J Nutr Health Aging. 2020;24(5):525-533

PREVALENCE AND ITS ASSOCIATED FACTORS OF PHYSICAL FRAILTY AND COGNITIVE IMPAIRMENT: FINDINGS FROM THE WEST CHINA HEALTH AND AGING TREND STUDY (WCHAT)

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Abstract: *Objectives:* Previous literature has reported that physical frailty (PF) closely associated with cognitive impairment (CI). In this study, we aim to describe and evaluate the prevalence and associated factors with different patterns of PF and cognitive impairment. *Design:* A cross-sectional study. *Setting and participants:* Community-dwelling older adults aged ≥60 from the West China Health and Aging Trend (WCHAT) study were included in this study. *Measurements:* Participants were assessed the PF and cognitive impairment. PF was assessed using the physical phenotype as defined by Fried's criteria. Cognitive impairment was identified using the Short Portable Mental Status Questionnaire (SPMSQ). According different patterns of PF and cognitive impairment, participants were divided into 4 groups: not-PF and cognitive intact ("neither" group), not-PF and cognitive impairment ("CI only" group), PF and cognitive intact ("PF only" group), and PF and cognitive impairment ("both" group). Multinomial logistic regression was used to explore the association between medical conditions and different patterns of PF and cognitive impairment after adjusting the demographic characteristics. *Results:* Among 4,103 participants (age 67.8 ± 5.9 years, female 58.3%), 78.8%, 3.9%, 14.5% and 2.9% were "neither", "PF only", "CI only", and "both", respectively. The prevalence of "PF only", "CI only" and "both" were associated with age, lower education level and single status. In addition, there was substantial ethnicity heterogeneity in the prevalence of different patterns of PF and cognitive impairment. Comparing with "neither", PF and/or cognitive impairment had higher association with depression, ADLs impairment, and malnutrition. Of note, obesity was only significantly associated with "PF only", but not associated with "CI only" or "both". *Conclusions:* We found the substantial demographic and medical conditions disparities in different patterns of PF and cognitive impairment. Further research should focus on the efficient and practical screen to predict the risk of "PF only", "CI only" and "both".

Key words: Physical frailty (PF), cognitive impairment (CI), older adults, China.

Introduction

Frailty is an age-associated medical syndrome characterized by the diminished reserve and function across multiple physiologic systems, that increases an individual's vulnerability and correlates with a number of adverse health events such as disability, falls, hospitalization, and mortality (1-3). Frailty is prevalent among older adults, the overall prevalence of frailty was reported to be 7.0% in China, according to the China Health and Retirement Longitudinal Study (CHARLS) (4). Furthermore, with an dramatic increase of aged population, cognitive impairment and dementia, are also one of the most pressing worldwide public health concerns (5). Physical frailty (PF) and cognitive impairment, these two common geriatric syndromes, place a burden not only on affected older adults, their families, and caregivers but also on health and social care systems (6).

Since PF and cognitive impairment are associated with advancing age, more recently, substantial studies have been conducted in understanding the relationship between PF and cognitive impairment. Recent cross-sectional studies have found higher rates of cognitive impairment in frail compared to robust elders (7-10). Moreover, PF also has been shown to increase the risk of future cognitive decline and incident dementia in longitudinal studies (11-13). A very recent meta-analysis including 14302 participants showed that comparing with free from frailty and cognitive impairment, isolated cognitive impairment had 3.83 hazard ratio for dementia, 1.47 for isolated PF, and 5.36 for co-occurrence of PF and cognitive impairment (14). Similarly, another cohort study reported individuals with cognitive impairment but non-PF had higher risk of developing PF after 4 years, comparing with those who were robust and cognitive intact at baseline (15). This conclusion was supported by another longitudinal study, that also reported in older Mexican Americans cognitive impaired pre-frail participants were more likely to develop into frail (16).

Accordingly, various measures of cognitive performance have been included in recently proposed operational definition of PF, such as cognitive impairment considered as one of many deficits included in the frailty index (FI) (17); Moreover, cognitive impairment is considered a component of PF such as "cognitive frailty" (18). A recent study from China

Received January 9, 2020
Accepted for publication February 11, 2020
Published online April 15, 2020, http://dx.doi.org/10.1007/s12603-020-1363-y

showed that 3.3% of 5,708 community-dwelling older adults were co-occurrence of PF and cognitive impairment without dementia (19). In addition, some studies have shown that those with both PF and cognitive impairment had the higher risk of functional disability (15), poorer quality of life (13), and mortality (16, 20), compared with those with PF only or cognitive impairment only. Moreover, Ruan, et al proposed that cognitive impairment from cognitive frailty results from frailty or pre-frailty (21). Despite such large body of research on the relationship between PF and cognitive impairment, little has been carried out on finding the risk factors associated with different patterns of PF and cognitive impairment. Furthermore, most studies on PF and cognitive impairment were conducted in developed countries, little is known about the prevalence of these subgroups in Chinese population.

In this study, we examined the prevalence and associated factors of separate and joint of PF and cognitive impairment among older adults aged ≥60 years in western China. To the note, we would firstly examine the prevalence of PF and cognitive impairment in multiple ethnicity groups. We examined the associations between the risk factors including demographic and medical characteristics and different patterns of PF and cognitive impairment, which might help us to better understand the etiology of PF and cognitive impairment, and further to detect the promising targets for preventive and therapeutic actions.

Methods

Study Population

Data are from the West China Health and Aging Trend (WCHAT) study, a prospective, observational study designed to evaluate factors associated with healthy aging among community-dwelling adults aged 50 years and older in western China. Multi-stage random cluster sampling was conducted in this study and the response rate was 50.2%. All WCHAT participants (or their proxy respondents) provided written informed consent, and the study was approved by our institutional review boards. WCHAT baseline was conducted from July 2018 to November 2018 comprising 7,538 people from 18 ethnicity groups in four provinces (Sichuan, Yunnan, Guizhou, Xinjiang), and the data were collected through personal interviews and physical examinations. For the present study, we included the subset of 4,514 older adults aged ≥60 years. The final analysis consisted 4,103 participants after excluding 370 individuals with missing data on more than two of the 5-criteria of PF phenotype, and 41 individuals with missing data on cognition function.

Definition of PF

Frailty was defined by the physical frailty phenotype (PFP) scale developed by Fried et al (2), that included 5 elements: shrinking, slowness, weakness, exhaustion, and low physical activity. Based on the five criteria, those who met two or less criteria of the above were defined as non-PF, those met three or more were defined as frailty. We modified the operational definition since the measurements were not identical in the WCHAT study.

Shrinking was considered if participant reported weight loss of 4.5kg in the last 12 months or body mass index (BMI) <18.5 kg/m^2. Slowness was measured by usual-pace 4-meters walking trials, as being≤20th percentile within four sex-by-height categories. Weakness was defined as maximum grip strength of dominant hand over 2 trials≤20th percentile within eight sex by–BMI categories (low weight: BMI <18.5 kg/m^2; normal: BMI 18.5-23.9 kg/m^2; overweight: BMI 24-27.9 kg/m^2; obese: BMI ≥28 kg/m^2). Exhaustion was determined if participants self-reported unusually fatigue or weak at a moderate amount of time (3-4 days per week) or most of the time (5-7 days per week); Or self-report low energy (using the numerical rating scale to assess the energy level from 0 to 10, where 0 represents the lowest energy and 10 represents the most energy, low energy defined if score ≤3). Low physical activity was determined by the total amount of kcal/week spend on commonly performed physical activities: walking, indoor housework, outdoor housework, dancing, playing ping-pong, and other regular exercises, as measured using a validated China Leisure Time Physical Activity Questionnaire (CLTPAQ) (22), which was a modified version of the Minnesota Leisure Time Physical Activity Questionnaire (MLTPAQ) (23) according to the Chinese lifestyle and cultural background. The cutoff value of low physical activity was being≤20th percentile within four sex-by-total energy expenditure per week. The specific calculation of energy consumption was following: Energy consumption (kcal /week) = MET * Times per week * Minutes per time * Weight(kg)/60

Categories of physical activities included walking (4.0 MET), indoor housework (3.5 MET), outdoor housework (5.0 MET), dancing (4.5 MET), playing ping-pong (4.0 MET) and other regular exercises (5.0 MET).

Definition of Cognitive Impairment

The Short Portable Mental Status Questionnaire (SPMSQ) (24), an 10-item instrument administered to proxy respondents not reporting a diagnosis, was used to assess the cognitive performance. Score of the SPMSQ was ranged from 0 to 10; a higher SPMSQ score reflected more poor cognitive function. A score of more than 4 in individuals with primary school education and less or a score of more than 2 in individuals with high school education and higher are defined as cognitive impairment (25, 26).

Primary Outcome

According different patterns of PF and cognitive impairment, participants in this study were divided into 4 groups: not-PF and cognitive intact (“neither” group), not-PF and cognitive impairment (“CI only” group), PF and cognitive intact (“PF only” group), and PF and cognitive impairment (“both” group).

Demographic Characteristics

Demographic variables included age, sex, ethnicity group, education, and marital status. Age was converted to a categorical variable in 10-year increments (60-69; 70-79; 80+ years). Ethnicity groups were condensed to six categories (Han, Qiang, Zang, Yi, Uiguhur, and other minorities (Uzbekistan, Dong, Lisu, Hui, Tujia, Zhuang, Dong, Miao, Kirgiz, Tujia, Uighurs, Mongolian)). Education was categorized as: illiterate, primary school (5th grade) and secondary school graduate or higher (8th grade or higher). Marital status was coded as married vs. others (unmarried or widowed or divorced).

Medical Characteristics

The following medical conditions were included: (1) Obesity vs. non-obesity; (2) Chronic disease: self-reported history of the number of diagnosed chronic diseases, including hypertension, diabetes mellitus, heart disease, lung disease, arthritis, stroke, and cancer (categorized as 0, 1, ≥2); (3) Barthel Index was used to assess the risk for functional dependence (27). Activities of daily living (ADLs) (i.e., using the toilet, getting cleaned up, dressing and eating) ranged from normal (Barthel index ≥100) and ADLs impairment (Barthel index <100); (4) Depression was measured via the 15-item Geriatric Depression Scale (GDS-15) (28). Depression was defined as a GDS-15 score ≥8; (5) Mini Nutritional Assessment (MNA-SF) was used to assess the nutritional status and a score≤12 was considered malnutrition (29); (6) Insomnia symptoms: based on the self-reported difficulty in falling asleep and/or maintaining sleep, four categories were created as follows: no insomnia symptoms, difficulty initiating sleep only, difficulty maintaining sleep only and both insomnia symptoms; (7) Hospitalization and falls condition in the last 12 months were also recorded.

Statistical Analysis

Firstly, we estimated the prevalence of different patterns of PF and cognitive impairment in the overall sample and stratified by demographics characteristics including age, sex, ethnicity group, education, and marital status. Means ± standard deviation (SD) were used to describe continuous variables. Frequencies and proportions were used for categorical variables. Respectively, ANOVA and $\chi 2$-test were carried out to compare the continuous and categorical variables among the four groups: "neither", "CI only", "PF only", and "both". Secondly, we identified the prevalence of four groups by different ethnicity groups, adjusting for age using multinomial logistic regression. Thirdly, we identified the prevalence of medical conditions, such as depression, sleep quality, comorbidity, ADLs disability, malnutrition, falls and hospitalization in last 12 months across the four patterns of PF and cognitive impairment. Finally, multivariable logistic regression was used to analyze the correlation between medical characteristic and different patterns of PF and cognitive impairment adjusting for age, sex, ethnicity, education, and marital status. Results were presented as odds ratio (OR) with 95% confidence intervals (CI).

P-values <0.05 were considered as statistically significant. All analyses were performed using Stata 15.1 (Stata Corp, College Station, TX).

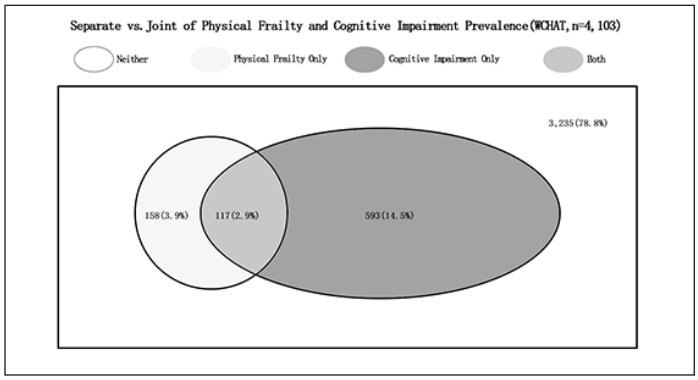
Results

Prevalence of PF and Cognitive Impairment by Demographics

Among the 4,103 participants aged 60 and older, 3,235 (78.8%), 158 (3.9%), 593 (14.5%) and 117 (2.9%) were "neither", "PF only", "CI only", and "both", respectively. In the people with PF (n=275), 42.5% had cognitive impairment. In people with cognitive impairment (n=710), 16.5% were PF (Figure 1). 2,392 of 4,103 participants (58.3%) were female, and the means ± SD age of all participants was 67.8 ± 5.9 years. The prevalence of "PF only" (2.2% -12.7%), " CI only" (12.2%-21.2%) and "both" (1.6%-12.2%) were increased steeply with advancing age. The prevalence of "CI only" (18.9% vs. 8.2%) and "both" (3.4% vs. 2.1%) were higher in women than men, while "PF only" prevalence (3.1%) was lower in women than men (4.9%). In addition, the higher prevalence of "PF only", "CI only" and "both" was found in those with lower education level, and single status (Table 1).

Figure 1

Venn diagram of the separate versus joint prevalence of PF and cognitive impairment status



Prevalence of PF and Cognitive Impairment by Ethnicity

Of note, we found there was substantial ethnicity group disparity in the prevalence of different PF and cognitive impairment status. The prevalence of "PF only" varied from 3.8% in Qiang to 34.8% in Han. The prevalence of "CI only" ranged from 5.2% in Uighur to 24.5% in Han. And the prevalence of "both" ranged from 9.4% in other minorities to 25.6% in Tibetan. (Figure 2).

Medical Characteristics of PF and Cognitive Impairment

Among the four groups, the "both" individuals had the highest prevalence of underweight (10.3%), depression (53.9%), difficulty initiating sleep (17.1%), ADLs impairment

Table 1
Prevalence of Physical Frailty and Cognitive Impairment Status by Demographic Subgroups Among 4,103 Older Adults Aged ≥60 From the West China Health and Aging Trend (WCHAT) study

Characteristic	Subgroup Prevalence, n (%)	Prevalence Within Subgroup, n (%)			
		Neither	Physical Frailty Only	Cognitive Impairment Only	Both
All sample	4,130 (100)	3,235 (78.8)	158 (3.9)	593 (14.5)	117 (2.9)
Age***, years (Means±SD)	67.8±5.9	67.2±5.6	71.9±6.4	68.9±6.4	72.7±7.3
Age***, n (%)					
60-69	2,706 (66.0)	2,273 (84.0)	60 (2.2)	331 (12.2)	42 (1.6)
70-79	1,208 (29.4)	860 (71.2)	74 (6.1)	222 (18.4)	52 (4.3)
80+	189 (4.6)	102 (54.0)	24 (12.7)	40 (21.2)	23 (12.2)
Sex***, n (%)					
Male	1,711 (41.7)	1,452 (84.9)	83 (4.9)	140 (8.2)	36 (2.1)
Female	2,392 (58.3)	1,783 (74.5)	75 (3.1)	453 (18.9)	81 (3.4)
Ethnicity***, n (%)					
Han	1,552 (37.8)	1,323 (85.2)	55 (3.5)	145 (9.3)	29 (1.9)
Qiang	862 (21.0)	713 (82.7)	6 (0.7)	_ 129 (15.0)	14 (1.6)
Tibetan	692 (16.9)	506 (73.1)	42 (6.1)	114 (16.5)	30 (4.3)
Yi	370 (9.0)	229 (61.9)	13 (3.5)	115 (31.1)	13 (3.5)
Uighur	307 (7.5)	222 (72.3)	34 (11.1)	31 (10.1)	20 (6.5)
Other minority	320 (7.8)	242 (75.6)	8 (2.5)	59 (18.4)	11 (3.4)
Education***, n (%)					
Illiterate	1,385 (33.8)	889 (64.2)	54 (3.9)	369 (26.6)	73 (5.3)
Primary school	1,566 (38.2)	1,340 (85.6)	55 (3.5)	145 (9.3)	26 (1.7)
Second school or higher	1,152 (28.1)	1,006 (87.3)	49 (4.3)	79 (6.7)	18 (1.6)
Marital status***, n (%)					
Married	3,230 (78.7)	2,625 (81.3)	106 (3.3)	431 (13.3)	68 (2.1)
Others	873 (21.3)	610 (69.9)	52 (6.0)	162 (18.6)	49 (5.6)

Notes: The p values were calculated using Pearson chi-square test for categorical variables and t-test for continuous variables, ***p<0.001.

(43.6%), and risk of malnutrition (63.8%). Otherwise, the group was comparable to the "PF only" group with respect to sleep quality (both insomnia symptoms), comorbidity burden, history of falls and hospitalization in last 12 months. Compared to those who were PF (with or without cognitive impairment), the "CI only" group had the lowest prevalence of depression, hospitalization, comorbidity burden, falls, ADLs impairment, as well as the lowest education level. No significant differences were found between the "CI only" group and the "neither" group with respect to comorbidity burden, falls and hospitalization in past 12 months. However, those with "CI only" were more likely to have higher risk of malnutrition, and depression than the "neither" group.

Medical Characteristics Associated with PF and Cognitive Impairment

In the multinomial logistic regression analyses, demographic characteristics including age, gender, ethnicity, education, and marital status were adjusted. Compared with the "neither" group, those with PF with or without cognitive impairment had higher odds of underweight ("PF only": OR=5.42, 95% CI=2.85-10.32; "both": OR=4.01, 95% CI=1.91-8.42); difficulty initiating sleep ("PF only": OR=1.83, 95% CI=1.09-3.10; "both": OR=2.35, 95% CI=1.35-4.07) and both difficulty initiating and maintaining sleep ("PF only": OR=1.88, 95% CI=1.02-2.37; "both": OR=1.77, 95% CI=1.08-2.89); hospitalization ("PF only": OR=2.37, 95% CI=1.69-3.33; "both": OR=1.77, 95% CI=1.08-2.89); ≥2 of comorbidities ("PF only": OR=2.21, 95% CI=1.39-3.51; "both": OR=2.78, 95% CI=1.64-4.68; compared to having none), and falls ("PF

Table 2
Distributions of Clinical Characteristics by Physical Frailty and Cognitive Impairment Status: The West China Health and Aging Trend (WCHET) Study, 2018; n=4,103

	Overall 4,103 (100)	Neither 3,235 (78.8)	Physical Frailty Only 158 (3.9)	Cognitive Impairment Only 593(14.5)	Both 117 (2.9)	P value
Weight status, n (%)						<0.001
Not-obese	3,622 (88.3)	2,876 (88.9)	120 (76.0)	528 (89.0)	98 (83.8)	
Obese	481 (11.7)	359 (11.1)	38 (24.1)	65 (11.0)	19 (16.2)	
Depression, n (%)	803 (19.6)	524 (16.2)	44 (27.9)	172 (29.0)	63 (53.9)	<0.001
Sleep quality, n (%)						<0.001
No insomnia	2,502 (61.0)	2,005 (62.0)	85 (53.8)	352 (59.4)	60 (51.3)	
Difficulty initiating sleep only	396 (9.7)	308 (9.5)	20 (12.7)	48 (8.1)	20 (17.1)	
Difficulty maintaining sleep only	592 (14.4)	469 (14.5)	15 (9.5)	99 (16.7)	9 (7.7)	
Both insomnia symptoms	612 (14.9)	452 (14.0)	38 (24.1)	94 (15.9)	28 (23.9)	
Number of comorbidity, n (%)						<0.001
0	2,924 (71.3)	2,326 (71.9)	88 (55.7)	444 (74.9)	66 (56.4)	
1	810 (19.7)	649 (20.1)	36 (22.8)	101 (17.0)	24 (20.5)	
≥2	369 (9.0)	260 (8.0)	34 (21.5)	48 (8.1)	27 (23.1)	
Activities of daily livings (ADLs), n (%)						<0.001
Normal ADLs	3,586 (87.4)	2,934 (90.7)	102 (64.6)	484 (81.6)	66 (56.4)	
ADLs impairment	517 (12.6)	301 (9.3)	56 (35.4)	109 (18.4)	51 (43.6)	
Malnutrition, n (%)	987 (24.6)	583 (18.4)	50 (32.5)	280 (48.0)	74 (63.8)	<0.001
Falls in last 12 months, n (%)	651 (17.5)	473 (16.2)	45 (29.6)	102 (19.0)	31 (27.0)	<0.001
Hospitalization in last 12 months, n (%)	1,071 (26.1)	784 (24.2)	77 (49.0)	164 (27.7)	46 (39.3)	<0.001

Notes: The p values were calculated using Pearson chi-square test for categorical variables.

only": OR=2.11, 95% CI=1.45-3.09; "both": OR=1.79, 95% CI=1.15-2.80; compared to no fall history), but not "CI only". In addition, comparing with "neither" group, individuals with "PF only", "CI only" and "both" had significantly higher odds of depression ("PF only": OR=2.88, 95% CI=1.95-4.23; "CI only": OR=1.80, 95% CI=1.45-2.24; "both": OR=6.88, 95% CI=4.56-10.40), ADLs impairment ("PF only": OR=4.29, 95% CI=2.97-6.21; "CI only": OR=1.89, 95% CI=1.46-2.45; "both": OR=5.36, 95% CI=3.54-8.10), and odds of risk of malnutrition ("PF only": OR=1.76, 95% CI=1.22-2.53; "CI only": OR=3.25, 95% CI=2.66-3.96; "both": OR=5.67, 95% CI=3.78-8.52). Of note, obesity significantly associated with "PF only" (OR=2.10, 95% CI=1.34-3.29), but not associated with "CI only" or "both".

Discussion

In the present study, we investigated the prevalence and associated factors of separate and joint of PF and cognitive impairment in community-dwelling older adults aged ≥60 in western China. This study showed that there was significant degree of overlap between PF and cognitive impairment in older adults, consistent with previous studies. However, there were sizeable subgroups who had PF but not cognitive impairment, and vice versa. Moreover, we also observed substantial ethnicity heterogeneity in PF and cognitive impairment prevalence in western China. Finally, our findings also showed that older adults with separate and joint of PF and cognitive impairment had different association with various medical characteristics.

Based on this cross-sectional study, we estimated the prevalence of "PF only", "CI only", and "both" (3.9%, 14.5% and 2.9%, respectively) among older adults aged 60 years and older in western China. A cross-sectional study of community-dwelling older adults aged 65 years or older from the National Health Interview Survey in Taiwan presented 11.0% had co-occurring frailty/pre-frailty and cognitive impairment (30). Recently, a nationally representative study in the United States (31), including 7338 community-dwelling people aged 65 years and over, showed that the prevalence of cognitive impairment alone was 14.6%, PF alone was 9.2%, and both PF and cognitive impairment was 5.4%. The prevalence of PF

Table 3
Multinomial Logistic Regression Analysis of Medical Conditions for Physical Frailty only, Cognitive Impairment only and Both, Relative to Neither: The West China Health and Aging Trend (WCHET) Study, 2018; n=4,103

	Physical Frailty Only VS. Neither (OR, 95%CI)	P value	Cognitive Impairment Only VS. Neither (OR, 95%CI)	P value	Both VS. Neither (OR, 95%CI)	P value
Weight status						
Not-obese	Reference		Reference		Reference	
Obese	2.32 (1.53, 3.52)**	<0.001	1.01 (0.74, 1.36)	0.972	1.44 (0.83, 2.49)	0.189
Depression	2.88 (1.95, 4.23)***	<0.001	1.80 (1.45, 2.24)***	<0.001	6.88 (4.56, 10.40)***	<0.001
Sleep quality						
No insomnia	Reference		Reference		Reference	
Difficulty initiating sleep only	1.83 (1.09, 3.10)*	0.023	0.80 (0.57, 1.12)	0.195	2.35 (1.35, 4.07)**	0.002
Difficulty maintaining sleep only	0.67 (0.50, 1.38)	0.166	1.13 (0.87, 1.47)	0.354	0.57 (0.28, 1.18)	0.131
Both insomnia symptoms	1.88 (1.02, 2.37)**	0.003	1.02 (0.78, 1.33)	0.912	1.77 (1.08, 2.89)*	0.023
Hospitalization in last 12 months	2.37 (1.69, 3.33)***	<0.001	1.12 (0.90, 1.38)	0.307	1.59 (1.07, 2.38)**	0.023
Number of comorbidity						
0	Reference		Reference		Reference	
1	1.29 (0.85, 1.95)	0.069	0.89 (0.70, 1.15)	0.372	1.29 (0.79, 2.12)	0.312
≥2	2.21 (1.39, 3.51)**	0.001	0.94 (0.66, 1.34)	0.740	2.78 (1.64, 4.69)***	<0.001
Falls in last 12 months						
No fall	Reference		Reference		Reference	
>1 fall	2.11 (1.45, 3.09)***	<0.001	1.13 (0.88, 1.46)	0.335	1.79 (1.15, 2.80)*	0.010
Activities of daily livings (ADLs)						
Normal ADLs	Reference		Reference		Reference	
ADLs impairment	4.29 (2.97, 6.21)***	<0.001	1.89 (1.46, 2.45)***	<0.001	5.36 (3.54, 8.10)***	<0.001
Malnutrition, n (%)						
Normal	Reference		Reference		Reference	
Risk of malnutrition	1.76 (1.22, 2.53)***	0.002	3.25 (2.66, 3.96)***	<0.001	5.67 (3.78, 8.52)***	<0.001

Notes: Multinomial logistic regression for "physical frailty only" vs "neither", "cognitive impairment only" vs "neither", and "both" vs "neither" were conducted for each health events, adjusted for age, sex, ethnicity groups, education, and marital status. Odds ratios (OR) with 95% confidence intervals (CI) were presented. * p<0.05; **p<0.01; ***p<0.001.

alone and both PF and cognitive impairment was much higher than in the present study, however, the prevalence of "CI only" is similar as our results. The discrepancy may attribute to the mean age of the community-dwelling older adults comprised in this study were significantly older than the participants included in our study (74.4 vs. 67.8 years). Moreover, a study including 5,708 community-dwelling older adults from seven cities representing the six main regions of China showed that the prevalence of cognitive frailty, defined as co-occurrence of PF and cognitive impairment without dementia was 3.3% (19), slightly higher than the prevalence of "both" in our study (2.9%).

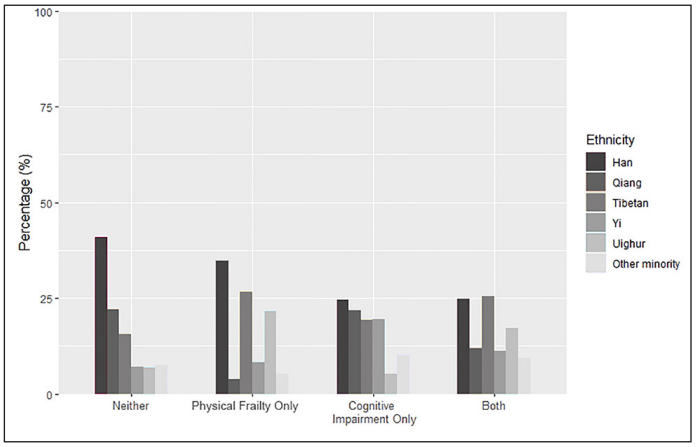
To our knowledge, this study was the first to examine the prevalence of separate and joint of PF and cognitive impairment in Chinese older adults including multiple ethnicity groups. Interestingly, our findings showed that the prevalence of "PF only" in Qiang was significantly lower than other ethnicity groups, while Uighur had the lowest prevalence of "CI only". A large body of literature demonstrating the cultural and group exercise could help to prevent the PF (32-35). In our study, the folk dance was a well-accepted exercise in Qiang nationality (36), which may have a beneficial effect on physical function to prevent the PF. In addition, the possible mechanism of Uighur with higher cognitive function might be that education level was better in Uighur than other ethnicity groups (secondary school and above, 62.5% vs. 25.3%, not shown in the results). Previous epidemiologic studies had showed that educational level was positively correlated with cognitive functions (37) and significantly reduced the risk of dementia (38) and cognitive decline (39).

In addition, we found depression, malnutrition, and ADLs impairment had much stronger associations with joint and separate presence of PF and cognitive impairment, but had no association with "neither". These findings were in close

agreement with the previous studies which consistently show that the above characteristics had strong association with PF or cognition impairment. For example, association between psychological problems such as depression and PF (40, 41) and cognitive impairment (42, 43) have been proved; With regard to the adverse clinical outcomes, there had been a number of evidence indicating that PF, cognitive impairment, and joint of both all had significantly higher prevalence and incidence of functional disability, prolonged hospitalization (15, 16, 44). But owning to the cross-sectional study design, we could not identify the causal relationship between disability and PF and cognitive impairment. Taken together, our findings will help us to distinguish those people who were free from PF and cognitive impairment. Those with the above factors were more likely to be PF, cognitive impairment, or "both". On the contrary, people without these factors were most likely to be free from PF and cognitive impairment.

Figure 2

Age-adjusted prevalence of four patterns of PF and cognitive impairment among older adults aged ≥ 60 years by ethnicity groups, West China Health and Aging Trend (WCHAT) study, n=4,103



Recently, some researches advised to combine PF and cognitive impairment in order to improve the predictive accuracy in identifying those at high risk of adverse health outcomes such as disability and mortality (31, 13, 20). In the present study, however, we found that multimorbidity was strongly associated with PF with or without cognitive impairment, but not with cognitive impairment only. Moreover, in our study observed that PF and cognitive impairment were not totally overlapped. A very recent longitudinal study by Chu et al. (45) using a US. nationally-representative sample of older adults aged 65 and older in the National Health Aging Trends Study (NHATS), found that the temporal sequence of onset of PF and cognitive impairment associated with different correlates. Taken together, more longitudinal studies on PF and cognitive impairment were recommended to help us to better understand the bidirectional relationship between PF and cognition impairment.

The present study has many strengths. First, we firstly provided the epidemiological characteristics of "CI only", "PF only" and "both", providing a simple method to distinguish these conditions in the older adults; Second, this study was conducted in a large sample including multiple ethnicity groups, providing the prevalence of "CI only", "PF only" and "both" in west of China and by different ethnicity groups. Nevertheless, attention should be drawn to the study limitations. Cross-sectional design induces that no conclusions with regard to cause and consequences between adverse health indicators and different cognitive impairment and PF status can be drawn. However, our findings are consistent with the prospective cohort study, which also demonstrated participants with both PF and cognitive impairment at baseline had poorer physical and cognitive performances, higher risks of incident physical limitation and increased cumulative hospital stay over follow-up (15). The next step, we will use WCHET longitudinal study to examine the adverse medical outcomes in different patterns of PF and cognitive impairment. Additionally, missing data was another limitation. Although the Short Portable Mental Status Questionnaire (SPMSQ), an accepted method, was used to assess the cognitive performance, the cut-points for defining cognitive impairment may not be applicable to ethnic minority groups. Finally, although we have analyzed so many demographic and health characteristics as potential risk factors to identify the characters of "CI only", "PF only" or "both", the other potential factors such as work life, neuropsychiatric or emotion issues, and family or social support may also play a role affecting PF and cognitive functioning which were not included in our research.

Conclusions

Conclusively, our research provides the prevalence and associated factors of "CI only", "PF only" and "both" in western China. Our results not only support to increase our understanding of the different patterns of PF and cognitive impairment but also bolster the evidence of measure who might get "PF only", "CI only" or "both" in clinical practice. It's worth noting that identifying the profiles of "PF only", "CI only" and "both" is just the first step, further research on developing an efficient and practical screen to predict the risk of "PF only", "CI only" and "both" is advocated.

Acknowledgement: This work was supported by 1.3.5 project for disciplines of excellence, West China Hospital, Sichuan University; National Key R&D Program of China (2017YFC0840100 and 2017YFC0840101); Sichuan Science and Technology Program (2018TJPT0015, 2018JY0094); National Clinical Research Center for Geriatrics, West China Hospital (Z20191007). The financial sponsors had no role in the design, implementation, analyses, or reporting of the results.

Conflict of Interests: The authors declare no conflict of interests.

Ethical Standards: This study was approved by the Ethics Committee of West China Hospital, Sichuan University.

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