International Journal of Gerontology 13 (2019) 207–211
https://doi.org/10.6890/IJGE.201909_13(3).0005

International Journal of Gerontology

journal homepage: http://www.sgecm.org.tw/ijge/

Original Article

Influence of Gender Disparity in Predicting Occurrence of Successful Aging, Usual Aging and Mild Cognitive Impairment

Divya Vanoh [a], Suzana Shahar [b *], Rosdinom Razali [c], Zahara Abdul Manaf [b], Tengku Aizan Hamid [d]

[a] *Programme of Nutrition and Dietetics, School of Health Sciences, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan,* [b] *Centre of Healthy Aging and Wellness, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur,* [c] *Department of Psychiatry, Hospital Canselor Tuanku Muhriz, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Batu 9 Cheras,Wilayah Persekutuan Kuala Lumpur, Malaysia,* [d] *Malaysian Research Institute on Ageing, Universiti Putra Malaysia, 43400, Serdang, Selangor*

ARTICLE INFO

Accepted 25 December 2018

Keywords:
gender,
successful aging,
usual aging,
mild cognitive impairment

SUMMARY

Background: The aim of this study was to investigate the prevalence of successful aging, usual aging and mild cognitive impairment among older men and women, and further determine the influence of gender in predicting cognitive decline.
Method: A total of 1,993 respondents aged 60 years old and above were selected through a multi-stage random sampling method from Johor, Kelantan, Selangor and Perak. The respondents were interviewed to obtain information on socio-demography, diet, cognitive functions, psychosocial conditions and lifestyle. Subjects were classified in either the category of successful aging, usual aging and mild cognitive impairment.
Results: The predictors of cognitive decline among men were poor upper body flexibility and lower body strength, higher fasting blood sugar, hyperlipidaemia, lower education level, and poor participation in mechanical repairing activities. Meanwhile, hyperlipidaemia, not adhering to calorie restrictions, poor lower body flexibility, disabilities and lower education status were the risk factors for memory impairment among women.
Conclusion: Specific gender-tailored interventions are essential for preventing or managing cognitive decline among older adults and preserving mental health.

1. Introduction

Drastic population and social changes have led to the emergence of a new concept known as successful aging (SA), which upholds a positive vision of aging.[1] Rowe and Khan established a SA framework, which comprised of higher cognitive functioning, no physical disabilities, lower likelihood of diseases, and a positive commitment to life, especially having excellent social interactions.[2] Gender disparities in SA have been investigated in previous studies, which showed a higher prevalence of successful aging among men.[3,4]

Unlike successful aging and mild cognitive impairment, usual aging (UA) has no 'gold standard' definition and has not been as extensively studied. Vanoh et al. (2016) stated that usual agers are at higher risk of being diagnosed with chronic diseases, having minimal functional limitations, slight memory impairment and no dementia.[5]

In addition, mild cognitive impairment (MCI) is an intermediate stage between normal aging and dementia, and individuals with MCI have a higher likelihood of succumbing to dementia.[6] Gender specific risk factors for MCI were investigated in a small-scale local study and it was found that MCI was highly prevalent among women. Risk factors for MCI among women were being married, not exercising, and being either overweight or obese.[7] However, large scale studies in Malaysia are scarce to investigate the gender disparity in cognitive decline.

Thus, this current study filled the gap in the previous literature by determining the impact of gender on the occurrence of MCI as compared to SA and UA. This study was part of a large scale study, the details of which were published earlier.[8]

2. Methodology

2.1. Study design and participants

This study, which was approved by the Research Ethical Committee of Universiti Kebangsaan Malaysia (UKM), was conducted via a multi-stage random sampling procedure in four states in Malaysia based on the highest prevalence of geriatric populations, namely in Perak, Johor, Selangor and Kelantan. This study was conducted for nine months from May 2012 till February 2013. The location maps, addresses, and names of the participants were provided by the Department of Statistics, Malaysia. The selection of participants was carried out in three stages, namely primary sampling unit (PSU) which involved selection of states within each region, secondary sampling unit (SSU) included choosing census circle and tertiary sampling unit (TSU) was the random selection of living quarters.

A total of 1,993 participants were selected to participate in this study. The participants were classified in one of the three groups,

* Corresponding author. Centre of Healthy Aging and Wellness, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur.
E-mail address: suzana.shahar@ukm.edu.my (Shahar, S.)

namely SA, UA and MCI. Participants who failed to meet criteria of these three groups were excluded. The MCI and SA were adapted based on the criteria suggested by Petersen et al. and Hamid et al., respectively with some modifications.[9,10] The criteria for MCI were; 1.) self-reported memory complaints; 2.) no dementia; 3.) full score in Activities of Daily Living (ADL); Instrumental Activities of Daily Living (IADL) score was 1.5 SD above the population mean value); 4.) had objective cognitive impairment (at least 1.5 SD below the mean for either digit span or Rey Auditory Verbal Learning Test (RAVLT)) and normal global function Mini Mental State Examination (MMSE) score ≥ 19. MMSE score of ≥ 19 for MCI has been chosen because it had been used in an earlier local study by Shahar et al.[11] after controlling for age and education level.

Meanwhile, SA was defined as being free from hypertension, heart diseases, chronic lung diseases, cancer, stroke, and diabetes, normal global function (MMSE score ≥ 22), no depression (15 item-Geriatric Depression Scale (GDS) score ≤ 4), having full score for both ADL and IADL, good quality of life and excellent self-perceived health. Although SA and MCI shared similar criteria of having normal global function, the current study used different MMSE cut-off points owing to significant differences in levels of cognition and education as stated in Shahar et al. (2015).[8]

The participants were placed in the UA group if they had no dementia, very minimal functional limitations (IADL score was 1.5 SD above the mean), and had average performance in cognitive tests such as Digit Span and RAVLT (had mean score below SA but above MCI).[5]

2.2. Measures

A validated interview-based questionnaire was used to obtain information of the socio-demography, co-morbidities and history of falls of the respondents. A total of 5 ml of blood was taken by a trained phlebotomist to measure the level of fasting blood glucose.

The dietary intake was obtained by means of a Diet History Questionnaire (DHQ),[12] and was analysed using the Nutritionist Pro (AXXYA Systems, LLC) software. The data obtained were entered into the SPSS software for further analysis. Food albums and household measuring items were used to measure the precise quantity of food or beverages consumed.

The participants were asked if they had been practising any calorie restriction (CR) over the past month. The CR included 'Sunnah' fasting (fasting from dawn to dusk every Monday and Thursday by Muslims), omission of solid food but allowing only liquids, consuming only one meal a day or consuming a moderate vegetarian diet.

The cognitive tests that were administered included the Digit Span test for working memory,[13] the Rey Auditory Verbal Learning Test (RAVLT) for verbal memory,[14] and the Mini Mental State Examination (MMSE) for global functions.[15] The fitness level of the participants was measured using several fitness tests such as the hand grip, chair stand test, chair sit-and-reach test, time up-and-go test, two-minute step test, and back scratch test. The functional status was assessed using the Instrumental Activities of Daily Living (IADL)[16] and Activities of Daily Living (ADL).[17]

The WHODAS 2.0 questionnaire with a Cronbach's alpha of 0.98 was used to assess disabilities.[18] The WHODAS 2.0 had 19 items covering six domains, namely understanding and communicating, getting around, self-care, getting along with people, life activities, and participation in society. Depressive symptoms was measured using the 15-item Geriatric Depression Scale.[19]

The participation in physical, mental and social lifestyle activities was assessed using the adapted version of the Victoria Longitudinal Study-Activities Lifestyle Questionnaire (VLS-ALQ).[20]

2.3. Statistical analysis

The SPSS version 20.0 was used to analyse the data for each gender. Association between categorical variables were determined using cross tabulation. Normality testing was done using histogram. Parametric test such as One-Way Between Group ANOVA was employed in case of normal distribution or Kruskal-Wallis test for non-normal distribution, to determine the mean or median difference between the three groups (SA, UA and MCI) with continuous parameters. On the other hand, differences between gender had been analysed using Independent-t-test for normal distribution and Mann-Whitney test for non-normal distribution. For certain variables such as lifestyle activities, missing value was less than 1%, thus the values was imputed with the mean values. However, this imputation was not done for fasting blood sugar as this test was not conducted on all the subjects due to refusal or was not in fasting state. The variables associated with neurocognitive decline for each gender were investigated using ordinal logistic regression (OLR). The independent variables for the final OLR model were selected using a stepwise approach. Firstly, six different OLR models consisting of the socio-demographic, health status, psychosocial conditions, nutritional status and fitness, diet and lifestyle factors were created. The significant variables from each model were entered into the final OLR model. The significance level was set at $p < 0.05$.

3. Results

The men tended to have a higher percentage of SA (56%) compared to the women (44%). The MCI was also greater in men (56.5%) as compared to women (43.5%). A total of 51.9% of the women and 48.1% of men were in the usual aging category. As shown in Table 1,

Table 1
Sociodemographic, biochemical, cognitive function and fitness profile according to gender [presented as mean ± SD, median ± IQR or n (%)].

Parameters	Men (n = 1002)	Women (n = 991)	Total (n = 1993)
Age (years)	69.24 ± 6.00	67.76 ± 5.77	68.51 ± 5.93***
Education level (years)	6.40 ± 3.81	4.67 ± 3.89	5.54 ± 3.94***
Fasting blood sugar (n = 1609)			
High	384 (46.2)	323 (41.6)	707 (43.9)
Normal	448 (53.8)	454 (58.4)	902 (56.1)
Digit span	7.98 ± 2.39	7.48 ± 2.31	7.73 ± 2.37***
Total Score RAVLT	25.37 ± 11.04	28.00 ± 12.63	26.68 ± 11.93***
IADL	12.74 ± 2.01	12.42 ± 2.21	12.58 ± 2.12**
Hand grip, kg	28.46 ± 6.77	18.59 ± 4.97	23.53 ± 7.72***
Chair stand test, number	10.45 ± 3.10	9.75 ± 3.09	10.10 ± 3.11***
Chair sit and reach (median ± IQR), cm	-1.30 ± 14.00	-1.00 ± 9.70	-1.20 ± 11.40*
Time up and go test, seconds	10.36 ± 2.73	11.24 ± 3.41	10.80 ± 3.12***
Back scratch test (median ± IQR), cm	15.00 ± 18.40	11.50 ± 16.60	13.50 ± 18.00***

Significant at * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ using Independent-t-test or Chi-Square test.
RAVLT: rey auditory verbal learning test; IADL: instrumental activities of daily living; IQR: interquartile range.

the majority of the men participating in this study were older (69.24 ± 6.00) and had a higher education level (6.40 ± 3.81). The women tended to have a better verbal memory, as measured by means of the RAVLT. The men had an advanced level of fitness in almost all the fitness domains except for poor upper body flexibility, as indicated by the higher scores in the back-scratch test.

Both the men and women who were categorised as SA were younger, had a higher level of education, good social support, fewer disabilities and better fitness levels (Table 2).

With respect to participation in three major lifestyle domains,

Table 2
Factors associated with neurocognitive status in men (N = 1002) and women (N = 991) [presented as mean ± SD, median ± IQR or n (%)].

Factors	SA (n = 122)	UA (n = 702)	MCI (n = 178)
Men			
Prevalence (%)	56.0	48.1	56.5
Age (years)	67.76 ± 5.53	69.28 ± 5.99	70.10 ± 6.22**
Education level (years)	8.04 ± 4.03	6.32 ± 3.87	5.57 ± 2.99***
	Dietary		
Practice of Calorie Restriction			
Yes	52 (43.3)	311 (45.3)	67 (38.3)
No	70 (56.7)	391 (54.7)	111 (61.7)
Fibre (g/day)	4.10 ± 2.55	3.78 ± 2.36	3.78 ± 2.44
Energy (kcal/day)	1760.68 ± 488.73	1812.51 ± 489.16	1790.51 ± 468.55
Protein (g/day)	70.14 ± 21.89	75.53 ± 21.86	74.81 ± 20.26
Carbohydrate (g/day)	252.34 ± 81.26	252.09 ± 81.09	245.17 ± 77.78
Fat (g/day)	52.13 ± 18.68	55.38 ± 19.74	55.84 ± 19.45
	Fitness		
Hand grip, kg	30.72 ± 6.60	28.12 ± 6.56	28.22 ± 7.38***
Chair stand test, number	12.26 ± 2.95	10.26 ± 3.11	9.95 ± 2.72***
Chair sit and reach, cm (median ± IQR)	-1.14 ± 10.81	0.24 ± 12.24	3.06 ± 12.82**
Time up and go, seconds	9.09 ± 2.25	10.46 ± 2.78	10.86 ± 2.61***
Back scratch test (median ± IQR)	10.35 ± 19.38	15.00 ± 17.75	20.05 ± 18.30***
2-min step test, number	77.19 ± 25.31	66.53 ± 22.82	63.74 ± 24.01***
	Psychosocial		
Disability	4.97 ± 10.60	6.01 ± 8.70	7.65 ± 9.69*
	Health status		
Hyperlipidemia			
Yes	13 (10.7)	216 (30.8)	54 (30.3)***
No	109 (89.3)	486 (69.2)	124 (69.7)
Osteoarthritis			
Yes	17 (13.9)	163 (23.2)	37 (20.8)
No	105 (86.1)	539 (76.8)	141 (79.2)
Fasting blood sugar[a]			
Normal	81 (81.0)	286 (49.0)	81 (54.7)***
High	19 (19.0)	298 (51.0)	67 (45.3)
Women	SA (n = 96)	UA (n = 758)	MCI (n = 137)
Prevalence (%)	44.0	51.9	43.5
Age (years)	65.55 ± 5.24	67.89 ± 5.80	68.62 ± 5.57***
Education level (years)	7.48 ± 4.25	4.55 ± 3.82	3.38 ± 3.00***
	Dietary		
Practice of Calorie Restriction			
Yes	51 (53.7)	399 (53.6)	50 (36.5)**
No	45 (46.3)	359 (46.4)	87 (63.5)
Fibre (g/day)	4.67 ± 2.49	4.00 ± 2.52	3.67 ± 2.70*
Energy (kcal/day)	1610.61 ± 456.76	1513.97 ± 430.57	1512.07 ± 408.95
Protein (g/day)	66.82 ± 19.25	66.64 ± 22.14	65.74 ± 18.81
Carbohydrate (g/day)	215.07 ± 65.80	198.31 ± 63.56	198.46 ± 62.35
Fat (g/day)	53.78 ± 21.50	50.40 ± 19.83	50.54 ± 20.39
	Fitness		
Hand grip, kg	20.31 ± 4.94	18.47 ± 4.95	18.03 ± 4.88**
Chair stand test, number	10.71 ± 3.30	9.57 ± 3.06	10.01 ± 2.95**
Chair sit and reach, cm (median ± IQR)	-1.90 ± 8.25	1.10 ± 9.90	0.00 ± 12.70**
Time up and go, seconds	9.62 ± 2.62	11.44 ± 3.50	11.26 ± 3.09***
2-min step test, number	65.79 ± 25.27	55.11 ± 25.01	57.34 ± 28.23**
Back scratch test, cm (median ± IQR)	6.60 ± 16.83	12.00 ± 16.20	12.00 ± 14.00***
	Psychosocial		
Disability	4.03 ± 6.50	6.68 ± 8.78	8.81 ± 9.47***
	Health status		
Hyperlipidemia			
Yes	19 (19.8)	278 (36.7)	58 (42.3)**
No	77 (80.2)	480 (63.3)	79 (57.7)
Osteoarthritis			
Yes	18 (18.8)	202 (26.6)	41 (29.9)
No	78 (81.2)	556 (73.4)	96 (70.1)
Fasting blood sugar[a]			
Normal	52 (69.3)	346 (57.5)	56 (56.0)
High	23 (30.7)	256 (42.5)	44 (44.0)

*p <0.05; **p <0.01; ***p <0.001 significant using One way ANOVA or Chi-Square analysis. Abbreviation: IQR: Interquartile range. [a] Fasting blood sugar test was not done for all the subjects involved in this study.

namely the physical, mental and social domains, the men were frequent users of modern gadgets (SA: 16.4%, UA: 7.7%, MCI: 2.2%) as compared to the women (SA: 14.6%, UA: 5.0%, MCI: 2.2%) ($p < 0.001$). The SA men (14.8%) were also more likely to be involved in simple household-based repairing activities compared to the men with MCI (4.0%) ($p < 0.01$). Sewing and reading emerged as significant lifestyle-enhancing factors among the SA women (19.8%, 89.6%) ($p < 0.05$) compared to the women with MCI (8.0%, 65.0%%) ($p < 0.001$) (Table 3).

After adjusting for age, gender and ethnicity, the predictors of cognitive decline in men were poor upper body flexibility as indicated by the higher back scratch test score, limited lower body muscular strength, as shown by the lower chair stand test score, education level, higher fasting blood sugar, hyperlipidaemia and poor participation in mechanical-based activities. Meanwhile, among the older women, the risk factors for cognitive impairment were poorer lower body flexibility, as indicated by the higher scores for the chair-sit-and-reach test, disabilities, low fibre intake, lower education level, hyperlipidaemia and not frequently practising calorie restriction (Table 4).

4. Discussion

This cross-sectional study examined the influence of gender disparity on the prediction of SA, UA and MCI within a single study. The men in this study were more likely to age successfully and had a higher occurrence of MCI compared to the women. The brain reserve hypothesis proposed that men have better resilience towards aging in view of the pathological changes in the brain.[21] This is closely associated with a higher education level and greater participation in mentally-related tasks during midlife.[22] Although men have better cognitive reserves, the presence of other confounding factors, such as smoking and chronic diseases might explain a higher risk of MCI among the men in the present study.

Results of current study has revealed that poor fitness levels, especially upper body flexibility and lower body muscular strength, increase the risk of cognitive decline in both older men and women. Meta-analysis has shown that contribution of strength and flexibility training together with aerobic exercise may improve cognition as compared to aerobic exercise per se.[23]

Interestingly, the current study had showed that calorie restrictions is associated with cognitive decline, especially among older women. Teng et al. (2011) showed that 'Sunnah' fasting, which is a type of calorie restriction, provides health benefits, especially a reduction in body weight, body mass index, and body composition.[24] However, their study was only carried out among older men and did not investigate the effect of 'Sunnah' fasting on the cognitive func-

Table 4
Predictors of cognitive decline

Parameters	Estimate	SE	OR (95% CI)
Predictors in men			
Back scratch test score	0.018	0.006	1.02 (1.00-1.03)**
Chair stand test score	-0.092	0.027	0.91 (0.87-0.96)**
Education years	-0.060	0.026	0.94 (0.90-0.99)*
Fasting blood sugar			
High	0.518	0.161	1.68 (1.22-2.30)**
Normal (ref)			
Hyperlipidemia (HPL)			
With HPL	0.594	0.176	1.81 (1.28-2.55)**
Without HPL (ref)			
Repairing activities			
Not regular	0.854	0.286	2.35 (1.34-4.11)**
Regular (ref)			
Predictors in Women			
Chair sit reach test score	0.017	0.008	1.02 (1.00-1.03)*
Disability	0.026	0.009	1.03 (1.01-1.04)**
Education level (years)	-0.125	0.026	0.88 (0.84-0.93)***
Hyperlipidemia			
Yes	0.523	0.173	1.69 (1.20-2.37)**
No (ref)			
Fiber intake	-0.068	0.034	0.93 (0.87-1.00)*
Practice of calorie restriction			
No	0.365	0.174	1.44 (1.02-2.03)*
Yes (ref)			

† Ordinal logistic regression with successful aging as the reference group; ref: reference group; Significant at * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.
SE: standard error; OR: odds ratio; CI: confidence interval.

Table 3
Participation in lifestyle activities between men and women [presented as n(%)].

Domains	Men (N = 1002)			Women (N = 991)		
	SA (n = 122)	UA (n = 702)	MCI (n = 178)	SA (n = 96)	UA (n = 758)	MCI (n = 137)
Housework						
Not regular	28 (23.0)	274 (39.0)	64 (36.0)**	3 (3.1)	59 (7.8)	9 (6.6)
Regular	94 (77.0)	428 (61.0)	114 (64.0)	93 (96.9)	699 (92.2)	128 (93.4)
Exercise						
Not regular	63 (52.1)	405 (58.1)	103 (58.2)	54 (56.2)	473 (62.4)	78 (56.9)
Regular	59 (47.9)	297 (41.9)	75 (41.8)	42 (43.8)	285 (37.6)	59 (43.1)
Repair						
Not regular	104 (85.2)	647 (92.2)	171 (96.0)**	94 (97.9)	744 (98.2)	136 (99.3)
Regular	18 (14.8)	55 (7.8)	7 (4.0)	2 (2.1)	14 (1.8)	1 (0.7)
Reading						
Not regular	11 (9.0)	90 (12.8)	35 (19.7)*	10 (10.4)	179 (23.6)	48 (35.0)***
Regular	111 (91.0)	612 (87.2)	143 (80.3)	86 (89.6)	579 (76.4)	89 (65.0)
Sewing						
Not regular	120 (98.4)	693 (98.7)	175 (98.3)	77 (80.2)	679 (89.6)	126 (92.0)*
Regular	2 (1.6)	9 (1.3)	3 (1.7)	19 (19.8)	79 (10.4)	11 (8.0)
Calculation activities						
Not regular	66 (54.1)	446 (63.5)	96 (53.9)*	50 (52.1)	493 (65.0)	92 (67.2)*
Regular	56 (45.9)	256 (36.7)	82 (46.1)	46 (47.9)	265 (35.0)	45 (32.8)
Use of modern gadgets						
Not Regular	102 (83.6)	648 (92.3)	174 (97.8)***	82 (85.4)	720 (95.0)	134 (97.8)***
Regular	20 (16.4)	54 (7.7)	4 (2.2)	14 (14.6)	38 (5.0)	3 (2.2)

Significant at * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ using Chi-Square analysis.

tion. Calorie restrictions slow down brain damage by inhibiting oxidative stress via a reduction in the production of free radicals.[25]

High blood glucose emerged as one of the significant risk factors of cognitive decline among the older men. Persistent high blood glucose has been closely associated with increased production of advanced glycation end product (AGE), which accelerates the accumulation of beta-amyloid, thereby enhanced oxidative stress.[26] In addition, hyperlipidaemia (HPL) has been proven to be a significant risk factor in cognitive decline in both the older men and women. The pathogenesis of cognitive decline associated with HPL is more likely to be related to a higher risk of vascular factors such as carotid atherosclerosis, atrial fibrillation and an increase in the coagulation factor I.[27]

Lower fibre intake was linked to cognitive decline among the older women who participated in the current study. The Nurses' Health Study found that total vegetable intake was associated with lower cognitive decline among 13,388 older women.[28]

The strength of this study lies in the fact that, it is the first large-scale multi-ethnic population-based study to be conducted in Malaysia to investigate gender disparities in the prevalence and predictors of cognitive decline among older adults with SA, UA, and MCI. However, the limitation of this study is that it reported the results of a cross-sectional study within a large cohort study and therefore, the factors that had been identified cannot be viewed as precise predictors.

5. Conclusion

The findings of this study indicate that there are marked gender differences in the prevalence of SA and MCI, with the men reporting a higher percentage of SA and MCI compared to the women. In this cross sectional study, poor cognitive functioning in men is associated with poor physical fitness, elevated fasting blood glucose level, a lower education level, hyperlipidaemia, and poor involvement in mentally-demanding tasks such as mechanical repairing and using modern gadgets. Meanwhile, successful aging in women is related to a good fitness level, adequate fibre intake, optimal control of blood cholesterol levels, no disabilities and frequent practice of calorie restriction. These findings are beneficial to support future gender specific longitudinal researches focusing on preventative strategies for poor cognition and healthy longevity.

Conflict of interest

No potential conflict of interest was disclosed.

Compliance to ethical standard

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration. Informed consent was obtained from all participants in the study.

Acknowledgements

We express our gratitude to Ministry of Education for funding our study under the Longterm Research Grant Scheme LRGS/BU/2012/UKM-UKM/K/01, the co-researchers, fieldworkers, and subjects for their effort in making this project a success.

References

1. Cheng ST, Fung HH, Li LW et al. *Successful Aging: Asian Perspectives*. Netherlands: Springer; 2015.
2. Rowe JW, Kahn RL. Successful aging. *The Gerontologist*. 1997;37(4):433.
3. Hsu HC. Gender disparity of successful aging in Taiwan. *Women & Health.* 2005;42(1):1–21.
4. Feng Q, Son J, Zeng Y. Prevalence and correlates of successful aging: A comparatie study between China and South Korea. *Eur J Aging*. 2015; 12:83–94.
5. Vanoh D, Shahar S, Din NC, et al. Predictors of poor cognitive status among older Malaysian adults: Baseline findings from the LRGS TUA cohort study. *Aging Clin Exp Res*. 2017;29:173–182.
6. Gao S, Unverzagt FW, Hall KS, et al. Mild cognitive impairment, incidence, progression and reversion: Findings from a community-based cohort of elderly Africans Americans. *Am J Geriatr Psychiatry.* 2014;22(7):670–681.
7. Lee LK, Shahar S, Chin AV, et al. Prevalence of gender disparities and predictors affecting the occurrence of mild cognitive impairment (MCI). *Arch Gerontol Geriatr.* 2012;54(1):185–191.
8. Shahar S, Omar A, Vanoh D, et al. Approaches in methodology for population-based longitudinal study on neuroprotective model for healthy longevity (TUA) among Malaysian older adults. *Aging Clin Exp Res*. 2016; 28(6):1089–1104.
9. Petersen RC, Caracciolo B, Brayne C, et al. Mild cognitive impairment: A concept in evolution. *J Intern Med.* 2014;275(3):214–228.
10. Hamid TA, Momtaz YA, Ibrahim R. Predictors and prevalence of successful aging among older Malaysians. *Gerontology.* 2012;58(4):366–370.
11. Shahar S, Lee LK, Rajab N, et al. Association between vitamin A, vitamin E, and apolipoprotein E status with mild cognitive impairment among elderly people in low cost residential areas. *Nutr Neurosci*. 2013; 16(1):6–12.
12. Shahar S, Earland J, Rahman SA. Food intakes and habits of rural elderly Malays. *Asia Pac J Clin Nutr.* 2000;9(2):122–129.
13. Wechsler D. *Wechsler Adult Intelligence Scale*. 3rd edition. San Antonio: Harcourt Assessment; 1997.
14. Fichman, Helenice Charchat, et al. Normative data and construct validity of the Rey Auditory Verbal Learning Test in a Brazilian elderly population. *Psychol Neurosci.* 2010;3(1):79–84.
15. Folstein MF, Folstein SE, McHugh P. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12(3):189–198.
16. Graf C. The Lawton instrumental activities of daily living scale. *Am J Nurs.* 2008;108(4):52–62; quiz 62–63.
17. Katz S, Ford AB, Moskowitz RW, et al. Studies of illness in the aged. The Index of ADL: A standardized measure of biological and psychosocial function. *JAMA*. 1963;185(12):914–919.
18. Üstün TB. *Measuring health and disability: Manual for WHO disability assessment schedule WHODAS 2.0*. 2010;90.
19. Sheikh JI, Yesavage JA. Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. *Clin Gerontol*. 1986;5(1–2): 165–173.
20. Hultsch DF, Hertzog C, Small BJ, et al. Use it or lose it: Engaged lifestyle as a buffer of cognitive decline in aging? *Psychol Aging*. 1999;14(2):245–263.
21. Stern Y. Cognitive reserve in aging and Alzheimer's disease. *Lancet Neurol*. 2012:1006–1012.
22. Carlson MC, Helms MJ, Steffens DC, et al. Midlife activity predicts risk of dementia in older male twin pairs. *Alzheimer's Dement.* 2008;4(5): 324–331.
23. Colcombe S, Kramer AF. Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychol Sci.* 2003;14:125–130.
24. Teng NIMF, Shahar S, Manaf ZA, et al. Efficacy of fasting calorie restriction on quality of life among aging men. *Physiol Behav.* 2011;104(5):1059–1064.
25. Heilbronn LK, Ravussin E. Calorie restriction and aging: Review of the literature and implications for studies in humans. *Am J Clin Nutr.* 2003;78(3):361–369.
26. Pasquier F, Boulogne A, Leys D, et al. Diabetes mellitus and dementia. *Diabetes Metab*. 2006;32:403–414.
27. Breteler MM. Vascular risk factors for Alzheimer's disease: An epidemiologic perspective. *Neurobiol Aging*. 2000;21(2):153–160.
28. Kang JH, Ascherio A, Grodstein F. Fruit and vegetable consumption and cognitive decline in aging women. *Ann Neurol.* 2005;57(5):713–720.