.9 (5.2)	23.8 (3.8)

* HBP: high blood pressure; DM: diabetes.

Table 2. The baseline and follow up cognitive function performance for participants in exercise regularity and co-morbidity subgroups.

	Neither		HBP only		DM only		Both	
	Regular (n=58)	Irregular (n=29)	Regular (n=49)	Irregular (n=26)	Regular (n=7)	Irregular (n=3)	Regular (n=15)	Irregular (n=9)
MMSE_baseline	25.8 (4.0)	26.8 (2.5)	26.4 (2.9)	27.6 (2.6)	24.0 (4.0)	29.3 (0.6)	26.5 (3.1)	27.0 (2.7)
MMSE_follow up	26.3 (4.2)	26.1 (2.6)	26.0 (3.4)	26.2 (2.9)	23.6 (5.7)	28.3 (0.6)	24.4 (4.1)	22.7 (3.2)
Change score	-0.4 (3.4)	-0.7 (3.3)	-0.4 (2.8)	-1.4 (2.1)	0.6 (3.6)	-1.0 (1.0)	-2.1 (3.2)	-4.3 (1.5)

Results

A total of 199 community-dwelling older adults (104 men, 95 women) with a mean age of 72.3 ± 6.3 years volunteered to participate this study. Most (81.4%) of them had 6+ years of education and exercised regularly (66.3%). Only 16.1% perceived themselves not be as healthy as others. With regard to chronic illnesses, 37.7%, 5.5%, and 12.1% had high blood pressure only, diabetes only, and both chronic diseases, respectively.

As can be seen in Table 1, a summary of group characteristics, we found no significant group differences in age, BMI, distribution of sex, education levels, self-perceived health status, and exercise regularity (Table 1). As can be seen in the figure, the results of our repeated measure ANOVA revealed cognitive function to be significantly influenced by time ($F_{(1)}=16.98$, $p<0.0005$) and

exercise regularity ($F_{(1)}=5.15$, $p=0.024$) and co-morbidity to have a significant interaction effect

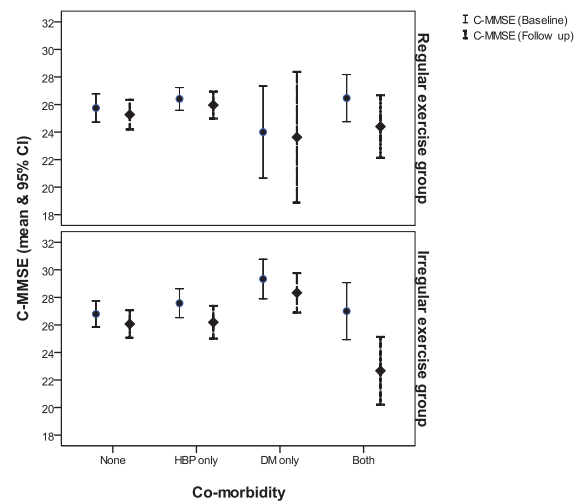


Fig. 1. The cognitive function at baseline and follow up across all co-morbidity and exercise regularity subgroups.

($F_{(1)}=4.40$, $p=0.005$), with those with both high blood pressure and diabetes showing significantly greater decline in cognitive function over the two years than the group with neither or one of the chronic diseases alone (Figure).

Discussion

The results of our study indicated that older adults with both high blood pressure and diabetes, rather than one or the other, tended to have greater cognitive function decline over the two-year study period, echoing the findings of previous studies reporting an association between having that these diseases cognitive decline and risk of dementia^[2-3]. Different from previous studies, we found that having both simultaneously significantly increased that likelihood more than having one or neither of the diseases^[18-19]. We also found that older adults with both co-morbidities that exercised regularly had a slower rate of cognitive decline (2.1 ± 3.2 points) than those with both co-morbidities who led an irregular exercise or sedentary lifestyle (4.3 ± 1.5 points), supporting the protective effect of regular exercise on cognitive functioning in older adults.

To date, the underlying mechanisms of high blood pressure and diabetes in cognitive function decline are unknown. Several plausible mechanisms have been mentioned in the literature^[18-21]. White matter lesions have been found to be associated with long-standing hypertension, possibly through disturbances to cerebral circulation and metabolism^[20,21]. Other possible mechanisms could be increased cerebrovascular disease, facilitated development of neurofibrillary tangles, accelerated β -amyloid aggregation, and a high level of inflammation^[20, 22-23].

The percentages of our participants diagnosed with high blood pressure and diabetes were 49.7% and 17.6%, respectively, which is slightly lower than, but still close to, the prevalence in older adults (>65 years old) in Taiwan, >50% (men 55.9%, women 52.3%) and >20% (men 28.2%, women 24.5%)^[24]. Studies have found that the effects of these co-morbidities on cognitive function might be different for older adults at an advanced age (≥ 85 years of age) and for females,

but the results to date are not conclusive.^[25-26] These co-morbidities might cause different types of cognitive impairment^[23] and affect different aspects of cognitive function^[27]. Accelerated cognitive decline has been found in older adults up to 75 years old, but decelerated decline has been found in the oldest old^[25-26]. To date, very few studies have been conducted on older Asian adults^[28]. The limited number of participants in this study who suffered from both high blood pressure and diabetes (12.1%) meant small numbers of subjects in the exercise and co-morbidity subgroups. Future studies employing larger samples and a more comprehensive cognitive function assessment to identify the specific aspects that are more greatly affected by the co-morbidities are warranted. It is also worth investigating performing a study of a nationally representative sample on the effect of the other co-morbidities that are commonly seen in older adults on cognitive function with a national representative sample.

Our study has several limitations. While the cognitive function decline due to normal aging process can occur in all four groups, the amount of decline in cognitive function was greater in the group with both co-morbidities (hypertension and diabetes) than those with either one or without any one co-morbidity. However, since our study was based on a convenience sample, generalization of our results is limited. In addition, we did not control for other factors that might have influences on cognitive function such as medications and diets.

In conclusion, the combination of both high blood pressure and diabetes, rather than one or the other, was a significant predictor of older adults' cognitive function. The cognitive function of older adults who suffered from both high blood pressure and diabetes but engaged in regular exercise declined at a slower rate than those that exercised irregularly or led sedentary lives. Our results suggest that programs encouraged to target older groups at increased risk of cognitive decline to exercise regularly to help them maintain cognitive functioning.

Acknowledgment

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Conflict of Interest

The authors claim no conflict of interest.

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運動規律性、高血壓、糖尿病對台灣社區老人兩年期間認知功能的影響

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目的：本研究的目的為檢驗兩種慢性病及規律運動習慣對台灣社區老人兩年期間認知功能的影響。

方法：199位居住於社區中年滿60歲的老人自願參與本研究。基線評估時，以面訪方式收集慢性病病史、健康相關訊息、及規律運動的習慣。同時，也評估其認知功能。依擁有慢性病的情況分成四組：無糖尿病及高血壓、僅有高血壓、僅有糖尿病、有糖尿病及高血壓。兩年後追蹤時，收集運動習慣及認知功能。

結果：年齡、性別、身體質量及教育程度於四組慢性病中皆無顯著差異。三因子重複測量的變異數分析結果發現有顯著的“時間”主效應，顯著的“運動”主效應，及“疾病和時間”的交叉效應。一般而言，認知功能於兩年期間皆發現有下降。無論哪一組，有規律運動習慣者比無規律運動者有較少的認知衰退。具兩種慢性病者的認知功能衰退比僅具一種慢性病或都無此二種慢性病者為多。

結論：向國內60歲以上的長者倡導規律運動行為，有助於預防認知功能衰退及減低衰退的量。

關鍵詞：認知功能、老人、慢性病、高血壓、糖尿病、規律運動

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