Longitudinal Analysis of the Cognitive Function of the Elderly in Taiwan

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Abstract

Majority of the dementia (89%) is elderly. Examining the decline of cognitive function is crucial. Many have explored the possible causes of dementia. However, most of them are done in cross-sectional studies. We utilized a set of longitudinal data to examine the long-term change of cognitive function. We used the group-based trajectory method to identify trajectories, and GEE to examine the factors associated with the identified factors. The full model shows (a) decline in ADL, IADL, and having stroke decreased the cognitive function; and (b) higher BMI and exercise would result in better cognitive function given the same age, gender, and education level.

1. Introduction

Majority of the dementia (89%) is elderly. Examining the decline of cognitive function is crucial. Many have explored the possible causes of dementia (Stuck, Walthert et al. 1999, Plassman, Williams et al. 2010). However, most of them used cross-sectional data, which could not show the development process. Therefore, this study utilized a national representative sample of elderly, who were followed for over 14 years, to describe the trajectory of their cognitive function and possible risk factors. The full model shows (a) decline in ADL, IADL, and having stroke decreased the cognitive function; and (b) higher BMI and exercise would result in better cognitive function given the same age, gender, and education level.

2. Method

Data for this study came from the Taiwan Longitudinal Study of Aging (TLSA). TLSA took national representative sample of people aged 60 years or older in 1989. Cognitive function was measured by the short portable mental status questionnaire (SPMSQ). It was administered to 3155 subjects in 1993. Altogether, 1135 individuals were followed for 14 years (Figure 1). Face-to-face interview was conducted. The questionnaire contained: (a) demographic characteristics; (b) household schedule, social and economic exchanges; (c) health, health care utilization and behaviors; (d) occupational history; (e) activities; (f) residence history; (g) economic/financial well-being; and (h) emotional and instrumental support. The questionnaire evolved over time.

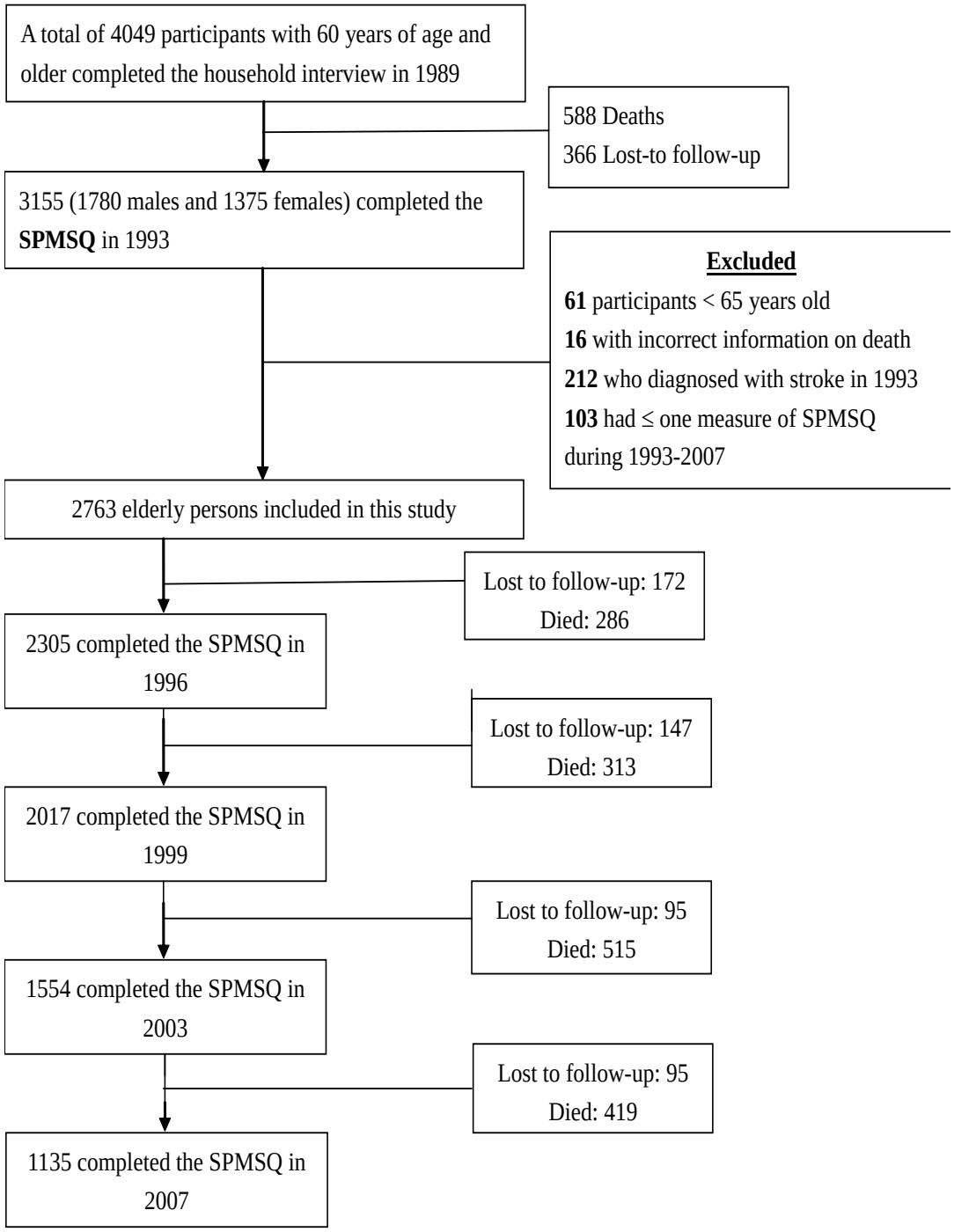

Figure 1. Number of subjects in each wave of interview.

We used group-based trajectory method to identify trajectories of cognitive function. The group-based trajectory model combines the methods for finite mixture models and cluster analysis with longitudinal data. The model classifies individuals into clusters with similar trajectories (Nagin 2005) according to the longitudinal data of individuals, assuming that individual differences in trajectories can be summarized by a finite set of different polynomial functions for age or time (Nagin 1999, Nagin and Odgers 2010) by an SAS macro (Jones, Nagin et al. 2001, Jones and Nagin 2007) (http://www.andrew.cmu.edu/user/bjones/index.htm). The likelihood function is $P(Y_i = y_i|K_i = k,) = \prod_{y_{ij}} p_{ijk} \prod_{y_{ij}=0} (1 - p_{ijk})$, where y_i is the variable of interest of individual i, and K_i indicates the group, P_{ijk} indicates the probability of individual i, at time j, in group k. The Bayesian information criterion (BIC) was used to select the optimal model (Nagin and Odgers 2010). After identified the trajectories, we examined the associated factors using generalized estimation equation.

Results

We identified three trajectories of the cognitive function, namely low-decline, high-decline, and high (Figure 2). The comparisons of baseline characteristics are presented in Table 1. Table 2 shows the results of GEE model.

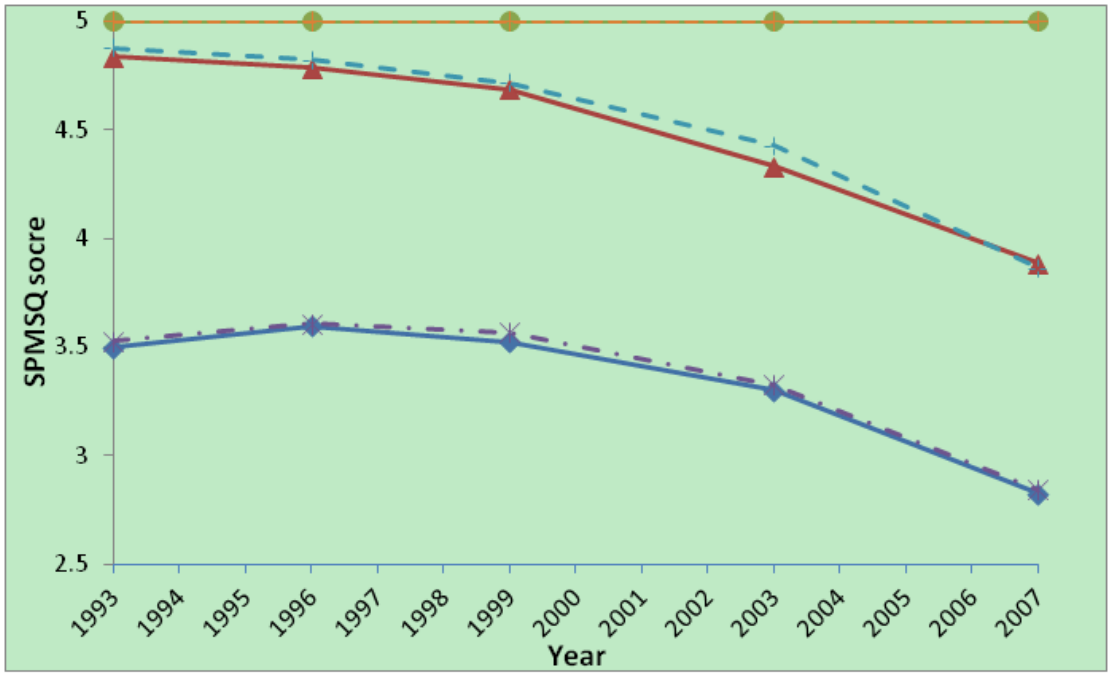

Figure 2. Trajectories of cognitive function of Taiwanese elderly.

Table 1. Baseline characteristics of the study population for each trajectory group

Variables	Low-decline-1 (n=905)	High-decline-2 (n=1497)	High-3 (n=361)	Post hoc test[#]
Age (years)***	73.76 ± 6.27	71.04 ± 4.95	68.50 ± 3.26	1>2>3
65-74***	527 (58.23)	1183 (79.02)	344 (95.29)	
75-84	328 (36.24)	291 (19.44)	17 (4.71)	
≧85	50 (5.52)	23 (1.54)	0	
Gender***				
Male	284 (31.38)	999 (66.73)	260 (72.02)	
Female	621 (68.62)	498 (33.27)	101 (27.98)	
Education***				
Illiterate	655 (72.46)	412 (27.58)	34 (9.42)	
Uneducated but literate	70 (7.74)	141 (9.44)	22 (6.09)	
Primary	151 (16.70)	589 (39.42)	161 (44.60)	
Secondary or above	28 (3.10)	352 (23.56)	144 (39.89)	
Exercise***	418 (46.19)	1056 (70.59)	269 (74.52)	
Smoking***	161 (17.79)	538 (35.94)	118 (32.69)	
Alcohol use***	75 (8.29)	326 (21.78)	105 (29.09)	
BMI*	22.45 ± 3.50	22.82 ± 3.42	22.88 ± 2.96	2>1
Self-reported health status***				
Good	274 (30.68)	716 (48.18)	201 (55.99)	
Average	319 (35.72)	516 (34.72)	122 (33.98)	
Not good	300 (33.59)	254 (17.09)	36 (10.03)	
Hypertension	262 (30.47)	380 (25.90)	94 (26.55)	
Diabetes**	94 (10.85)	140 (9.58)	16 (4.48)	
Heart disease	90 (11.64)	135 (10.14)	23 (6.93)	
CES-D score (0-30)***	8.42 ± 6.67	6.01 ± 5.31	4.52 ± 4.62	1>2>3
Mobility tasks (0-24)***	5.08 ± 5.68	2.02 ± 3.48	1.12 ± 2.34	1>2>3
ADL score(0-18)***	0.47 ± 1.99	0.06 ± 0.78	0.01 ± 0.17	1>2, 1>3
IADL score(0-18)***	3.94 ± 4.65	1.09 ± 2.29	0.43 ± 1.07	1>2>3
Social support				
Social Interaction (0-2)**	0.61 ± 0.55	0.78 ± 0.61	0.84 ± 0.66	1<2, 1<3
Emotion support (0-3)***	2.50 ± 0.79	2.58 ± 0.76	2.69 ± 0.68	1<2, 1<3

Data are presented as n (%) or Mean ± SD.

*p<0.05, **p<0.01, ***p<0.001 for X^2-test (categorical variable) or ANOVA (continuous variable) comparing cognitive trajectory group.

[#] Multiple comparison tests based on Tukey's test.

Age, education level, exercise, smoking, alcohol drinking, BMI diabetes, mobility, Activity of daily living (ADL), and instrument activity of daily living (IADL) , depression , and social support at baseline were significantly associated with their trajectory of cognitive function.

Table 2. Relationships between cognitive function and risk factors

Variables	Univariate[a]				Full model			
	β	95% C.I		p value	β	95% C.I		p value
Age	-0.0176	-0.0214	-0.0137	<0.0001	-0.0064	-0.0101	-0.0028	0.0006
Female vs. male	-0.1103	-0.1413	-0.0793	<0.0001	-0.0339	-0.0639	-0.0039	0.0265
Education (Reference: Illiterate)								
Uneducated but literate	0.1407	0.0784	0.2029	<0.0001	0.0873	0.0298	0.1449	0.0029
Primary	0.1774	0.1388	0.2159	<0.0001	0.1011	0.0636	0.1386	<0.0001
Secondary or above	0.2153	0.1772	0.2534	<0.0001	0.1195	0.0814	0.1576	<0.0001
BMI	0.0089	0.0035	0.0142	0.0011	-	-	-	-
Self-reported health scores	0.0583	0.0434	0.0732	<0.0001	-0.0145	-0.0300	0.0010	0.0673
ADL	-0.0609	-0.0710	-0.0508	<0.0001	-0.0225	-0.0342	-0.0108	0.0002
IADL	-0.0569	-0.0631	-0.0507	<0.0001	-0.0427	-0.0503	-0.0350	<0.0001
Mobility tasks	-0.0289	-0.0329	-0.0249	<0.0001	-	-	-	-
CES-D	-0.0144	-0.0175	-0.0114	<0.0001	-0.0033	-0.0066	-0.0001	0.0441
Social support	0.0482	0.0328	0.0637	<0.0001	0.0165	0.0020	0.0310	0.0261
Social interaction	0.0723	0.0478	0.0969	<0.0001	-	-	-	-
Emotion support	0.0564	0.0310	0.0819	<0.0001	-	-	-	-
Exercise	0.1901	0.1512	0.2289	<0.0001	0.0383	0.0006	0.0760	0.0462
Hypertension	0.0091	-0.0250	0.0431	0.6015	-	-	-	-
Diabetes	-0.0338	-0.0836	0.0160	0.1835	-	-	-	-
Heart disease	0.0114	-0.0288	0.0515	0.5781	-	-	-	-
Stoke	-0.2367	-0.3609	-0.1125	0.0002	-0.0441	-0.1645	0.0764	0.4736
Survey (Reference: 1993)								
1996					0.0167	0.0012	0.0323	0.0350
1999					0.0387	0.0133	0.0642	0.0029
2003					0.1066	0.0673	0.1459	<0.0001
2007					0.1092	0.0494	0.1691	0.0003
SPMSQ group (Reference: High)								
High-decline					-0.0291	-0.0519	-0.0063	0.0122
Low-decline					-1.3209	-1.396	-1.2458	<0.0001
Survey*SPMSQ group								
1996* high-decline					-0.0857	-0.1192	-0.0521	<0.0001
1996* low-decline					0.1310	0.0165	0.2455	0.0249
1999* high-decline					-0.1778	-0.2202	-0.1353	<0.0001
1999* low-decline					0.1288	0.0084	0.2492	0.0360
2003* high-decline					-0.6248	-0.6928	-0.5568	<0.0001
2003* low-decline					-0.0549	-0.1906	0.0808	0.4278
2007* high-decline					-1.0346	-1.1297	-0.9396	<0.0001
2007* low-decline					-0.4824	-0.6792	-0.2856	<0.0001

a. The social support score includes social interaction and emotional support score.

The full model shows (a) decline in ADL, IADL, and having stroke decreased the cognitive function; and (b) higher BMI and exercise would result in better cognitive function given the same age, gender, and education level.

Discussion

We only used complete data for analysis at this time. We would like to examine the effect of attrition on the trajectory of cognitive function. We are exploring the possibility using latent growth cure. There are two perspectives of constructing latent growth curve models, the multilevel modeling and the structural equation modeling (Raudenbush and Bryk 2002). In the multilevel model, level 1 represents

intra-individual differences in initial status and growth, and level 2 models individual initial status and growth parameters as a function of inter-individual differences.

Level 1 equation is $y_{ip} = \pi_{0p} + \pi_{1p} t_i + \varepsilon_{ip}$, where y_{ip} is the measure of behaviors for person p at time i, π_{0p} represents the initial status at time $t = 0$, π_{1p} represents the growth trajectory, t_i represents a temporal dimension that is assumed to be the same for all individuals at this place, and ε_{ip} is the disturbance term. In the level 2 model, the individual differences in the initial status and growth rates are modeled. We first considered the time-invariant predictor of initial status and growth for person p as x_p.

$\pi_{0p} = \mu_{\pi 0} + \gamma_{\pi 0} x_p + \zeta_{0p}$, and $\pi_{1p} = \mu_{\pi 1} + \gamma_{10} x_p + \zeta_{1p}$, where $\mu_{\pi 0}$ and $\mu_{\pi 0}$ are intercept parameters relating to initial status; $\gamma_{\pi 0}$ and $\gamma_{\pi 1}$ are slopes relating to growth. Eventually, time-varying predictor of change can be added to the model. The model specifications are similar in structural equation modeling.

Low cognitive function appeared in very early stage. That requires public health attention.

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