Research report

Trajectory of depression symptoms and related factors in later life — A population based study

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ABSTRACT

Background: A number of studies of elderly depression have examined the association between depression and its related factors; however, they did not observe how the development of related factors influenced elderly depression over time. This study aims to understand the rising trajectory of depressive symptoms found in elderly male and female, and whether the causation of depression due to related factors would be heterogeneous between male and female over a decade from 1993 to 2003.

Method: This study uses the data from the "Survey of Health and Living Status of the Elderly in Taiwan". A total of 1017 elderly Taiwanese, aged 60 and over, completed four survey modules. The latent growth curve model and general growth mixture model were used to identify the trajectories of depression symptoms, and to assess their related factors in the elderly male and female in Taiwan during the 10 year survey study.

Result: The results showed that a rising trajectory of depressive symptoms came about for both Taiwan elderly male and female over ten years. We also found that in the trajectories of depressive symptoms between elderly male and female across four waves of data, the results were heterogeneous. The trajectory of depressive symptoms in males was affected by perceived health and disability; the trajectory of depressive symptoms in females was influenced by disability and social support.

Conclusion: These findings demonstrated that the final depressive symptoms of the elderly would differ from the elderly with developmentally different depressive related factors. The findings also highlighted the developmental trajectories of depressive symptom in terms of their related factors in the elderly.

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1. Introduction

Depression is the most common mental disorder in the elderly, and there is a higher prevalence of depression with increasing age (Stordal et al., 2003). The prevalence of depression in the elderly was reported to be between 11.2% and 13.3% in industrialized countries (Niti et al., 2007;

Steffens et al., 2009). In Taiwan, the prevalence of elderly depression was found to be between 17.7% and 21.3% (Chiu et al., 2005; Chong et al., 2001). Depression is often mistakenly accepted as a normal part of aging, and therefore overlooked as a mental disorder which needs to be treated. Symptoms of depression in the elderly are identifiable and may include sadness, insomnia, increase or decrease in appetite, weight loss, a sense of hopelessness and helplessness, unwillingness to speak, and withdrawal (Cohen, 2002; Unützer, 2007). Depression causes the elderly to have a lower quality of life accompanied by reduced physical activity and fewer emotional connections. More serious depressions often lead to suicidal tendencies (Turvey et al., 2002). Depression also increases the risk of death (Van der Weele et al., 2009).

Health issues are a major contributing factor to depression in the elderly (Niti et al., 2007). The elderly often experience increased physical disability due to illness and this can also cause depression; the more serious the disability, the more severe the depressive symptoms (Harris et al., 2003). It is worth mentioning that physical disability is a dynamic and progressive process, and is mainly a consequence of underlying co-morbidity with chronic medical conditions and psychosocial factors that are associated with aging (Armenian et al., 1998). Depression is also considered to affect well-being and ability to function (Wang et al., 2002). Research suggests that depression and poor physical function are mutually reinforcing, causing a progressive and spiraling decline in the physical and psychological health of older persons.

Furthermore, women have been reported to have a greater tendency to experience depression than men when faced with poor health and physical disability (Zunzunegui et al., 2007). The elderly are also affected by a sense of belonging received from others (Choenarom et al., 2005). Without support from society, depression can defeat the elderly (Li and Liang, 2007), which leads to a reduced sense of self worth. Financial considerations may be a major contributing factor leading to depression among the elderly. Most elderly people are retired and may have limited income. Also, their children usually have left home. It was found that the lower the income level, the more severe the depression (Mojtabai and Olfson, 2004). This is especially true among women (Sonnenberg et al., 2000).

A number of cross sectional studies of depression have examined the association between depression and its related factors (Kaneko et al., 2007; Tsai et al., 2005). These cross sectional studies classified depressive symptoms observed over the same time period. In Belgium, a longitudinal study was conducted to explore depressive trends with the latent variable growth curve model (LGM) (Wauterickx and Bracke, 2005); however, the study did not observe how the development of related factors influenced depression over time. In addition, other longitudinal studies of depression have focused on repetitive measurements over time (Anstey et al., 2007; Barry et al., 2009). However, they lacked growth parameter estimation in intercept and slope, with respect to the initial difference and longitudinal changes for each subgroup and individuals. In this study, we employed data from a longitudinal survey completed by the Taiwan Bureau of Health Promotion, Department of Health. In this program, one thousand and seventeen Taiwan seniors, who were aged

65 or above, were interviewed four times between 1993 and 2003. Our hypotheses are that a rising trajectory of depressive symptoms comes into existence for both Taiwan elderly male and female from 1993 to 2003 (identified with latent growth curve model; LGCM), and that the depression related factors (perceived health, disability, social support, and perceived economic status) would be heterogeneous over time between males and females (identified with growth mixture model; GMM).

2. Methods

2.1. Participants and procedures

In Taiwan, a survey of health and living status of the elderly began in 1989 with a nationally representative sample – including the institutionalized population – of 4049 persons aged 65 and older (response rate 92%). The sample excluded aboriginal areas of Taiwan (i.e., aboriginal areas included the 30 mountainous rural townships as designated by the Ministry of the Interior); due to the fact that people in these areas had different lifestyles and diseases (Cheng and Chen, 1995). The aborigines would probably have a different trajectory of depressive symptoms. The sample was drawn as a multi-stage probability sample. The first segment involves the selection of 56 administrative districts (primary sampling unit; PSU) from the total population of 331 administrative districts based on administrative level, educational level, and fertility rate of each township. Data for this segment was further classified into 27 strata. The second segment of the survey involves a randomized selection of blocks within the PSU. The third segment of the survey involves a systematic random selection of two elderly persons from neighborhood population registers within each block. Both PSUs and blocks were selected with probabilities proportional to the size of the population in the sampling unit. A total of 4049 interviews divided into five waves were conducted between 1989 and 2003. However, in this study, 1989 data was excluded because the response categories have been changed. We could not get consistent responses from the first to the next four waves. This study used variables that were consistent across four waves starting in 1993, and followed up in 1996, 1999, and 2003. There were 1017 respondents who were 65 years and above who completed the follow-up survey in 2003. Those respondents had to fill out all paperwork for the Center for Epidemiologic Studies Depression (CES-D) Scale in 1993, 1996, 1999, and 2003.

2.2. Study design

Initially, the LGCM was used to observe individual differences in initial levels and the rates of change from the beginning point of male and female trajectory. Depression scores of the elderly were taken over four years, namely in the years 1993, 1996, 1999, and 2003, and were formulated into two latent variables. The first latent variable measured the initial stage (1, 1, 1, 1) of depression in elderly men and women. The second latent variable measured the depression gradient, or the rate of change (0, 1, 2, 3), of the subjects. In addition, the GMM was used to examine the standing with dissimilar rate of change over time of depressive symptoms in

elderly male and female. The latent variables of GMM were the perceptions of the study subjects on their own health, disability status, social support, and financial status. The relationship between these latent variables and the elderly depression growth trajectory for the years 1993, 1996, 1999, and 2003, were evaluated. To explore depression in the elderly with such sophisticated longitudinal data, GMM is more realistic than the traditional repeated measures analysis of variance, due to the fact that GMM offers parameter assumptions. The GMM model provides parameter estimates of the mean initial status (intercept), the mean growth rate (slope), and individual variability over time. Furthermore, multiple logistic regression analysis was adopted to model for depression related factors and co-morbidity at study entry (in 1993) in predicting subsequent depressive syndromes from 1993 to 2003. In order to clarify the temporal relationship between depression and related factors, we excluded subjects with signs of initial depression in 1993 within this analysis.

2.3. Measurements

An orally administered, structured questionnaire was used during the face-to-face interview. Questions on chronic disease conditions were also included in the questionnaire (e.g., hypertension, arthritis, heart disease, bronchitis, and diabetes mellitus). The following variables were used in this study to explore the association between depressive symptoms and related factors in elderly Taiwanese.

2.3.1. Depressive symptom

We used the CES-D Scale to measure the characteristics and severity of depressive symptoms in the elderly (Kohout et al., 1993). There were 10 items surveyed, to which the subject needed to indicate the frequency of the events listed occurring over the past week. The frequency range was from 0 to 3, and the total score was 30. A cut-off score of ≥ 10 for depressive symptoms was used (Andresen et al., 1994), and higher scores meant greater depressive symptoms.

2.3.2. Perceived health

Perceived health refers to an individual's own subjective assessment of his/her health status. Perceived health was measured as current health status in five degrees: very good, good, fair, bad, and very bad (Kaplan and Camacho, 1983). We recalibrated the direction of measurement. A higher score on perceived health measures indicated higher health status. For measuring in the regression model, we categorized the five degrees into two levels. The level recoded for perceived good health (for responses good and very good), or poor (for responses fair, bad, and very bad).

2.3.3. Disability

The evaluation of disability status was based on an individual's daily activity as measured by the Activities of Daily Living (ADL) Scale (Katz et al., 1963), and the Instrumental Activities of Daily Living (IADL) Scale (Lawton and Brody, 1969). The measurements taken were used to ascertain the degree of difficulty the elderly had in going about in his/her daily routine. There were 6 questions each on personal daily activities for the ADL scale and for the IADL scale. Points from 0 to 3 were awarded for each answer, with

zero points being awarded for the answer "no difficulty", and three points being awarded for the answer "completely impossible". In this study, the ADL and the IADL scales were combined together as a "disability" variable. The higher the score is on the variable, the more serious the disability. For measuring in the regression model, we created a new binary variable. Disability domain defined "yes" as difficulty in performing one or more activities. Conversely, disability domain defined "no" as no difficulty in performing activities.

2.3.4. Social support

In this study, social support included the support of family members, relatives, neighbors, and friends. The "instrumental support" and the "emotional support" indicators were measured in older persons getting support from people around him/her, which were assessed by self report (Berkman et al., 1992). There were two questions asked on "instrumental support". The first question was, "When you need someone to take care of you when you are sick, can you rely on your family and friends?". The second question was, "In general, do you feel that your care and help to your family and friends are not so great?". There were four questions on "emotional support". These four questions were: 1) "When you need to talk to someone about your problems, do you feel that your family, relatives, or friends are willing to listen to you?", 2) "In general, how much do your family or friends take care of you with regard to your psychological and emotional needs?", 3) "When your family decides or discusses something, do they ask your opinion?", and 4) "When your family or friends do something for you, do you criticize them?". The answers to the four questions were scored from 1 to 5. The Likert scale was used to evaluate social support. A higher score in each item represented a higher social support. For measuring in the regression model, the cut off point for the high-social support group was a score of 20 or above.

2.3.5. Perceived economic status

We measured a person's subjective feeling of satisfaction with his/her financial situation (Cheng et al., 2002). The single question asked was, "Are you satisfied with your current economic situation?" The Likert scale was used whereby points of 1 to 5 were assigned to five answers the subject can pick, with 1 point given to the answer "very unsatisfied" and 5 points given to the answer "very satisfied".

2.3.6. Socio-demographic variables

This study used socio-demographic variables, including age, education level, marital status, and living arrangements. Data was consistently collected across four waves starting in 1993.

2.4. Statistical analysis

Data was analyzed using SPSS17.0 (Chicago, IL, USA) and AMOS 7.0 (Chicago). Baseline characteristics were compared between elderly male and female using a t-test for continuous data and χ^2-test for discrete data. Comparison of perceived health, disability, social support, perceived economic status, and CES-D and depressive symptom rates at different years were made using repeated measured ANOVA and Cochran's Q test, respectively. The depression trajectory models were

estimated and the model fit by maximum likelihood techniques with structural equation modeling. LGCM allows us to summarize individual differences in initial levels and the rates of change from the beginning point of a single overall group trajectory (male and female). We further explored the heterogeneity of these relationships using GMM to identify classes with different trajectories of depressive symptoms and their related factors (e.g., perceived health, disability, social support and perceived economic status). The overall fit indices of the depression trajectory models were assessed using the Incremental Fit Index (IFI), Comparative Fit Index (CFI), Non-normed Fit Index (NNFI), and Root Mean Square Error of Approximation (RMSEA). The following criteria were used for judging the models employed in this study: IFI > .9 (Bollen, 1989), CFI > .8 (Hu and Bentler, 1999), NNFI > .8, and RMSEA < .05 (Hair et al., 1995). Multiple logistic regression model was also used to calculate the odd ratios (OR) and 95% confidence interval (CI) to assess statistical association between possible risk factors and subsequent depressive symptoms. Statistical significance was defined at p-value<0.05.

For missing answers (when questions asked were not answered and left blank), the Full Information Maximum Likelihood Model based on AMOS was used to obtain estimated parameter values. The values generated were randomly assigned by way of stochastic regression imputation.

3. Results

In this study, there were 1017 elderly (532 men and 485 women) in the final analysis. Baseline characteristics of subjects in 1993 are shown in Table 1. The mean age of elderly men and women was 69.8 and 70.8 years in 1993, respectively. Significant differences between elderly males and females were found for age (p<.001, t-test), education level (p<.001, χ^2-test), marital status (p<.001), and living

arrangement (p=.02). A significant portion of the elderly had no education and was, in fact, illiterate (42.5%); generally, elderly males had attained higher education than elderly women. Sixty-seven percent of the elderly males were married or cohabiting compared to 29.1% of elderly females. Of the elderly females, 70.3% were widows. Women lived to a greater extent with families (60.2%) than men (53.9%), and more elderly males were living with a spouse/partner (31.0%) than elderly females (22.5%). The prevalence of three chronic diseases differed significantly between elderly male and female. Elderly females had more arthritis, heart disease, and diabetes mellitus compared to elderly males, respectively.

Mean scores of perceived health, disability, social support, perceived economic status, CES-D scale and prevalence of depressive symptoms across the four waves are presented in Table 2. In self-perceived health, we found that the elderly were significantly getting worse from 1993 to 2003 (p<.01, repeat measured ANOVA). The disability of the elderly showed a significant deterioration from 1993 to 2003 (p<.01). The elderly felt a lack of social support significantly from 1993 to 2003 (p<.01), and perceived economic status significantly got worse from 1993 to 2003 (p<.01). By CES-D measurement, there was significant degeneration in the elderly from 1993 to 2003 (p<.01). Among our elderly subjects, the prevalence of depressive symptom was significantly increased from 1993 to 2003 (p<.01, Cochran's Q test).

We used LGCM to evaluate depressive symptom differences in elderly male and female at initial levels and at changing trajectories (Fig. 1A). Possible confounding effects (including age, educational level, marital status, and living arrangement) were adjusted in our LGCM. Depressive symptom scores of the elderly were taken over four years, namely in the years 1993, 1996, 1999, and 2003, and were formulated into two latent variables. The first latent variable

Table 1
Baseline characteristics (numbers and row percentages) of Taiwan elderly study population by sex in 1993.

Characteristics	Men (n = 532)	Women (n = 485)	Total (n = 1017)	p-value
Age, mean ± standard deviation	69.8 (4.4)	70.8 (4.9)	70.3 (4.7)	<.001
Education level, n (%)				<.001
No education and illiterate	117 (22.0)	315 (64.9)	432 (42.5)	
≤6 years education	214 (40.2)	128 (26.4)	342 (33.6)	
7–12 years education	140 (26.3)	39 (8.0)	179 (17.6)	
≥13 years education	61 (11.5)	3 (0.7)	64 (6.3)	
Marital status, n (%)				<.001
Married/cohabiting	356 (66.9)	141 (29.1)	497 (48.9)	
Unmarried	18 (3.4)	3 (0.6)	21 (2.1)	
Separation/divorce	14 (2.6)	0 (0.0)	14 (1.4)	
Widowed	144 (27.1)	341 (70.3)	485 (47.7)	
Living arrangement, n (%)				.02
Living alone	56 (10.6)	63 (13.0)	119 (11.7)	
Living with spouse/partner	165 (31.0)	109 (22.5)	274 (26.9)	
Living with families	287 (53.9)	292 (60.2)	579 (56.9)	
Others	24 (4.5)	21 (4.3)	45 (4.4)	
Chronic illness, n (%)				
Hypertension	158 (29.7%)	150 (31.0%)	308 (30.3%)	.67
Arthritis	123 (23.1%)	148 (30.5%)	271 (26.7%)	.01
Heart disease	94 (17.7%)	113 (23.3%)	207 (20.4%)	.03
Bronchitis	60 (11.3%)	44 (9.1%)	104 (10.2%)	.25
Diabetes mellitus	30 (5.6%)	45 (9.3%)	75 (7.4%)	.03

Table 2
Mean scores and standard deviations of perceived health, disability, social support, perceived economic status, CES-D scale and prevalence of Taiwan elderly depressive symptoms in each year.

Characteristics	Men	Women	Total
	(n = 532)	(n = 485)	(n = 1017)
Perceived health			
In 1993	3.83 ± 0.95	3.30 ± 1.05	3.58 ± 1.03
In 1996	3.54 ± 1.04	2.96 ± 0.97	3.27 ± 1.05
In 1999	3.22 ± 1.04	2.84 ± 1.06	3.04 ± 1.67
In 2003	2.99 ± 1.14	2.74 ± 1.06	2.87 ± 1.11
p-value	p < .01	p < .01	p < .01
Disability			
In 1993	.53 ± 1.83	1.14 ± 1.54	.82 ± 1.65
In 1996	.86 ± 3.08	1.15 ± 1.57	1.00 ± 2.29
In 1999	1.77 ± 4.94	1.79 ± 2.47	1.78 ± 3.61
In 2003	4.32 ± 8.66	4.68 ± 5.53	4.49 ± 7.45
p-value	p < .01	p < .01	p < .01
Social support			
In 1993	20.31 ± 3.11	19.20 ± 3.19	19.80 ± 3.20
In 1996	24.60 ± 4.39	23.54 ± 4.57	24.11 ± 4.50
In 1999	24.49 ± 4.24	23.37 ± 4.29	23.97 ± 4.30
In 2003	23.07 ± 4.55	22.29 ± 4.13	22.71 ± 4.38
p-value	p < .01	p < .01	p < .01
Perceived economic status			
In 1993	3.69 ± .92	3.76 ± .93	3.72 ± .93
In 1996	3.33 ± .84	3.42 ± .91	3.37 ± .88
In 1999	3.27 ± .91	3.27 ± .99	3.27 ± .95
In 2003	3.33 ± .92	3.34 ± .90	3.33 ± .91
p-value	p < .01	p < .01	p < .01
CES-D scale			
In 1993	4.71 ± 4.61	6.53 ± 5.49	5.54 ± 5.11
In 1996	4.53 ± 5.25	6.73 ± 5.84	5.54 ± 5.63
In 1999	4.84 ± 5.45	6.55 ± 5.95	5.62 ± 5.75
In 2003	5.36 ± 5.46	7.29 ± 6.06	6.24 ± 5.82
p-value	p = .01	p = .04	p < .01
Prevalence of depressive symptoms, n (%)			
In 1993	75 (14.1)	127 (26.2)	202 (19.9)
In 1996	80 (15.0)	161 (33.2)	241 (23.7)
In 1999	102 (19.2)	153 (31.5)	255 (25.1)
In 2003	115 (21.6)	167 (34.4)	282 (27.7)
p-value	p < .01	p < .01	p < .01

CES-D = Center for Epidemiologic Studies Depression.

Fig. 1. (A) Path diagram for LGCM for DS in Taiwan elderly from 1993 to 2003. (B) Path diagram for GMM for DS in Taiwan elderly from 1993 to 2003. Control variables (including age, educational level, marital status, and living arrangements) were also included in two separate models, and their indicators of latent and measurement errors are not shown. DS = depressive symptoms; LGCM = latent growth curve modeling; GMM = growth mixture model.

measured the initial stage (1, 1, 1, 1) of depressive symptoms in elderly men and women. The second latent variable measured the depressive symptom intercept, or the rate of change (0, 1, 2, 3), of the subjects. The result is shown in Table 3, and two models provided an acceptable fit to the data (male: IFI = .96, CFI = .96, NNFI = .93, RMSEA = .06; female: IFI = .99, CFI = .99, NNFI = .97, RMSEA = .03). The intercept (μ = 3.90) and slope (μ = .49) means of latent classes of male elderly depressive symptoms were significantly different from 0, and variances of these parameter estimates were significant (p < .05). The intercept (μ = 6.32) and slope (μ = .28) means of latent classes of female elderly depressive symptoms were also significantly different from 0, and variances of these parameter estimates also showed significant differences (p < .05). This means that the depressive symptoms of the elderly male and female had an upward trend in the overall average over time. In addition, the covariance of intercept and slope in elderly male and female depressive symptoms were not significantly different.

Subsequently, we conducted a GMM analysis to examine whether perceived health, disability status, social support,
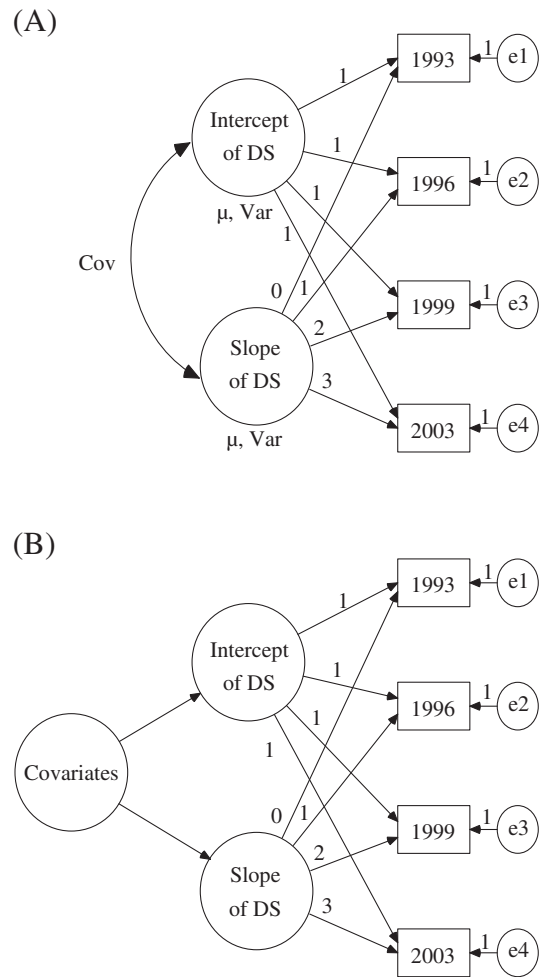
and perceived economic status were related to depressive symptoms in elderly male and female and whether there is a change in trajectory over time (Fig. 1B). We also adjusted the possible confounding effects of age, educational level, marital status, and living arrangement. The result is shown in Table 4. The first class, elderly male and female perceived health mixture models, was an acceptable fit to the data (male: IFI = .85, CFI = .87, NFI = .86, RMSEA = .08; female: IFI = .90, CFI = .92, NNFI = .90, RMSEA = .07). Perceived health had significant negative effects on the intercept of elderly male depressive symptoms (β = − 2.42) and female depressive symptoms (β = − 6.28). It also had a significant negative slope for elderly male depressive symptoms (β = − .55; p < .001), but not in elderly females. The second class, elderly male and female disability mixture models, was well fit to the data (male: IFI = .90, CFI = .90, NNFI = .83, RMSEA = .09; female: IFI = .90, CFI = .90, NFI = .82, RMSEA = .08). Disability had separately significant positive effects on the intercept

Table 3
Gender differences of Taiwan elderly depressive symptoms in LGCM from 1993 to 2003.

	Standardized path coefficients	
	Men	Women
Intercept of depressive symptoms		
Mean	3.90*	6.32*
Variance	7.81*	11.20*
Slope of depressive symptoms		
Mean	.49*	.28†
Variance	.73†	.91†
Covariance	−.62	−.71

Adjusted effects of age, educational level, marital status, and living arrangement.
LGCM = latent growth curve modeling.
*.01<p<.05, †p<.01.

of elderly male depressive symptoms (β = .13) and female depressive symptoms (β = .28). Disability also had significant positive effects on the slope trends for elderly male depressive symptoms (β = .05; p<.001) and female depressive symptoms (β = .14; p<.001). The third class, elderly male and female social support mixture models, was an acceptable fit to the data (male: IFI = .84, CFI = .84, NNFI = .81, RMSEA = .09; Female: IFI = .82, CFI = .82, NNFI = .80, RMSEA = .09). Social support had separately significant negative effects on the intercept of older male depressive symptoms (β = −.94) and female depressive symptoms (β = −1.22). It also had a significant negative slope for elderly female depressive symptoms (β = −.15; p<.05), but not for elderly males. The fourth class, elderly male and female perceived economic status mixture models, was a perfect fit to the data (male: IFI = .99, CFI = .98, NNFI = .94, RMSEA = .02; female: IFI = .99, NNFI = .95, CFI = .99, RMSEA = .01). As time went on, perceived economic status for elderly males and females had no effect on depressive symptoms.

Furthermore, the adjusted OR for the joint effects of perceived health, disability, social support, and chronic physical illness on subsequent depression symptom is

Table 4
Gender differences of Taiwan elderly depressive symptoms in four-class growth mixture model from 1993 to 2003.

Path	Standardized path coefficients	
	Intercept	Slope
Men		
Perceived health to elderly depressive symptoms	−2.42*	−.55*
Disability to elderly depressive symptoms	.13*	.05*
Social support to elderly depressive symptoms	−.94*	−.04
Perceived economic status to elderly depressive symptoms	.54	−.02
Women		
Perceived health to elderly depressive symptoms	−6.28*	−.17
Disability to elderly depressive symptoms	.28*	.14*
Social support to elderly depressive symptoms	−1.22*	−.15†
Perceived economic status to elderly depressive symptoms	−.26	−.20

Adjusted effects of age, educational level, marital status, and living arrangement.
*p<.01, †.01<p<.05.

shown in Table 5. Confounding effects including age, educational level, marital status, and living arrangement were also adjusted in the multiple logistic regression models. Compared to elderly subjects who had perceived good health and no chronic illness at study entry, males (OR = 1.49, 95% CI = 0.97–2.30) and females (OR = 1.36, 95% CI = 0.85–2.18) who had perceived poor health and no chronic illness subjects had a higher risk to developing depression symptom; although their risks were not significant. Significant joint effects of perceived poor health and chronic illness on developing depressive symptoms for elderly males (OR = 1.91, 95% CI = 1.27–2.86) and females (OR = 1.61, 95% CI = 1.03–2.51) were observed, respectively. However, the interaction of perceived health and chronic illness on developing depression symptom was significant in elderly males but not in elderly females. Compared to the elderly those who had no disability and no chronic illness in the beginning year, elderly males (OR = 1.76, 95% CI = 1.14–2.71) and females (OR = 1.67, 95% CI = 1.12–2.51) who had disability and no chronic illness showed significant risks on developing depressive symptoms. Elderly males (OR = 2.02, 95% CI = 1.33–3.07) and females (OR = 1.82, 95% CI = 1.27–2.60) who had disability and chronic illness exhibited significant joint effects on developing depressive symptoms. In contrast to the elderly those who had high social support and no chronic illness at study entry, males (OR = 1.46, 95% CI = 0.86–2.49) and females (OR = 1.55, 95% CI = 1.00–2.42) who had low social support and no chronic illness had a higher risk to developing depression symptom even though risk in males was not significant. Similarly, elderly males (OR = 1.52, 95% CI = 1.01–2.29) and females (OR = 1.77, 95% CI = 1.24–2.52) who had low social support and chronic

Table 5
Effects of perceived health, disability, social support, with chronic illness in 1993 and subsequent depressive symptoms from1993 to 2003 in elderly Taiwanese.

Variables in 1993		Depressive symptoms (1993–2003)	
		Male	Female
		OR (95% CI)	OR (95% CI)
Perceived health	Chronic illness[a]		
Good	No	1.00 (Reference)	1.00 (Reference)
Good	Yes	1.02 (0.63–1.65)	1.48 (0.92–2.40)
Poor	No	1.49 (0.97–2.30)	1.36 (0.85–2.18)
Poor	Yes	1.91 (1.27–2.86)*	1.61 (1.03–2.51)†
p for interaction		<.01	.18
Disability	Chronic illness		
No	No	1.00 (Reference)	1.00 (Reference)
No	Yes	1.22 (0.90–1.65)	1.31 (0.89–1.91)
Yes	No	1.76 (1.14–2.71)†	1.67 (1.12–2.51)†
Yes	Yes	2.02 (1.33–3.07)*	1.82 (1.27–2.60)*
p for interaction		<.01	<.01
Social support	Chronic illness		
High	No	1.00 (Reference)	1.00 (Reference)
High	Yes	1.27 (0.96–1.69)	1.28 (0.97–1.68)
Low	No	1.46 (0.86–2.49)	1.55 (1.00–2.42)†
Low	Yes	1.52 (1.01–2.29)†	1.77 (1.24–2.52)*
p for interaction		.15	.01

Adjusted effects of age, educational level, marital status, and living arrangement using multiple logistic regression models.
[a]Chronic illnesses included hypertension, arthritis, heart disease, bronchitis, and diabetes mellitus.
*p<.01, †.01<p<.05.

illness exhibited significant joint effects on developing depressive symptoms. However, the interaction of social support and chronic illness on developing depression symptom was significant in elderly females but not in elderly males.

4. Discussion

This study was designed to investigate whether a rising trajectory of depressive symptoms occurred for Taiwanese elderly male and female. We found disparate depressive symptoms at the initial stage, which then developed differentially from 1993 to 2003. Although there was a general upward trend, initial depressive symptoms did not predict late stage depressive symptoms ten years in the future. In order to understand the changes of the depressive symptom trajectory paths in each individual, we tested the intercept, slope, and the direction of change in the LGCM. We did not find an obvious association between the initial depressive symptoms and the changes in depressive symptoms later on. These results indicated that a person's future condition, that is whether one's condition deteriorates rapidly, or at a slower rate, or improves, is not predictable by the initial stages of depressive symptoms observed. Hence the path of depressive symptoms in the elderly cannot be extrapolated directly using a progression of time. In fact, the upward trajectory over ten years in this study was influenced by more than one single factor, which is a similar finding to previous studies (Kasen et al., 2003; Yang, 2007). We predicted changes in depressive symptom trajectories in elderly Taiwanese that would be at least explained by perceived health, disability, social support, and perceived economic status, with distinct differences between elderly male and female. Consistent with our hypothesis, we found that there were heterogeneous in the trajectories of depressive symptoms between elderly male and female across four waves of data. The trajectory of depressive symptoms in males was affected by perceived health and disability while females were influenced by disability and social support.

Our study indicated that perceived health of elderly males and females had an impact on their initial depressive symptoms. Further, the perceived health status of elderly male and female can predict differences in depression in its initial state. When perceived health got worse, the elderly male and female had higher initial depressive symptom scores. A previous study also identified that as the elderly person's perception of his health worsens, the depression also worsens (Tsai et al., 2005). In our longitudinal study, male elderly depressive symptoms were negatively correlated with perceived health in direction and the rate of change (slope, Table 4). However, perceived health and changes in rates of female elderly depression were not related. A possible reason was that Taiwanese elderly females usually took better care of their health than males (Lue et al., 2010), and any health issues the women had did not trouble the female elderly over extended periods of time. Taiwanese elderly female were also more willing to seek medical treatment than males if health trouble arose. If the elderly perceive that they have better health, they become more positive in their attitude (Kozłowska et al., 2008). A more positive outlook on personal health usually leads to a more positive outlook on health

issues resulting in less depression. Conversely, a poor perception of health can lead to a more pronounced depressive state being observed (Niti et al., 2007; Tsai et al., 2005).

A previous study has indicated that physical disability affects the depression of the elderly (Zunzunegui et al., 2007). In this study, we found disability status of elderly males and females influenced their depressive symptom in the starting state. When the disability status got worse, the depressive symptoms had higher initial scores. We also found that disability status can affect the direction and rate of deterioration in the depressive symptoms of elderly male and female. Disability can be a predictor of trajectory change for elderly depressive symptoms. Previous longitudinal studies have demonstrated that elderly with higher disability had more severe depressive symptoms; over time, these elderly depressive symptoms got worse when the high disability persisted (Freyne et al., 2005; Yang and George, 2005). With increasing age, the elderly are less able to take care of themselves in functional decline (Freyne et al., 2005). Once a functional problem occurs in the elderly, the recovery from disability is more arduous leading to a vicious cycle of depression and disability in the aged.

Social support acts as an important role in elderly psychology (Bozo et al., 2009; Li and Liang, 2007). In this study, we found that when social support was poorer, the depressive symptoms had higher initial scores. Having others to care about them, to help them, and to talk to them can reduce psychological pressures which lead to depression (Strine et al., 2009). The elderly with greater social support would have direct preventive effects on depression (Greenglass et al., 2006). They are better buffered against the unfavorable influences of disability leading to depression (Jang et al., 2002). In the current study, we also found that as time changes, social support can affect the trajectory of depression in elderly females, but it does not affect that of elderly males (Table 4). There is a difference in the social support extended to males and females. The elderly female is better equipped than the male to receive social support (Antonucci and Akiyama, 1987), and it is therefore easier to predict their risk of depression. A longitudinal study has indicated that clarification of the nature of the causal links between low social support and depression in women is needed (Kendler et al., 2005). In Taiwanese society, most females are more affiliated with their families, are more involved in their family matters, and are thus more exposed to problems in their social network later in life. This may help to explain the trajectory development difference of depressive symptom between elderly males and females with social support.

In addition, we found that financial factors were not risk factors contributing to depressive symptoms in the elderly Taiwanese. One reason may be that most elderly Taiwanese have savings and they do readily accept financial support from their children (Hsu, 2010), both of which make economic factors less of a concern. Saving rates in eastern Asia are high, and Taiwan is no exception (Adams and Prazmowski, 2003). Most elderly Taiwanese receive financial support from their children. The proportion of the elderly receiving financial help from their children was 52.3% in 1993, and 53.4% in 2003 (Directorate-General of Budget,

Accountant and Statistics, R.O.C., 2006). The greatest expense for the elderly is on medical care (Glick and Thompson, 1997). Taiwan has had national health insurance since 1995, which provides for most of the medical costs for the elderly (Cheng, 2003). With medical expenses covered and some form of savings, elderly Taiwanese have less to worry about financially.

It has been suggested that depression and poor physical function are mutually reinforcing (Harris et al., 2003; Niti et al., 2007; Wang et al., 2002). A previous cohort study performed in Baltimore (Maryland, USA) has also illustrated that antecedent psychopathology increase the occurrence of disability associated with chronic illness (Armenian et al., 1998). The depression with chronic disease conditions in the elderly would draw forth a functional decline. In the current study, we made an attempt to clarify the temporal relationship between depression and related factors, thus we excluded subjects with signs of initial depression in 1993 within our multiple logistic regression model (Table 5). We found that our elderly subjects with perceived poor health, disability, and low social support had an elevated risk of developing depression symptom. This helped to clarify the temporal relationship between depression and disability among our elderly.

Chronic disease is a commonly situation in the elderly and may lead to depression (Chiu et al., 2005; Niti et al., 2007). For some chronic diseases, biological mechanisms could directly cause depression; for example, heart disease, diabetes and arthritis may inevitably lead to decreased physical and mental ability and eventually depression (Dunlop et al., 2004; Naranjo et al., 2011). Our logistic regression analyses further demonstrate that the joint effects of poor perceived health and chronic diseases lead to higher risk of depressive symptoms development in elderly individuals. However, the interaction of perceived health and chronic illness on developing depression symptom was significant in elderly males but not in elderly females. An explanation was that elderly males are not as likely to take care of their health as elderly females (Lue et al., 2010), particularly for chronic diseases. However, when the chronic disease symptoms worsened, the elderly male could not as easily accept a deteriorating physical situation. Thus, such denial and inability to cope resulted in higher risk to develop depression for elderly males who had perceived poor health and chronic illness. Disability is strongly connected with chronic disease; associations with chronic diseases accounted for about two-thirds of prevalent disability (Sousa et al., 2009). In the current study, elderly males and females who had disability and chronic illness exhibited significant joint effects on developing depressive symptoms. Chronic diseases can cause functional decline and pain, thereby affecting daily activities. Disability also resulted in daily activities with low autonomy and therefore dependence on others for care. Collectively, life's daily inconveniences result in more psychological pressure for the elderly and can make them more prone to develop depression in later life. Usually, chronic diseases lead to a reduction in the ability for self-care in the elderly and results in changes in interaction between the elderly and their environment such as withdraw or change in communication. In this study, the joint effect of lower social support and chronic disease on the development

of depressive symptoms was also observed. These findings support the need for involvement of the elderly with some form of social support as a means to reduce psychological pressure. Especially, the interaction of social support and chronic illness on developing depression symptom was significant in our elderly females but not in elderly males. A reason is when facing the dilemma of chronic disease, the elderly female more often actively seeks the support of a social network than the elderly male (Antonucci and Akiyama, 1987). However, if these females could not obtain high social support, they would have elevated psychological pressure and were more likely to develop depression.

In this study, we observed that the prevalence of depressive symptoms in the elderly Taiwanese increased with age. Since depressive symptom trajectories could be influenced by the interaction of age and cohort effect (Yang, 2007), the exploration of depression in elderly needed to further understand age related biography like co-mobility and cohort based changes. In the current study, we also took chronic illness into considerations to identify our findings. Interestingly, our results showed a significant joint effect of chronic diseases with perceived health, disability, and social support on the development of subsequent depression. Generally speaking, the measuring of self-reported health is more subjective. The measurement of our perceived health corresponded with a previous study (Niti et al., 2007) that most co-morbid associations of depressive symptoms with specific chronic illnesses are explained by accompanying poor self-reported health and functional status. Disability and chronic diseases have been found to be associated with increased signs of depressive symptoms, which are similar to the results in previous studies (Dunlop et al., 2004; Yang and George, 2005). We also found the interaction of social support and chronic disease predicted the different development of depressive symptoms in the elderly Taiwanese.

In addition to age, significant differences between our elderly males and females were found for education level, marital status, and living arrangement. We must pay attention to the trajectory of elderly depressive symptoms, which might arise along with lower education, devoeced and widowed status, and living lonely. Usually, better income and less economic hardship experience built on the educational achievement. Thus, education attainment would influence the development of depression (Mojtabai and Olfson, 2004). Stable marriages have displayed to decrease depression (Barrett, 2000). The elderly who lived alone also displayed more depressive symptoms than those who lived with others (Brown et al., 2002), and this depression is often attributed to social isolation (Hughes and Gove, 1981) that might result in psychological pressure. As we are not intending to develop an elderly comprehensive depression model, therefore, the effects of age, educational level, marital status, and living arrangement were adjusted in our statistical models.

This study uses secondary data for analysis. The study is therefore limited by the availability of such secondary data, and the availability of the respondents for follow-up. Some factors which could influence the mental condition of the elderly by causing depression were not included in the current study, especially the level of stress faced by the elderly, and the relationship between stress and depression of

the elderly. For future studies we hope to include these and other contributory factors. Another limitation of this study is the selection bias. This longitudinal study looked at four repeated surveys. We excluded those who could not complete the survey due to physical and psychological problems, including infirmity and death. The cases of infirmity were more likely to be the elderly with poor health, with physical disabilities, with less social support, and low levels of economic status, factors that might lead to an underestimation of the depressive symptoms of the elderly Taiwanese in this study.

In this study, we found that the final depressive symptoms of elderly would differ from the elderly with developmentally different depression related factors. These findings highlighted the developmental trajectories of depressive symptom in terms of their related factors in the elderly. Future eldercare work should pay attention to the trajectory development of depressive symptom in the elderly.

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