Associations of Falls with Quality of Life and Correlated Factors in Community-Dwelling Older Adults: A Two-Wave Cohort Study

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Abstract

Background

Falls contribute to disability and burden of care among older adults. Studies of fall-related impacts on quality of life (QOL) are warranted for future prevention interventions.

Methods

Fall-related data were collected from adults aged 70 years and above using questionnaire interviews in the 1996 and 1999 surveys at Hunei community in southern Taiwan. Their QOL was measured using the Short Form 36 Health Survey (SF-36) and World Health Organization Quality of Life questionnaire (WHOQOL-BREF) in the 1999 follow-up only. The bilateral relationship among fall category, selected covariates (i.e., age, sex, number of difficulties in performing activities of daily living (ADLs) or instrumental ADLs, number of comorbidities, Geriatric Depression Scale (GDS) scores, Mini-Mental Stated Examination (MMSE) scores, fear of falling, and Physical Activity Scale for the Elderly (PASE) scores), and mean QOL scores were investigated. Hierarchical linear regression models were tested to examine the associations between fall frequency and QOL with sequential entry of explanatory variables. The final models were established by substituting fall category for fall frequency.

Results

Fall category was significantly associated with physical-related subscale scores, except body pain. Almost every QOL score revealed a negative association with the number of comorbidities, GDS scores, and fear of falling; however, a positive association with MMSE and PASE scores was observed.

Conclusions

Future prevention interventions should target common risk factors of both QOL and falls among older people, including control of comorbidities, depressive symptoms, cognitive impairment, and inactivity.

Background

After a comprehensive assessment of morbidity and mortality from falls, the Global Burden of Disease Study 2017 revealed that global age-specific years lived with disability increased with age, and hip and femur fractures increasingly contribute to disability in older age groups [1]. As the population aged 65 and older is rapidly increasing [2], the medical costs attributable to both fatal and nonfatal falls are assumed to keep growing at the nation [3] and state levels [4]. In addition to financial impacts, falls pose an emerging threat to the quality of life (QOL) of older adults due to psychological and functional consequences, such as causing feelings of powerlessness, instilling fear of falling, and raising the need to seek care [5]. In fact, falls have a widespread and profound influence on QOL among older people, as assessed using different measurement QOL instruments. For instance, falls have had a significant impact on the physical component of the SF-12 [6] and SF-36 [7], whereas the fear of falling is associated with poor QOL for both physical component summary (PCS) and mental component summary (MCS) of the SF-36 [7]. The World Health Organization Quality of Life questionnaire (WHOQOL-BREF) effectively distinguishes fallers from non-fallers in terms of QOL scores among older adults in low-income communities [8, 9]. Moreover, the strength of association between falls and impairments in the Euro-QOL (EQ-5D)-rated QOL varies across fall category, with a significant mean score difference between each pair of fall category (10).

Noteworthy, the relationship between falls and QOL is confounded by many risk factors, including advanced age, female gender, falling history, fear of falling, and history of diabetes and arthritis [7]. Other risk factors for falls, including difficulty in performing one basic ADL, difficulty in performing two or more instrumental ADLs (IADLs), comorbidities, and depressive symptoms [11], are also supposed to lead to poor QOL. For example, disability in ADL and IADL is negatively associated with QOL in older people aged 75 years and older [12]. Comorbidities have a negative effect on the general adult population in terms of the EQ-5D-5L [13] and the CDC HRQOL-4 (i.e., general health, mental distress, physical distress, and activity limitations) [14]. A significant negative correlation between depressive symptoms and EQ-5D scores was found among rural older people in central China [15]. Moreover, recent studies on the relationship between cognitive function and QOL have shown that older adults with cognitive complaints tended to perceive lower general mental wellbeing (SF-12 MCS) [16], and cognitive impairment was associated with poor scores on the physical and psychological domains of WHOQOL-BREF [17]. An 18-month panel study has revealed that physical activity would indirectly influence global QOL across time via more proximal outcomes of physical activity, including self-efficacy, disability limitations, and physical self-worth [18].

However, the relationship between falls and QOL has received insufficient attention. Most multivariate models of the preceding studies were not completely adjusted for the aforementioned confounding factors to differentiate the subscale effect of single fall and recurrent falls on QOL. To bridge the gap of knowledge, this study was designed to examine the associations between fall category and every subscale QOL using the SF-36 and WHOQOL-BREF with sufficient adjustment for selected covariates in community-dwelling older adults in southern Taiwan.

Methods

Study subjects and data collection

Data used were collected from a two-wave cohort study conducted at Hunei, Kaohsiung, in southern Taiwan. The Hunei community is located in northern Kaohsiung and people mainly relied on agriculture and fishery for a livelihood. The eligibility criteria were as follows: community-dwellers aged 70 and older and had lived for more than 6 months with local household registration. Meanwhile, the exclusion criteria included individuals who were hospitalized, those who had moved, and those who lived in institutions. From September 1996 to April 1997, 1,092 older adults finished the first-wave survey for face-to-face questionnaire interviews, of which the content included age, sex, number of ADL (activities of daily living) /IADL (instrumental ADL) difficulties, and fall experience in the previous year, among others. Among them, only 600 persons (54.9%) completed a follow-up from November 1999 to May 2000. The second-wave survey questionnaire consisted of the SF-36 and WHOQOL-BREF scales, comorbidities, depressive symptoms, cognitive impairment, fear of falling, and physical activities, among others, in addition to fall experience. However, 492 persons were lost to follow-up due to death ($n = 304$) and unknown causes ($n = 188$). Informed consent was obtained before questionnaire administration to each participant.

Measurement instruments of QOL

The QOL of the study participants was measured using the SF-36 and WHOQOL-BREF. The SF-36 measures eight dimensions of health: physical functioning (PF), role physical (RP), body pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE), and mental health (MH). Raw scores were transformed into a score from 0 to 100, with higher scores reflecting better health. Although the SF-36 has been recommended for its validity and feasibility [19, 20], it was translated and developed according to the standard methodology of the International Quality of Life Assessment project [21].

The Taiwanese version of the WHOQOL-BREF used in this study was originally developed by Yao et al. [22] from the original WHOQOL-BREF [23–25]. It consists of 28 items, including the 26 standard WHOQOL-BREF items for assessing QOL in four domains: Physical (Phy), Psychological (Psy), Social relations (Soc) and Environmental (Env). Two additional items were added to reflect unique cultural characteristics in Taiwan: being respected/accepted by others and eating what one loves to eat. Reliability and cross-validation examination had shown that the Taiwanese version of the WHOQOL-BREF is analogous to the global version [26]. Each item of the scale uses a five-point Likert-type response measurement. Item scores are equivalent to facet scores; however, domain scores were calculated from the average of the item/facet scores in the same domain multiplied by 4 so that the final range of the transformed domain score lies between 4 and 20. A higher score indicates better QOL [22]. The WHOQOL-BREF is a suitable method for assessing health-related QOL for community-dwelling older persons in central Taiwan [27].

Relatively minor modifications were made to make the SF-36 more relevant to the Taiwanese culture, as was done in other studies [28–30]. For example, Tai-Chi Chuan was substituted for playing golf, and “mile” was changed to “kilometer.” The SF-36 used in this study was validated [31–32], and its scoring and interpretation followed the SF-36 manual [33]. Similarly, the WHOQOL-BREF was further translated from Mandarin Chinese into the Taiwanese dialect by local interviewers and an advisory panel of experts before it was administered to the interviewees. In this study, physical-related subscales were defined to include PF, RP, BP, GH, PCS, and Phy, whereas psychological-related subscales include VT, SF, RE, MH, MCS, and Psy.

Fall measures and covariates

A fall was defined as “an event of falling down to a lower surface that occurs while one stands up, sits down, gets into bed, walks, etc., regardless of its underlying causes.” The number of falls reported in the two surveys was summed as fall frequency, which was further grouped into fall category, including three categories: no falls (NF), single fall (one fall (OF)), and recurrent falls (RF) (two or more falls).

Covariates chosen for the correlation analyses included sociodemographic characteristics (age, sex, the number of ADL difficulties, and the number of IADL difficulties), medical factors (the number of comorbidities, depressive symptoms [34], cognitive impairment [35], and fear of falling), and a lifestyle factor (physical activity level, measured using the Physical Activity Scale in the Elderly (PASE) [36] (Additional file 1: Table S1).

Statistical analyses

The distribution and mean with standard deviation of sociodemographic characteristics and assessment scores and prevalence by fall category were presented. The chi-square test was used, as appropriate, to differentiate fall category by the aforementioned covariates. Differences in the mean QOL scores were examined using one-way analysis of variance (ANOVA) or Student's *t* test not only across the fall category but also across the selected covariates. A series of hierarchical linear regression models was tested to examine the associations between falls and QOL with a sequential entry of fall frequency and sociodemographic, medical, and lifestyle covariates. The final models were established by substituting fall category for fall frequency to differentiate the effect of single fall from that of RF. All statistical analyses were conducted using STATA/SE 17 for Windows. The statistical significance level (α) was set at 0.05.

Results

Despite a similar sex distribution, the age distribution of the 492 nonrespondents was respectively 41, 23, and 36% for those aged 70–74, 75–79, and ≥ 80 years, significantly differing from that of respondents (chi-square test; $p < 0.05$). In the 600 respondents who completed the follow-up, the mean baseline age was 76.2 ± 4.6 years with a range of 70–96 years (Table 1). Moreover, 50.8% were females, and 40.7% were afraid of falling. They had 0.1 ± 0.9 ADL difficulty, 0.7 ± 1.5 IADL difficulty, 1.4 ± 1.1 comorbidities, and a mean score of 4.3 ± 3.8 for the GDS, 21.8 ± 7.9 for the MMSE, and 55.4 ± 59.3 for the PASE. Among them, 125 were fallers (20.8%), including 73 single fallers and 52 recurrent fallers. Approximately 3% had difficulty in at least one ADL task, and 34% had difficulty in at least one IADL task. Furthermore, 35% had depressive symptoms, 41% had either cognitive impairment or fear of falling, and approximately 65% had a moderate to high PASE score. Moreover, approximately 60% had 1–2 comorbidities, and 15% had three comorbidities, with the following rankings according to prevalence (not shown in the table): cataract (47.8%), hypertension (38.8%), heart diseases (14.2%), respiratory diseases (13.0%), diabetes (11.7%), gout (7.2%), and stroke (4.5%).

Table 1
Distribution of the characteristics of participants and prevalence according to the fall category.

Selected variables	Total (N = 600)		Prevalence by fall category (%)			P-value
	M ± SD/n	%	RF (N = 52)	OF (N = 73)	NF (N = 475)	
Age (years) #	76.2 ± 4.6					
70–74	264	44.0	7.6	10.2	82.2	0.269
75–79	209	34.8	7.7	14.4	78.0	
80+	127	21.2	12.6	12.6	74.8	
Sex#						
Male	295	49.2	5.8	8.5	85.8	<0.001
Female	305	50.8	11.5	15.7	72.8	
No. of ADL difficulties#	0.1 ± 0.9					
None	583	97.2	8.4	12.2	79.4	0.408
≥1	17	2.8	17.7	11.8	70.6	
No. of IADL difficulties#	0.7 ± 1.5					
None	394	65.7	6.1	11.7	82.2	0.003
1	138	23.0	10.9	11.6	77.5	
≥2	68	11.3	19.1	16.2	64.7	
No. of comorbidities	1.4 ± 1.1					
None	153	25.5	4.6	7.8	87.6	0.004
1–2	357	59.5	8.4	14.0	77.6	
≥3	90	15.0	16.7	12.2	71.1	
GDS score (if depressive)	4.3 ± 3.8					
No	389	64.8	6.4	9.5	84.1	<0.001
Yes	211	35.2	12.8	17.1	70.1	
MMSE score (if impaired)	21.8 ± 7.9					
No	350	58.3	7.7	10.9	81.4	0.272
Yes	250	41.7	10.0	14.0	76.0	
Fear of falling						
No	356	59.3	5.1	10.7	84.3	<0.001
Yes	244	40.7	13.9	14.3	71.7	
PASE score	55.4 ± 59.3					
Low	210	35.0	11.9	13.3	74.8	0.095
Moderate	186	31.0	8.1	14.0	78.0	
High	204	34.0	5.9	9.3	84.8	
Note: RF, recurrent falls; OF, single fall; NF, no falls; M, mean; SD, standard deviation; ADLs, activities of daily living; IADLs, instrumental activities of daily living; GDS, Geriatric Depression Scale; MMSE, Mini-Mental State Examination; PASE, Physical Activity Scale in the Elderly. P-values indicate the difference in variables across the fall category using the chi-square test. Explanatory variables, other than those specified with # sign, were measured in the second-wave survey.						

Bivariate analyses revealed that the characteristics significantly associated with the risk of falls included female gender, a higher number of IADL difficulties, a higher number of comorbidities, depressive symptoms, and fear of falling; however, age, the number of ADL difficulties, cognitive impairment, and physical activity level were not associated with fall risk. In contrast to the prevalence of RF, the prevalence of single fall did not present a smooth gradient of risk by age, the number of ADL difficulties, the number of IADL difficulties, the number of comorbidities, and physical activity level.

Table 2 shows that every mean QOL score significantly varied according to the fall category (ANOVA; $p < 0.05$), except for the Soc and Env domains. The highest and lowest mean QOL scores were 74.0 and 42.5 for BP and PCS, respectively, in the SF-36, whereas the corresponding mean subscale scores were 13.8 for the Soc domain and 12.9 for the Psy domain in the WHOQOL-BREF. Although both recurrent and single fallers tended to have a lower mean QOL score than non-fallers in most subscales (except for VT, MH, Psy, Soc, and Env), no significant difference was observed between recurrent and single fallers (Scheffé multiple-comparison test; $p > 0.05$).

Table 2
Mean subscale scores of SF-36 and WHOQOL-BREF by fall category.

Subscale	Total (N = 600)	Fall category			P-value
		RF (N = 52)	OF (N = 73)	NF (N = 475)	
SF-36					
PF ^a	61.7 ± 32.0	45.6 ± 29.5	46.0 ± 29.8	65.8 ± 31.3 ^a	<0.001
RP	53.8 ± 46.5	40.4 ± 46.2	30.1 ± 42.5	58.8 ± 45.8	<0.001
BP	74.0 ± 25.4	60.9 ± 28.4	65.5 ± 25.5	76.8 ± 24.3	<0.001
GH ^b	50.8 ± 17.9	38.2 ± 17.3 ^a	43.6 ± 17.6	53.3 ± 17.1 ^a	<0.001
VT ^a	65.0 ± 18.9	59.8 ± 18.5 ^a	59.3 ± 19.1	66.4 ± 18.7	0.001
SF	72.5 ± 27.4	59.6 ± 29.7	62.3 ± 28.0	75.4 ± 26.3	<0.001
RE	64.9 ± 45.5	48.1 ± 47.3	48.9 ± 46.8	69.3 ± 44.2	0.001
MH ^a	72.9 ± 16.3	69.3 ± 18.2 ^a	68.9 ± 17.5	73.9 ± 15.7	0.012
PCS ^c	42.5 ± 11.7	36.2 ± 11.2 ^a	36.4 ± 10.9	44.1 ± 11.4 ^b	<0.001
MCS ^c	47.8 ± 11.4	44.0 ± 12.2 ^a	44.6 ± 12.8	48.7 ± 10.9 ^b	<0.001
WHOQOL-BREF					
Phy	13.7 ± 2.9	11.9 ± 2.8	12.5 ± 2.7	14.0 ± 2.8	<0.001
Psy	12.9 ± 2.7	11.6 ± 2.9	12.5 ± 2.5	13.2 ± 2.7	<0.001
Soc ^a	13.8 ± 2.1	13.4 ± 2.0	13.5 ± 1.7	13.8 ± 2.1 ^a	0.150
Env	13.4 ± 2.5	12.8 ± 2.7	13.2 ± 2.3	13.5 ± 2.5	0.131
Notes: Mean ± standard deviation is presented for each subscale according to the fall category. PF, physical functioning; RP, role limitations due to physical health problems; BP, bodily pain; GH, general health perceptions; VT, vitality; SF, social functioning; RE, role limitations due to emotional problems; MH, mental health; PCS, physical component summary; MCS, mental component summary; Phy, Physical domain; Psy, Psychological domain; Soc, Social domain; Env, Environmental domain; RF, recurrent falls; OF, single fall; NF, no falls. a = one missing value; b = two missing values; c = three missing values.					
P-values indicate the mean subscale score difference across fall category using one-way analysis of variance.					

Individuals who were more advanced in age, female, with difficulty in at least one ADL/IADL task, with more comorbidities, with depressive symptoms, with cognitive impairment, and with fear of falling tended to have a lower mean QOL score than their counterparts, with only a few exceptions. In contrast, older people who had a high PASE score tended to have a higher mean QOL score, followed by those with a moderate PASE score and those with a low PASE score (Additional file 2: Table S2).

Table 3 shows the results of the hierarchical linear regression models for every QOL subscale. With a sequential entry of fall frequency and sociodemographic, medical, and lifestyle variables, the proportions of the total amount of variance explained gradually increased, and the effect of fall frequency declined in the models after initiation. However, the partial regression coefficients of fall frequency remained significantly negative for GH, PCS, and Phy only in the full models.

Table 3
Associations between fall frequency and every subscale of QOL by hierarchical linear regression models.

Fall frequency	SF-36										WHOQOL-BREF		
	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS	PH	PS	SR
Model 1													
Fall frequency	-4.81***	-5.17**	-3.51***	-3.56***	-1.79**	-3.75***	-5.16**	-1.21*	-1.89***	-1.14**	-0.50***	-0.32**	-0.12
R ²	0.03	0.02	0.03	0.05	0.01	0.03	0.02	0.01	0.03	0.01	0.04	0.02	0.00
Model 2													
Fall frequency	-3.55***	-3.80*	-2.84**	-3.20***	-1.28	-2.81**	-3.96*	-0.79	-1.49***	-0.83*	-0.42***	-0.26*	-0.05
R ²	0.27	0.13	0.09	0.10	0.08	0.19	0.12	0.06	0.18	0.09	0.17	0.08	0.03
Model 3													
Fall frequency	-1.41	-0.94	-1.01	-1.70**	0.30	-0.77	-0.94	0.56	-0.72*	0.14	-0.19**	-0.04	0.04
R ²	0.52	0.35	0.35	0.41	0.47	0.51	0.36	0.41	0.43	0.49	0.55	0.52	0.30
Model 4													
Fall frequency	-1.23	-0.80	-0.94	-1.66**	0.35	-0.66	-0.73	0.56	-0.67*	0.17	-0.18**	-0.04	0.03
R ²	0.58	0.36	0.36	0.42	0.48	0.54	0.40	0.41	0.46	0.50	0.57	0.52	0.31

Note: * $p < .05$; ** $p < .01$; *** $p < .001$. Model 1 was adjusted for fall frequency. Model 2 was adjusted for fall frequency, age, sex, number of ADL difficulty, and number of IADL difficulty. Model 3 was adjusted for Model 2 variables, number of comorbidities, GDS scores, MMSE scores, and fear of falling. Model 4 was adjusted for Model 3 variables, and PASE scores.

In the final models adjusted for fall category and the selected covariates, the proportions of total QOL variation collectively explained were between 0.5 and 0.7 for PF, SF, and MCS and the Phys and Psy domains and between 0.3 and 0.5 for the other subscales (Table 4). Relative to NF, one unit change in a single fall was significantly associated with losses of 10.28 PF scores, 17.05 RP scores, 4.93 GH scores, 4.62 PCS scores, and 0.65 Phy domain scores, whereas one unit change in RF was associated with losses of 6.17 GH scores and 0.59 Phy domain score.

Table 4
Multiple linear regression models for each subscale of SF-36 and WHOQOL-BREF.

	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS	Phy	P
Fall category												
OF vs. NF	-10.28***	-17.05***	-3.93	-4.93**	-0.67	-4.62	-7.57	0.17	-4.62***	-0.06	-0.65**	0
RF vs. NF	-1.86	3.22	-3.81	-6.17**	3.85	-0.13	0.90	3.50	-1.85	1.77	-0.59*	-
Age	-0.79***	-0.68	0.06	0.08	-0.07	-0.26	-0.33	0.11	-0.22*	0.02	-0.01	0
Sex	-2.12	-1.47	-3.51	1.78	-1.95	0.07	-3.54	-2.81*	-0.16	-1.36	0.29	0
No. ADL difficulty	-1.19	-1.72	0.37	1.35	0.48	0.19	-2.97	1.93**	-0.22	0.17	-0.08	0
No. IADL difficulty	-3.23***	-1.06	0.29	-0.37	-0.09	-2.46***	-0.82	-0.72	-0.53	-0.29	-0.16*	-
No. of comorbidities	-2.11**	-5.48***	-2.89***	-3.27***	-1.03*	-2.19**	-3.02*	-0.96*	-1.51***	-0.62*	-0.27***	-
GDS score	-2.43***	-3.21***	-2.36***	-1.63***	-2.59***	-2.86***	-4.10***	-2.27***	-0.76***	-1.60***	-0.33***	-
MMSE score	0.46**	1.13***	0.32*	0.31**	0.07	0.45***	0.52*	-0.21*	0.30***	-0.00	0.07***	0
Fear of falling	-12.54***	-12.33**	-7.31***	-5.87***	-6.64***	-8.76***	-3.59***	-5.74***	-3.65***	-3.91***	-0.95***	-
PASE score	0.14***	0.11***	0.06***	0.03*	0.04***	0.09***	0.16***	0.00	0.04***	0.03***	0.01***	-
Constant	142.12***	118.32***	89.39***	54.96***	91.11***	107.41***	117.66***	92.13***	62.23***	60.30***	15.35***	1
R^2	0.59	0.38	0.36	0.42	0.49	0.54	0.40	0.41	0.47	0.51	0.57	0
F	75.28***	32.50***	30.56***	38.50***	50.49***	63.01***	35.95***	37.21***	47.23***	54.4***	70.49***	5
Note: Every multiple linear regression model was adjusted for fall category, age, sex, number of ADL difficulty, number of IADL difficulty, number of comorbidities, fear of falling, and PASE score. Sex was coded as 1 for male and 2 for female.												
* $p < .05$; ** $p < .01$; *** $p < .001$.												

Moreover, age was negatively correlated with PF and PCS only but was positively correlated with the Psy domain (Table 4). Compared with older men, older women were negatively associated with MH but were positively associated with the Psy and Soc domains. The number of IADL difficulties was negatively associated with PF and SF and the Phy and Psy domains. In contrast, the number of ADL difficulties was positively associated with MH. Moreover, every subscale score of the SF-36 revealed a universal negative association with the number of comorbidities, GDS scores, and fear of falling and a universal positive association with MMSE (except for MH and MCS) and PASE scores. Fear of falling had the greatest inverse association with QOL ratings among all covariates. However, for the WHOQOL-BREF, the number of comorbidities was negatively associated with the Phy domain, but not with the other domains. GDS scores were negatively correlated with every QOL score. Despite a positive association with most subscale QOL, PASE scores had a negative association with the Soc and Env domains.

Discussion

The study contributes to limited fall-related QOL research among community-dwelling older adults that the associations between fall category with QOL varied according to the subscales of the SF-36 and WHOQOL-BREF. Multiple linear regression analyses revealed that the fall category was significantly associated with physical-related subscale scores, except for BP. Furthermore, almost every subscale score of QOL revealed a negative association with the number of comorbidities, GDS scores, and fear of falling and a positive association with MMSE and PASE scores.

Probably due to a higher proportion of loss of follow-up among those aged ≥ 80 years, the prevalence of single fall did not present a smooth gradient of risk as that of RF, by age, the number of ADL/IADL difficulties, the number of comorbidities, and physical activity level. Compared with those in a preceding study [37], our participants tended to have lower age-specific mean QOL in each subscale of the SF-36, but not in the WHOQOL-BREF. The influence of falls was displayed on the physical-related subscales only in multiple linear regression analyses, in contrast to the universal influence of fear of falling on every subscale. It not only conforms to the previous report that the impact of falling episodes was mainly presented on PCS and that of fear of falling on both PCS and MCS [7] but also strengthens the assertion that the SF-36 seems to be more suitable for QOL measurement of community-dwelling older adults than the WHOQOL-BREF, even though both measurement tools offer good validity and reliability [37]. The coefficients of determination increased with including medical variables into the modeling process, probably because they were associated with poor QOL in preceding studies, in terms of chronic disease [10, 37], depression [38], cognitive impairment [16, 17], and fear of falling [39–41]

However, compared with previous studies [7, 10], the other subscales in this study were not as responsive to fall category as the physical-related subscales in the multiple linear regression models. Moreover, no significant inverse trend was observed between fall frequency and each subscale score in the full models of hierarchical linear regression analyses, except for GH and PCS and the Phy domain. The discrepancy might be elucidated as follows: First, according to the

underlying mechanism of falls leading to poor QOL [42, 43], the fall-related influence on psychological-related subscales is assumed to lag behind that on the physical-related subscales. Second, compared with either non-fallers or single fallers, recurrent fallers might be more likely to withdraw from follow-up due to medical factors and leave their QOL deterioration under-presented. Hereby, analysis of the mean subscale score did not distinguish recurrent fallers from single fallers in Table 2. Third, some fallers could benefit from the buffering effects of favorable perceived social support [44].

Compatible with two previous studies [7, 45], a negative association was found between age and PF/PCS and between sex and MH. Further study is needed to determine whether the positive associations between age and the Psy domain and sex and the Psy/Soc domain reflected psychological resilience [46]. In contrast to Gobbens [12], a positive association was found between the number of ADL difficulties and MH. Three explanations are posed. First, it is probably due to selective survival [47]. Second, the sample size of older adults having ADL difficulties was too small to obtain a stable estimate. Third, it could reflect a phenomenon of disability paradox [48].

The beneficial effects of physical activities were underpinned by their positive association with each subscale score of the SF-36 and with the Phys domain of the WHOQOL-BREF. The reason is that exercise and physical activities help reduce the risk of developing numerous chronic conditions, offset loss in muscle mass and strength, counteract age-related decline in bone mineral density, preserve cognitive function, alleviate symptoms and behaviors associated with depression, and contribute to successful aging [49].

This study has two strengths. First, both the SF-36 and WHOQOL-BREF had been considerably modified to reflect the unique local culture. Second, these multiple linear regression models made differentiating the effects of single fall from those of RF on QOL for inter-subscale comparison possible. Nevertheless, several limitations of the study are worth considering. First, data collection based on self-perception is susceptible to recall bias, especially when several batteries of assessment items make interviewees committed to different recalling periods, such as 7 days for the GDS and PASE scales, 2 weeks for the WHOQOL-BREF, and 1 month for the SF-36. Second, the lack of repeated measurements of QOL and the selected covariates makes detecting their time-dependent changes due to falls difficult. Third, no ascertainment of falls was performed between the first- and second-wave surveys when some non-fallers or single fallers could have experienced one or more falls and resulted in the misclassification of fall category and underestimation of the impacts of recurrent fallers. Fourth, the lump sum of comorbidities does not reflect the real impact of each disease because not all chronic conditions affect QOL with similar magnitudes. For example, stroke might lower down QOL more severely than simple hypertension or metabolic syndrome, whereas diabetes without any complication might not affect QOL. Therefore, the generalization of the results of this study to other community-dwelling older adults might be restricted. Whether multidimensional QOL should be regularly assessed as a surrogate outcome indicator of fall risk evaluation and management for community-dwelling older adults should be assessed [50].

Conclusions

This is the first community-based prospective study that has used the SF-36 and WHOQOL-BREF to differentiate the subscale impacts of fall category on QOL, with sufficient adjustment for selected sociodemographic, medical, and lifestyle covariates. The results of this study demonstrated that fall-related impacts mainly influence the physical-related subscales and underscore the importance of future prevention interventions targeting multiple risk factors influencing both QOL and falls among community-dwelling older people, including control of comorbidities, depressive symptoms, cognitive impairment, and inactivity.

Abbreviations

QOL: quality of life; ADL: activities of daily living; IADL: instrumental activities of daily living; GDS: Geriatric Depression Scale; MMSE: Mini-Mental State Examination; PASE: Physical Activity Scale in the Elderly; SF-36: The Short Form 36 Health Survey; PF: physical functioning; RP: role limitations due to physical health problems; BP: bodily pain; GH: general health perceptions; VT: vitality; SF: social functioning; RE: role limitations due to emotional problems; MH: mental health; PCS: physical component summary; MCS: mental component summary; WHOQOL-BREF: World Health Organization Quality of Life questionnaire-BREF; Phy: Physical domain; Psy: Psychological domain; Soc: Social domain; Env: Environmental domain; RF: recurrent falls; OF: single fall; NF: no falls; ANOVA: one-way analysis of variance.

Declarations

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Authors' contributions

YJT had full access to the Hunei cohort study data, and took responsibility for the integrity of the data and data analysis. YJT, WJS, YCY, and PC were responsible for design of the study. WJS was in charge of data collection and curation. YJT drafted the manuscript and was responsible for interpretation of the data. WJS, YCY, PC, and JDW helped with the study methodology and participated in revision of the manuscript, writing review, and editing of the manuscript. All authors contributed to the critical revision of the manuscript for important intellectual content, and all approved the article submitted for publication.

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Availability of data and materials

YJT keeps the Hunei cohort study data.

Ethical approval and consent to participate

Informed consent was obtained from each participant, following the standardized operational procedures of questionnaire interview of the Taiwan Provincial Institute of Family Planning. The study proposals were approved after getting through the process of internal and external reviews, when no ethical concern was raised.

Consent for publication

Not applicable.

Competing Interest

The authors declare that they have no competing interests.

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