Archives of Gerontology and Geriatrics 82 (2019) 161–166

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

# Sociodemographic characteristics, disability trajectory, and health care and long-term care utilization among middle-old and older adults in Taiwan

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ARTICLE INFO

*Keywords:*
Disability trajectory
Growth mixture modeling
Long-term care
Sociodemographics

ABSTRACT

*Objectives:* To understand whether disability trajectories mediated the association between sociodemographic characteristics and later health care and long-term care services use.
*Methods:* Data were from the Taiwan Longitudinal Study on Aging Survey, 1996–2007 (N = 3429). Latent class growth curves modeling and structural equation modeling were applied to examine the effect of disability trajectory as mediator on sociodemographic characteristics and on later services use.
*Results:* Respondents were identified in three trajectories: maintained disability (1.92%), progressive disability (10.56%), and functional independence trajectories (87.52%). The progressive disability trajectory partially and fully mediated the effects of age on later use of health care and long-term care services (the partially mediating effect on age and long-term care service use: $\beta = 0.047$, $p < 0.001$, for example). With the progressive disability trajectory in the model, higher education had a direct effect on greater use of long-term care services ($\beta = 0.020$, $p = 0.020$), but through the mediating effect of the disability trajectory, education had an indirect effect on lower use of long-term care services($\beta = -0.025$, $p < 0.001$). Education had fully mediating effects on the later use of inpatient ($\beta = -0.016$, $p < 0.001$) and emergency services ($\beta = -0.012$, $p < 0.001$).
*Conclusions:* Preventing older adults from developing a fast-growing disability trajectory could be an effective way to decrease use of health care and long-term care services and related expenditures in late life.

## 1. Introduction

Disability in older adults is associated with higher use of health care (Fried, Bradley, Williams, & Tinetti, 2001; Wu et al., 2013) and long-term care (LTC) services (Hsu, 2013; Luppa et al., 2010; Tsai & Lai, 2011), which leads to an increase in care expenditures (Chan et al., 2002). In Taiwan, adults ages 65 years and over currently represent 14% of the overall population with a projection to exceed 20% by 2025 (Ministry of the Interior in Taiwan, 2017; National Development Council in Taiwan, 2012). One LTC survey in Taiwan also estimated a double increase in the number of older adults with disability in the next two decades (Lee et al., 2013). As Taiwan has a fast-growing aging population, a strategic understanding of the relationship between the nature of older adults' disability and the later use of health care and LTC services seems important to efficient policy.

Evidence shows that disability is a dynamic process and various factors can influence the acceleration or postponement of disability among older adults (Hardy & Gill, 2004; Verbrugge & Jette, 1994). Investigation of the dynamic nature of disability, in other words, the disability trajectory, has gained recognition in current published literature (Han et al., 2013; White et al., 2013; Yu, Chen, Chiang, Tu, & Chen, 2015; Zimmer, Martin, Jones, & Nagin, 2014). These studies found that the disability trajectory in older adults has heterogenic subtypes; furthermore, these studies suggested that sociodemographic factors played roles in determining older adults' development of different disability trajectories. Being older and female were characteristics associated with a higher likelihood of developing a rapid increase in disability, maintaining a level of disability, or developing an early onset of functional limitation—subtypes of disability trajectories, whereas a higher level of education was associated with a protective effect on disability (Han et al., 2013; White et al., 2013; Yu et al., 2015; Zimmer et al., 2014). Thus, consideration of sociodemographic characteristics in measuring the disability trajectory in older adults should be noted.

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https://doi.org/10.1016/j.archger.2019.01.019
Received 30 September 2018; Received in revised form 11 January 2019; Accepted 26 January 2019
Available online 29 January 2019
0167-4943/ 

Older adults' disability and use of health-related services are widely discussed in public health (Guralnik, Fried, & Salive, 1996). Based on the framework of Andersen's Behavioral Model of Health Services Use, sociodemographic characteristics function as predisposing factors that influence people's perceived need for care and use of health services afterward (Andersen, 1968, 1995). Researchers extended the concept of Andersen's model and found that not only sociodemographic factors should be considered, but how older adults with disabilities perceive needs for care should be addressed in examining the later use of health care and LTC services (Al Snih et al., 2006; Calsyn & Winter, 2001; Evashwick, Rowe, Diehr, & Branch, 1984; Kempen & Suurmeijer, 1991). A recent study also noted that older adults with different progressions of disability over time led to different choices in LTC utilization (Hsu, 2013). A recent study showed that receipt of disability benefits in the British senior population can be explained by not only socioeconomic factors but also perceived health (as reflected in claim behaviors) (Hancock, Morciano, & Udney, 2018). Accordingly, the relationships between sociodemographic characteristics, disability changes over time, and later use of health care services could be an issue in gerontology research.

We have adopted the causal framework proposed by Andersen's Behavioral Model of Health Services Use (Andersen, 1968,1995) and applied the current knowledge about disability trajectory measurement in a sample of middle-old and older Taiwanese adults. Researchers have demonstrated the roles of sociodemographic factors on determining older adults' development of different disability trajectories (Yu et al., 2015, Han et al., 2013; White et al., 2013; Zimmer et al., 2014), and others have addressed the importance of perceived need for care for disability on the use of health care and long-term care (LTC) services (Al Snih et al., 2006; Calsyn & Winter, 2001; Evashwick et al., 1984; Hsu, 2013; Kempen & Suurmeijer, 1991). To our knowledge, there has been little research testing the direct and indirect relationships among sociodemographic factors, perceived need for disability care and service use, and little research has examined whether the different disability trajectories can have a mediating effect on the relationship between sociodemographic characteristics and subsequent health care and LTC services use. Therefore, the study used growth mixture modeling and structural equation modeling to examine the degree to which older adults' disability trajectories might mediate the effects of older adults' sociodemographic factors and later use of health care and LTC services based on Andersen's Behavioral Model of Health Services Use.

## 2. Material and methods

### 2.1. Study population and measurements

We collected data from the Taiwan Longitudinal Study on Aging (TLSA) survey, a national representative survey initiated in 1989 and followed up in 1993, 1996, 1999, 2003, and 2007. The details of the TLSA study design can be found elsewhere (Hsu, 2013; Zimmer et al., 2014). Due to our study purpose, we needed to estimate health care and LTC services in 2007, the current study included only those who were alive in 2007. To ensure the robustness of our results, respondents who lost to follow-up in all four surveys were excluded. A detailed sample selection process is shown in Fig. 1. Accordingly, we analyzed the TLSA survey responses of middle-old and older adults ages 50 years and older beginning in 1996 and we traced their functional changes until 2007 ($N$ = 3429).

Sociodemographic factors, including age, gender, and years of education at baseline (1996) were determined from the TLSA survey. To determine the disability trajectory, we analyzed TLSA survey responses regarding whether respondents had any difficulties in activities of daily living (ADLs) and instrumental activities of daily living (IADLs). A total of 12 tasks, 6 ADLs and 6 IADLs, were employed consistently in each survey. The tasks were bathing, eating, dressing, standing up from a chair and bed, indoor walking, toileting, managing money, shopping, taking public transportation, doing light housework, doing heavy housework, and telephoning. Each was dichotomized into no difficulty (0) and having any difficulty (1) in performing the tasks. A sum score, including ADL and IADL disabilities ranging from 0 to 12, was calculated for each of the four surveys.

Each outcome variable, health care and LTC services at the end of the study period (2007), was dichotomized into no use (0) and use (1) of given service. The use of health care service was assessed by asking respondents whether they used emergency service, inpatient service, and outpatient service in the past year. LTC service was assessed by measuring respondents used any of one services, including institutional care (either nursing home, assisted living facility, veterans' retirement home, or retirement home), community care (day care center), personal home care services, skilled nursing home care services, respite care, native formal caregiver, and foreigner formal caregiver. The missing rate was 8.66% for the use of inpatient and emergency services and 8.69% for the use of outpatient services. The randomness of the missing values could plausibly reflect responses missing at random (MAR) due to the systematic relationship between response and non-response values found in our data. Multiple imputations were applied for missing data, as recommended to address missing survey data (Kmetic, Joseph, Berger, & Tenenhouse, 2002). We conducted multiple imputation analyses using the MCMC algorism with 10 imputed datasets generated by SAS software, Version 9.2 of the SAS System for PROC MI (SAS Institute Inc., Cary, NC, USA). The imputed datasets were generated by predictive distribution based on observed values for ADLs, IADLs, healthcare, and LTC service use, and basic demographics in the study.

### 2.2. Analytical steps in the study

Structural equation modeling (SEM) was used to test the mediating effect of disability trajectories on sociodemographic factors and the later use of health care and LTC services. We employed two steps of analyses in this study. First, growth mixture modeling (GMM) was used to identify different disability trajectories for older adults who followed similar progressions of ADL and IADL disabilities from 1996 to 2007. GMM is an extension of SEM that captures given variable changes over time, said, trajectory, and specifying the underlying trajectory subgroups in the model simultaneously. In this study, we tested both a linear GMM model and curvilinear GMM model with three sociodemographic factors included (age, gender, and years of education) to estimate four waves of disability changes over time (1996, 1999, 2003, and 2007). We compared the goodness-of-fit indices of the linear and curvilinear GMM model. The results showed that the three-trajectory linear model was better than curvilinear estimation in our study. For example, the BIC values were 47,921.096 and 49,167.295 in the linear and curvilinear model, respectively. Thus, we chose a three-trajectory linear GMM in the present study. Several goodness-of-fit indices have been suggested to test the optimal number of trajectories in a model, such as the Bayesian information criterion (BIC), Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR-LRT), and Lo-Mendell-Rubin adjusted likelihood ratio test (LMR-adj-LRT) (Nylund, Asparouhov, & Muthén, 2007). The optimal number of subgroups of disability trajectories we considered was three, due to the following reasons: the BIC value had a relative decline with three trajectories, and the values became diminished afterward. The $p$ values of VLMR-LRT and LMR-adj-LRT were significant in three trajectories. Fig. 2 shows the membership probabilities and the patterns of disability trajectories in GMM. Table 1 shows the participants' levels of disabilities among three disability trajectories during the study period. The disability trajectories included three distinct subtypes: maintained disability, progressive disability, and functional independence, with 66 (1.92%), 362 (10.56%), and 3001 (87.52%) adults in each subgroup, respectively.

Second, we tested the mediating effect of disability trajectories on sociodemographic factors and on the later use of services by applying SEM. In order to understand the mediating effect of the pattern of the

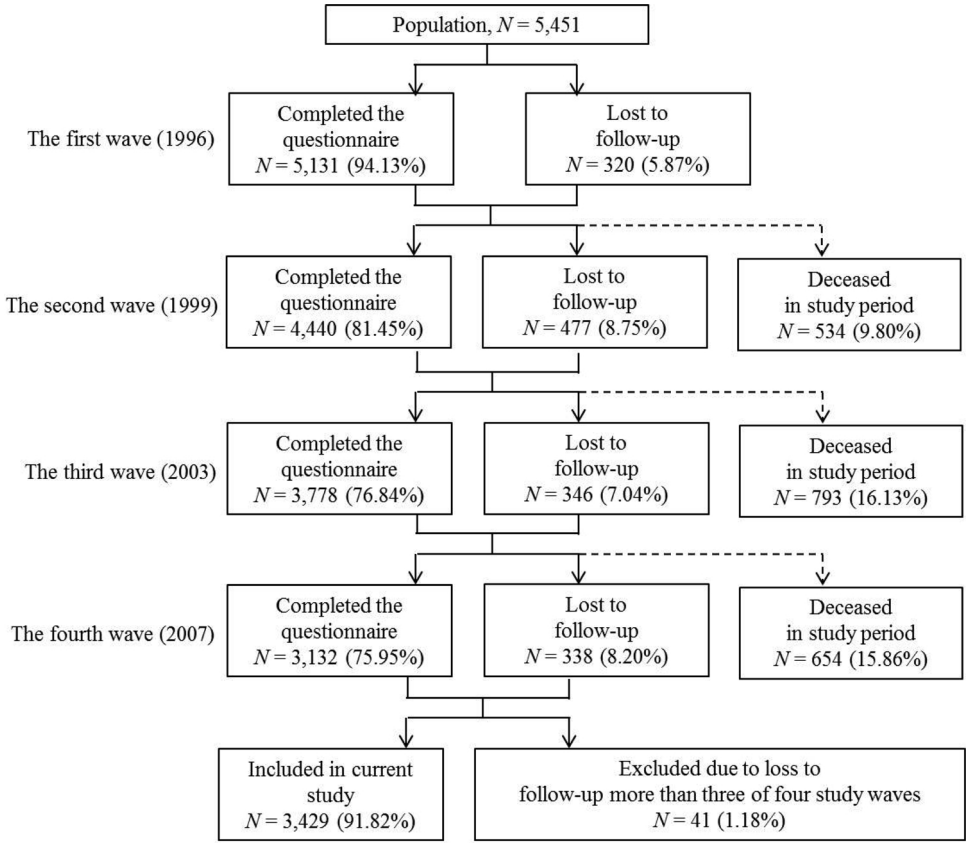


**Fig. 1.** Flow diagram of sample collection in current study.

disability changes in the model, we set trajectories of maintained disability and functional independence as one group, which represented those older adults who had steady functions throughout the study period. Model fits for SEM, such as a lower $\lambda^2$, comparative fit index (CFI) $\geq$ 0.90, root mean square error of approximation (RMSEA) $\leq$ 0.05, represent a better model fit (McDonald & Ho, 2002). The software package used for GMM and SEM analyses was Mplus version 7 (Muthén & Muthén, 1998-2012Muthén & Muthén, 1998-2012).

## 3. Results

We used the trajectories of maintained disability and functional independence as the reference and analyzed the mediating effects of the progressive disability trajectory on sociodemographic characteristics and on later use of health care and LTC services (Table 2). The model fits of SEM were $\lambda^2$ [3, n = 3429] = 8.177, $p < 0.001$; CFI = 0.998; RMSEA = 0.022.

The progressive disability trajectory had directly positive effects on LTC ($\beta = 0.795$, standardized $\beta = 0.022$, $p < 0.001$), outpatient ($\beta = 0.499$, standardized $\beta = 0.032$, $p < 0.001$), and emergency services ($\beta = 0.382$, standardized $\beta = 0.035$, $p < 0.001$). With the progressive disability trajectory in the model, the progressive disability trajectory partially and fully mediated the effects of age on later use of health care and LTC services. Compared to participants of the same age who had steady functions throughout the study period, those who developed a progressive disability trajectory had greater use of the later LTC ($\beta$ =

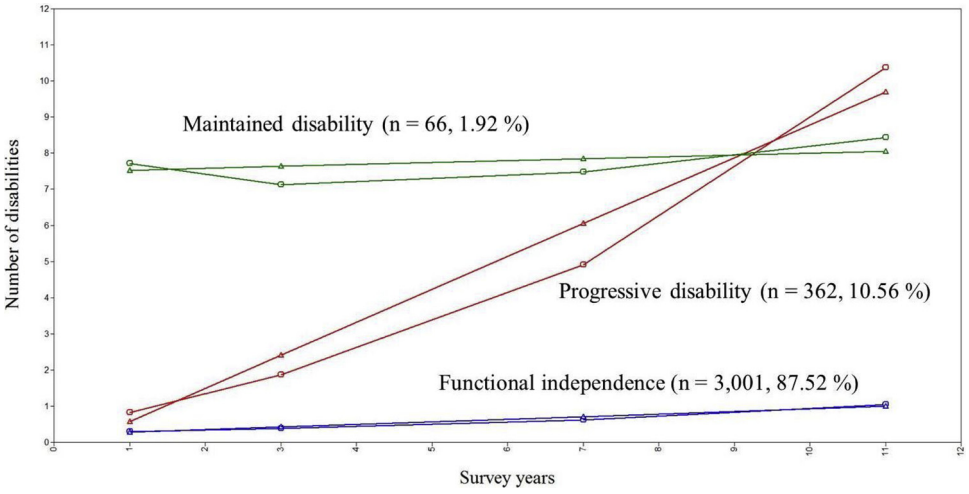


**Fig. 2.** Three disability trajectories in a sample of middle-old and older Taiwanese adults (N = 3429), 1996–2007.

**Table 1**
Sample characteristics in three disability trajectories (N = 3429), 1996–2007.

| Number of disabilities (0 ~ 12) | Disability trajectories | | |
|---|---|---|---|
| | Functional independence (n = 3001) | Progressive disability (n = 362) | Maintained disability (n = 66) |
| Disability in 1996 | 0.30 (0.74) | 0.81 (1.12) | 7.73 (2.67) |
| Disability in 1999 | 0.38 (0.94) | 1.87 (2.45) | 7.21 (3.76) |
| Disability in 2003 | 0.62 (1.21) | 4.95 (3.92) | 7.52 (3.53) |
| Disability in 2007 | 1.06 (1.62) | 10.46 (1.88) | 8.53 (3.48) |

Statistics are shown as means (standard deviations) for continuous variables.

**Table 2**
Direct and indirect effects of the progressive disability trajectory on sociodemographic characteristics and on the later use of health care and long-term care services in middle-old and older Taiwanese adults (N = 3,429).

| Characteristics | Healthcare and long-term care utilization | | | |
|---|---|---|---|---|
| | Long-term care | Inpatient services | Emergency services | Outpatient services |
| Disability trajectory | | | | |
| Direct effect | **0.795 (0.022) 0.808***** | **0.499 (0.032) 0.552***** | **0.382 (0.035) 0.431***** | −0.048 (0.040) -0.054 |
| Age | | | | |
| Direct effect | **0.012 (0.004) 0.089**** | −0.006 (0.004) -0.046 | **−0.009 (0.004) -0.073*** | **0.014 (0.004) 0.114***** |
| Indirect effect | **0.047 (0.003) 0.346***** | **0.029 (0.003) 0.237***** | **0.023 (0.003) 0.185***** | −0.003 (0.002) -0.023 |
| Female | | | | |
| Direct effect | 0.094 (0.066) 0.042 | **−0.150 (0.056) -0.073**** | −0.050 (0.056) -0.025 | 0.083 (0.049) 0.041 |
| Indirect effect | 0.107 (0.055) 0.048 | 0.067 (0.035) 0.033 | 0.051 (0.027) 0.026 | −0.006 (0.006) -0.003 |
| Educational years | | | | |
| Direct effect | **0.020 (0.007) 0.083**** | −0.008 (0.006) -0.038 | 0.003 (0.006) 0.013 | −0.001 (0.006) -0.003 |
| Indirect effect | **−0.025 (0.006) -0.105***** | **−0.016 (0.004) -0.072***** | **−0.012 (0.003) -0.056***** | 0.002 (0.001) 0.007 |
| **R - square** | **0.706** | **0.289** | **0.159** | **0.012** |
| **Model fit** | **$\lambda^2$ [3, $n$ = 3429] = 8.177, $p$ < 0.001; CFI = 0.998 ; RMSEA = 0.022** | | | |

Statistics are shown as estimates (standard error) standardized estimates. * $p$ < 0.05; ** $p$ < 0.01; *** $p$ < 0.001. Trajectory of functional independence was as reference group. PGS DIS TRAJ: progressive disability trajectory; MTD DIS TRAJ: maintained disability trajectory; CFI: comparative fit index; RMSEA: root mean square error of approximation.

0.047, standardized β = 0.346, $p$ < 0.001), inpatient (β = 0.029, standardized β = 0.237, $p$ < 0.001), and emergency services (β = 0.023, standardized β = 0.185, $p$ < 0.001). Age had positive direct effects on the later use of LTC (β = 0.012, standardized β = 0.089, $p$ = 0.003) and outpatient services (β = 0.014, standardized β = 0.114, $p$ < 0.001), but had a negative direct effect on emergency service (β = -0.009, standardized β = -0.073, $p$ = 0.016). The results showed no mediating effect of the progressive disability trajectory on gender and the later services use. It was only found that women were less likely to use inpatient service via direct effect (β = -0.015, standardized β = -0.073, $p$ = 0.008). The total effect of the model in testing both direct and indirect effects of the progressive disability trajectory on education and LTC service was insignificant (data not shown), but if the effects were tested separately, the direct effect of education on higher use of LTC services (β = 0.020, standardized β = 0.083, $p$ = 0.020) and the mediating effect of the progressive disability trajectory on education and on lower use of LTC service (β = -0.025, standardized β = -0.105, $p$ < 0.001) both were significant. With the progressive disability trajectory in the model, education had fully mediating effects on both the later use of inpatient (β = -0.016, standardized β = -0.072, p < 0.001) and emergency services (β = -0.012, standardized β = -0.056, p < 0.001). See a detailed effect diagram in Fig. 3.

## 4. Discussion

The major contribution of this study is to address the importance of the mediating effects of disability trajectories on sociodemographic characteristics and on the later use of health care and LTC services in a sample of middle-old and older Taiwanese adults. We found that with the progressive disability trajectory taken into consideration, older adults with rapid growth of disability changes had greater use of health care and LTC services. The level of education was found to have opposite effects on use of health care and LTC services, both directly and indirectly through the progressive disability trajectory. Adults with higher education were more likely to use LTC services, but the protective effect of education on less likely to develop a progressive disability trajectory led to a decrease in use of LTC services by the end of the study period.

Andersen's Behavioral Model of Health Services Use provides an operational framework of causal relations among population characteristics, perceived needs for care, and use of health-related services (Andersen, 1968, 1995). Similar to previous studies that addressed the importance of perceived needs for disability care on predicting the use of health care services (Al Snih et al., 2006; Calsyn & Winter, 2001; Evashwick et al., 1984; Kempen & Suurmeijer, 1991), we further integrated the current knowledge—disability trajectory—to test the causal relation in a sample of middle-old and older Taiwanese adults. We noted that disability trajectories played a central role in mediating sociodemographic characteristics on use of health care and LTC services, especially the progressive disability trajectory. The previous study showed that both socioeconomic factors and claim behaviors for disability care affected the receipt of disability benefits in the UK (Hancock et al., 2018). This could be partially explained by the findings in our SEM model testing. The receipt of LTC benefits might be due to not only the direct impact of socioeconomic status (education) but also the indirect mediating effect of perceived health status (disability trajectory) from socioeconomic status toward service use. Public health policy makers should strengthen their efforts to prevent adults from developing rapid growth of disability changes in order to decrease the burden of health costs in Taiwan.

The findings related to age and associated higher use of LTC service, regardless of whether the effect was direct or indirect, were consistent

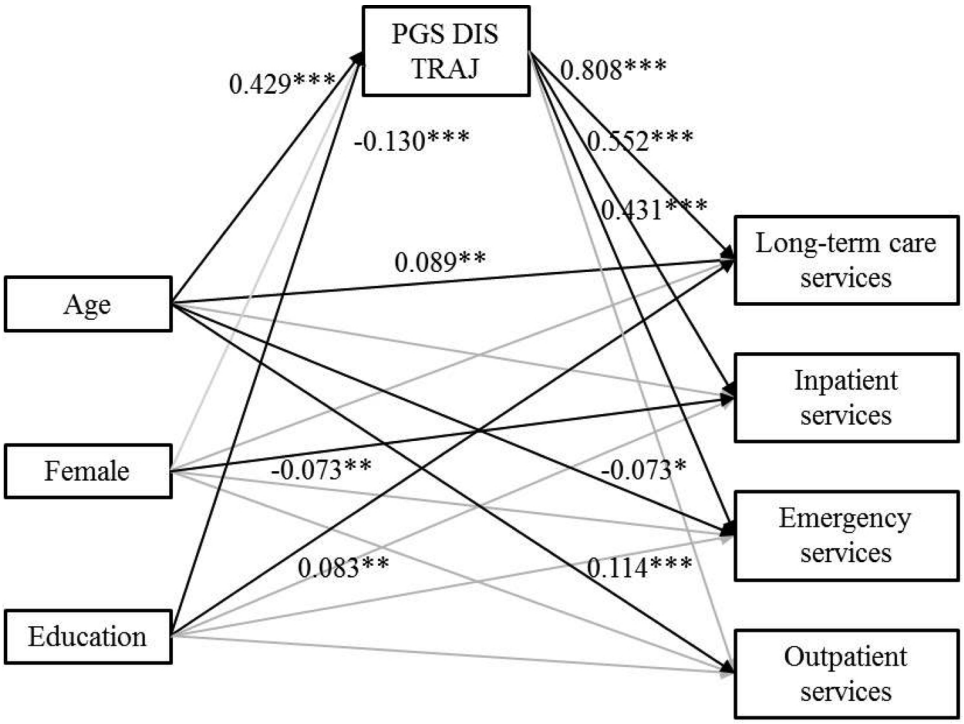


**Fig. 3.** Structural equation modeling for the mediating effect of the progressive disability trajectory on sociodemographic factors and on use of health care and long-term care services among older Taiwanese adults (N = 3429). Statistics are shown as standardized estimates. Only significant paths are reported with black lines. * $p$ < 0.05; ** $p$ < 0.01; *** $p$ < 0.001. CFI: comparative fit index; RMSEA: root mean square error of approximation.

with previous knowledge (Hsu, 2015; Luppa et al., 2010). Once adults had developed a disability, particularly in the progressive disability trajectory, the magnitude of impact on later use of LTC service was larger than the direct impact of age on use of LTC service. We noted that age might not be an inevitable predictor of higher use of health care services but only when they developed fast growth of disabilities. As the population is fast aging, preventing older adults from developing a fast-growing disability trajectory may prevent the use of health care services and reduce related costs. As previous study mentioned (Wingard, 1984), males tended to have higher vulnerability to fatal diseases because males have more risky behaviors than females, might explain why males were more likely to use inpatient service in this study.

Education was considered a protective factor on physical health and lower health expenditures in older adults in previous studies (Harris, Kovar, Suzman, Kleinman, & Feldman, 1989; Ross & Wu, 1996). An interesting finding was the inconsistency between the direct and indirect effect of education on use of LTC service through the developing a progressive disability trajectory. Although the statistical sum of total effects of both direct and indirect effects in the model was insignificant, the finding implied that adults with higher education levels might not only have the benefit of maintenance of their healthy function but also have the ability to seek more LTC services. This could be because most of the participants who reported using LTC services hired a foreigner caregiver or used relatively higher-cost LTC services such as institutional care, which required greater financial resources. Further analysis showed that participants with higher financial status in later life tended to have higher levels of education. The accumulative advantage of education, such as better income in middle life and access to resources, would lead to a better socioeconomic status in late life (Ross & Wu, 1996), which might make these older participants able to afford foreign caregivers or use institutional care for LTC services. Furthermore, the current study took place from 1996 to 2007, before the introduction of Taiwan's National 10-Year LTC Plan in 2008 (Ministry of Health & Welfare in Taiwan, 2007). Most LTC services were paid out of pocket. We noted that almost half of the participants who reported using LTC services chose a foreign caregiver (47.49%), followed by institutional care (42.14%), and other kinds of formal care (10.37%). Therefore, at least in the time before the introduction of Taiwan's National 10-Year Long-term Care Plan in 2008, education had a major impact on the use of LTC services in a sample of middle-aged and older Taiwanese adults.

Socioeconomic status has been operationalized in a variety of ways, such as education, financial status, and occupation. Researchers suggested that, although each of the socioeconomic indicators had a clear independent correlation with health, the effects of income and occupational class on health were largely explained by education, especially in the middle-aged (Lahelma, Martikainen, Laaksonen, & Aittomäki, 2004). In line with the previous study (Lahelma et al., 2004), our study participants' financial status in later life was significantly associated with their level of education. However, while the occupations of the middle-aged versus elderly were taken into account, careful discussion is needed. In our study, less than 10% of participants aged 65 and above had jobs (either full-time or part-time), and their job status had no effect on their later use of services. In contrast, more than half of the middle-aged participants held jobs at the beginning of observation (54.87%). In addition, middle-aged participants who had jobs were less likely to use healthcare and LTC services at the end of the 11-year follow up, even with gender and educational attainment taken into consideration. This might be due to the healthy worker effect (McMichael, 1976) in which having a job in middle age might decrease the need for services in later life. Further study considering middle-aged and older persons separately is needed to more precisely understand the effect of jobs on health. In addition, promoting job participation for as long as possible in older adults could be an effective way to improve health and decrease the later use of healthcare and LTC services.

Several limitations of this study should be noted. First, the sample included only those participants who were non-institutionalized and survived through 2007 and completed at least three of the four surveys (1996, 1999, 2003, and 2007). It is likely that the participants in our study tended to be healthier than those who were lost to follow-up due to death or major disability or were institutionalized. Second, in

accordance with Andersen's Behavioral Model of Health Services Use, other potentially enabling factors that might affect use of health care and LTC services were not included due to the limitations of secondary data analysis. Further research should address the contributions of these factors in studying of use of health-related services. Third, the Taiwan government LTC program was introduced in 2007 (Ministry of Health & Welfare in Taiwan, 2007); our analysis assessed the use of LTC services up to 2007, which was the last year of TLSA data we had. We strongly recommend further evaluation of service use, preferences, and accessibility of the various types of LTC services in Taiwan. Fourth, we employed two-step analytical methods (GMM and SEM) to link the sociodemographic characteristics, disability trajectories, and later use of services, due to the limitation of model burden. Further studies should test the relationships of these factors in the same model simultaneously or require adjustment for standard errors (e.g., bootstrapping) to prevent potential methodological bias. Finally, we carefully examined the pattern of missing values in the data. We found that participants with non-response values for using services tended to be healthier and with fewer disabilities in ADLs and IADLs, than participants with response values. This indicated that non-response values were not due to inferior health status (more serious disabilities) leading to more use of services. The outcome variables might not affect participants regardless of response values. Further studies are recommended to investigate the possible reasons participants fail to follow up in such longitudinal aging studies and address the potential bias in the current study.

## 5. Conclusion

The study employed Andersen's Behavioral Model of Health Services Use and integrated the current knowledge about disability trajectory measurement in a sample of middle-old and older Taiwanese adults. The results explicated that the speed of change in disability over time might had mediating effects on the association between sociodemographic characteristics and later use of health care and LTC services. Preventing adults from developing a fast-growing disability trajectory could be an effective way to decrease use of health care and LTC services and related expenditures in late life, especially important in a fast-aging society.

## Conflict of interest statement

The authors declared no conflicts of interest.

## Acknowledgments

The authors wish to express their gratitude to the Ministry of Science and Technology in Taiwan (MOST101-2410-H-002-212-MY2, MOST105-2410-H-002-214-MY3) and the Health and Welfare Data Science Center for its gracious help with data access (H102054). We also thank the Healthy Aging Research Center, Chang Gung University from the Featured Areas Research Center Program within the Framework of the Higher Education Sprout Project by the Ministry of Education (MOE) in Taiwan (EMRPD1H0421, EMRPD1H0551) for funding support. The current study has been approved by the Research Ethics Committee of National Taiwan University (201503016W).

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