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Original Study

The Association Between Psychological Resilience and Physical Function Among Older Adults With Hip Fracture Surgery

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A B S T R A C T

Objectives: To examine the associations of prefracture psychological resilience and prefracture general mental health with physical function among older adults with hip fracture surgery.
Design: Single-center observational study.
Intervention: None.
Setting and participants: Patients aged ≥50 years who underwent first hip fracture surgery between January 2017 and December 2017 (N = 152).
Methods: We used data collected prospectively from the hospital's hip fracture registry. We performed generalized estimating equations to examine the associations of prefracture psychological resilience (10-item Connor-Davidson Resilience Scale) and prefracture general mental health (Short Form–36 mental health subscale) with physical function (Short Form–36 physical functioning subscale) at 4 time points—prefracture (based on recall), and 1.5, 3, and 6 months after surgery.
Results: Prefracture psychological resilience had an association with physical function; a 1-unit increase in psychological resilience score was associated with 1.15 units [95% confidence interval (CI) 0.71, 1.59] higher physical function score across 4 time points. In contrast, the association between general mental health and physical function varied over time; a 1-unit increase in general mental health score was associated with 0.42 units (95% CI 0.18, 0.66) higher physical function score at prefracture, 0.02 units (95% CI −0.18, 0.22) lower at 1.5 months, 0.23 units (95% CI −0.03, 0.49) higher at 3 months, and 0.39 units (95% CI 0.09, 0.68) higher at 6 months after surgery.
Conclusions and implications: Psychological resilience is associated with physical function among older adults with hip fracture surgery, independent from general mental health. Our findings suggest the potential for interventions targeting psychological resilience for these patients and call for more studies on psychological factors affecting physical function recovery after hip fracture surgery.

Hip fracture causes acute loss of physical function and is one of the most debilitating health conditions affecting older adults. Its treatment generally focuses on optimizing patients for surgery and allowing them to undergo rehabilitation as soon as possible after surgical fixation of the fractured hip. Nevertheless, a significant proportion of patients still do not recover their prefracture physical function, even 1 year after surgery.[1–3] In addition to improved surgical

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management, it has been suggested that recovery may also benefit from attention to psychological factors.[4]

Psychological resilience is a characteristic in an individual that fosters the ability to adapt positively to adverse life circumstances.[5] There is growing interest in the role of psychological resilience among older adults, as empirical evidence suggests that psychological resilience may help them to cope with chronic health conditions. In particular, higher psychological resilience may prevent older adults from developing physical disabilities following new chronic diseases[6] and may help those with chronic disability maintain or improve their physical function.[7]

Given the role of psychological resilience in mitigating the effect of chronic health conditions on physical function, it is plausible that psychological resilience also has a role in the recovery of physical function after an acute health condition such as orthopedic surgery. On this point, existing studies have produced mixed findings. Of 4 studies on hip or knee conditions, 2 found significant positive associations between psychological resilience and physical function[8,9] whereas 2 found no evidence of association.[10,11] This may be due to heterogeneous study samples—1 study included patients with any fractures[11]; another included patients with either hip or knee surgeries regardless of whether the surgery was elective or following fractures.[8] Among the 2 studies that included only older adults with hip fracture,[9,10] the follow-up ended at 2 months after surgery, although the recovery of physical function tends to stabilize only about 6 months after surgery.[1,2]

Current literature is also unclear whether the association between psychological resilience and physical function is independent from that of general mental health, which has also shown to be associated with physical function recovery after hip fracture.[12] Psychological resilience and general mental health are different constructs—the former relates to self-perceived ability to cope or to adapt positively to adversity, whereas the latter relates to mood or mental states such as happiness, nervousness, and calmness.[13] There is evidence that psychological resilience and general mental health have independent associations with physical function among older adults living with physical disabilities; however, this was based on cross-sectional data.[14] A clear understanding of the associations would inform whether psychological resilience has a unique contribution to physical function recovery after hip fracture and could act as a target of intervention.

To address the evidence gaps, our study examined the longitudinal associations of prefracture psychological resilience and prefracture general mental health with physical function among older adults with hip fracture at 4 time points, up to 6 months after surgery. We hypothesized that the associations of psychological resilience and general mental health with physical function would both be positive and persist after adjusting for each other.

Methods

Samples

We used data from the Singapore General Hospital (SGH) Hospital Hip Fracture Registry, which follows up patients admitted to the hospital for hip fracture surgery as part of the routine clinical care. SGH is the oldest and the largest tertiary acute hospital in Singapore.

We included patients aged ≥50 years who received surgery for acute hip fracture between January and December 2017 in the hospital. We excluded patients with periprosthetic fracture, injured due to high-impact trauma, diagnosed with cognitive impairment, dementia, hearing impairment, or psychiatric disorder, as well as those with missing independent variables of interest and confounders from the analyses. Our sample consisted of 152 patients. We obtained the approval from the SingHealth Centralized Internal Review Board to use the data.

Dependent Variable

We used the physical functioning subscale of the Short Form−36 questionnaire (SF-36 PF) at 4 time points (prefracture, 1.5 months, 3 months, and 6 months after surgery) as the measure of physical function. SF-36 PF asks the respondents whether they experience limitations in any of 10 activities, such as climbing stairs, carrying groceries, and walking. Each question is rated 1 to 3, with 1 indicating "a lot," 2 indicating "a little," and 3 indicating "not at all." The ratings were summed and scaled based on the developers' recommendation,[15] such that the final scores ranged from 0 to 100, with higher scores indicating better physical function. Prefracture PF scores were based on recall during admission.

Independent Variables of Interest

Our study had 2 independent variables of interest—the 10-item Connor-Davidson Resilience Scale (CD-RISC10) as the measure of psychological resilience and the mental health subscale of the SF-36 questionnaire (SF-36 MH) as the measure of general mental health.

CD-RISC10 is one of the most widely used scales for measuring psychological resilience and is abbreviated from the original 25-item scale[16] after removing redundant items with poor fit to the underlying latent construct. Besides being more concise, CD-RISC10 has also demonstrated more stable psychometric properties than the 25-item version.[17,18] It asks respondents about their self-perceived ability to overcome or to adapt to challenges in the past 1 month. An example of an item is "I am able to deal with whatever that comes my way." Each item is rated on a 5-point Likert-type scale, with 0 indicating "never" and 4 indicating "almost always." Therefore, the total scores of the CD-RISC10 ranged from 0 to 40, with higher scores indicating higher psychological resilience.

SF-36 MH consists of 5 items relating to the respondents' mood and the mental state. It asks the respondents whether they have been feeling nervous, downhearted, calm, and happy during the past 4 weeks.[13] Each item is rated 1 to 6, with 1 indicating "all the time" and 6 indicating "none of the time." The ratings were summed and scaled based on the developers' recommendation,[15] such that the final scores ranged from 0 to 100, with higher scores indicating better general mental health.

Potential Confounders

Our analyses adjusted for age, gender, ethnicity, chronic disease counts, type of fracture, type of surgery, and past fall. We categorized ethnicity as Chinese or non-Chinese because of the small number of non-Chinese in our sample. Chronic disease count was the number of 10 chronic diseases known to delay or limit recovery of physical function after hip fracture, namely, type 2 diabetes mellitus, ischemic heart disease, stroke, arthritis, asthma, depression, Parkinson's disease, vascular disease, osteoporosis, and cognitive impairment. Previous studies have also used a similar approach of summing up the chronic diseases.[19] Type of fracture was categorized as neck of femur, intertrochanteric, or others, whereas type of surgery was categorized as either internal fixation or arthroplasty. Past fall status referred to whether patients had fallen in the past 1 year (yes vs no) prior to the admission.

Statistical Analyses

We first described the sample with mean and standard deviation (SD) for continuous variables, or count and percentage (%) for

categorical variables. We examined the differences between those with complete data (105/152 = 69.1%) at all observation time points and those without (47/152 = 30.9%) using *t* test for continuous variables, and chi-square test or Fisher exact test for categorical variables where appropriate.

We performed multiple linear regression with generalized estimating equations to examine the associations of prefracture psychological resilience and prefracture general mental health with physical function at prefracture, and 1.5, 3, and 6 months after surgery. The time of observation was a categorical variable in the models and the correlations between the repeated measures were assumed to be autoregressive of order 1 where correlations were higher between time points that are closer. The generalized estimating equation estimates the population-average association of the independent variables of interests while accounting for the correlation among repeated measures within an individual, and the sandwich variance estimator was used to obtain robust standard errors for the estimates.[20] We used 1.5 months as the reference for time of observation as physical function was the lowest at this time.

We performed model building, starting with an examination of the association of psychological resilience and general mental health separately with physical function, adjusting for time of observation (model 1), followed by further adjustment of the confounders listed above (model 2). Both models assumed the associations of psychological resilience and general mental health with physical function were time invariant, quantifying each association with 1 coefficient. We also investigated whether the associations were time varying by estimating a coefficient for each time point, with the addition of an interaction term between psychological resilience and time as well as between general mental health and time separately (model 3). Finally, we performed a forward variable selection by sequentially adding interaction term(s) with time having $P < .05$ into model 3 to obtain a parsimonious model (model 4). We reported the coefficient estimates with their respective 95% confidence intervals (95% CIs) and *P* values.

To visualize the associations, we plotted the trajectories of physical function using the estimated marginal mean[21] for the first quartile, median, and third quartile of psychological resilience and general mental health scores, where each continuous confounder took the value corresponding to its mean and each categorical confounder took the value based on its respective proportions in the overall sample.

In addition, we performed 4 sensitivity analyses. We applied the final models to patients with complete and incomplete data as well as those who were aged ≥60 years. We also replaced SF-36 PF with SF-36 physical component summary (SF-36 PCS) as the dependent variable and replaced SF-36 MH with SF-36 mental component summary (SF-36 MCS) as the independent variable, as a previous study[12] had used SF-36 PCS and SF-36 MCS as measures of physical function and general mental health, respectively. The rationale is that if the findings are consistent across more than 1 set of measures, it would further corroborate the findings. SF-36 PCS and MCS are weighted scores of 8 domains of quality of life—physical functioning, bodily pain, role limitation due to physical problems, role limitation due to emotional problems, mental health, vitality, general health, and social function.[22] The scores range from 0 to 100, with higher scores indicating better physical function and general mental health, respectively. Both PCS and MCS scores are normed such that a score of 50 represents the population average with each 10-point score deviation from 50 representing 1 SD.

We performed all statistical analyses using R version 3.5.1 (The R Foundation for Statistical Computing, Vienna). We used the geeglm command in the geepack package[23] to perform generalized estimating equations and the esticon command in the doBy package[24] to estimate an overall *P* value for each interaction term. In all statistical analyses, we considered a *P* value < .05 as statistically significant.

Table 1
Characteristics of Patients (N = 152)

	Mean ± SD or Count (%)
Age, y	75.5 ± 8.6
Gender	
Male	42 (27.6)
Female	110 (72.4)
Ethnicity	
Chinese	139 (91.4)
Malay	6 (3.9)
Indian	7 (4.6)
Type of fracture	
Neck of femur	101 (66.4)
Intertrochanteric	41 (27.0)
Others	10 (6.6)
Type of treatment	
Internal fixation	77 (50.7)
Arthroplasty	75 (49.3)
Fallen in the past 1 y	
No	112 (73.7)
Yes	40 (26.3)
Chronic disease count	0.7 ± 0.8
Prefracture psychological resilience*	28.1 ± 6.7
Prefracture general mental health†	87.2 ± 15.1

*Measured by CD-RISC10.
†Measured by SF-36 MH.

Results

Descriptive Analysis

The majority of the 152 patients were females (72.4%), of Chinese ethnicity (91.4%), experienced neck of femur fracture (66.4%), received internal fixation as treatment (50.7%), and had no falls in the past 1 year (73.7%). At admission, the mean age of patients was 75.5 (SD 8.8) years with an average of 1 comorbidity. Prefracture psychological resilience scores ranged from 3 to 40, with a mean of 28.1 (SD 6.7), whereas prefracture general mental health scores ranged from 0 to 100, with a mean of 58.4 (SD 11.0) (Table 1).

Of the 152 patients at admission, 90.8% were seen at 1.5 months, 82.9% at 3 months, and 76.3% at 6 months. The average physical function score at 1.5 months was substantially worse than that at prefracture (score of 23.1 vs 66.3), which recovered to a score of 48.4 at 6 months (Table 2).

There was no significant difference in characteristics between patients with complete data and incomplete data (Supplementary Table 1), except that those with complete data were slightly younger (74.4, SD 9.0, vs 77.8, SD 7.3) and had slightly higher psychological resilience score (28.9, SD 5.9, vs 26.4, SD 7.9) than those with incomplete data.

Association of Prefracture Psychological Resilience and Prefracture General Mental Health With Physical Function

Adjusting for time of observation alone, both prefracture psychological resilience and prefracture general mental health had significant associations with physical function at all 4 time points (model 1; Table 3). These associations remained statistically significant after

Table 2
Physical Function Over Time (as Measured by SF-36v1 PF Scores) With Respective Follow-up Information

	Prefracture	1.5 mo	3 mo	6 mo
Physical function, mean (SD)	66.3 (26.6)	23.1 (22.4)	42.3 (29.9)	48.4 (29.8)
Follow-up, n (%)	152 (100)	138 (90.8)	126 (82.9)	116 (76.3)

Table 3
Association of Prefracture Psychological Resilience and Prefracture General Mental Health With Physical Function at Prefracture and 1.5, 3, and 6 Months After Hip Fracture Surgery (N = 152)

Variables of Interest	Model 1			Model 2		
	Estimate	95% CI	*P* Value	Estimate	95% CI	*P* Value
Prefracture psychological resilience (time-invariant estimates)	1.49	1.00, 1.97	<.001	1.37	0.96, 1.78	<.001
Prefracture general mental health (time-invariant estimates)	0.71	0.48, 0.95	<.001	0.49	0.26, 0.72	<.001
	Model 3			Model 4 (Final Model)		
	Estimate	95% CI	*P* Value	Estimate	95% CI	*P* Value
Prefracture psychological resilience (time-varying estimates)			.50*			
Prefracture	1.42	0.94, 1.90	<.001			
1.5-mo	1.08	0.55, 1.61	<.001			
3-mo	1.21	0.63, 1.79	<.001			
6-mo	1.58	0.96, 2.20	<.001			
Prefracture psychological resilience (time-invariant estimates)				1.15	0.71, 1.59	<.001
Prefracture general mental health (time-varying estimates)			<.001*			<.001*
Prefracture	0.60	0.35, 0.85	<.001	0.42	0.18, 0.66	.001
1.5-mo	0.17	−0.04, 0.37	.12	−0.02	−0.22, 0.18	.84
3-mo	0.42	0.15, 0.69	.003	0.23	−0.03, 0.49	.08
6-mo	0.56	0.25, 0.87	<.001	0.39	0.09, 0.68	.010

Model 1: adjusted for time alone, assuming the associations are time-invariant, separately for prefracture psychological resilience and prefracture general mental health; *model 2:* adjusted for age, gender, ethnicity, chronic disease counts, type of fracture, type of surgery, past falls, and time, assuming the associations are time-invariant, separately for prefracture psychological resilience and prefracture general mental health; *model 3:* adjusted for age, gender, ethnicity, chronic disease counts, type of fracture, type of surgery, past falls, and time, assuming the associations are time-varying, separately for prefracture psychological resilience and prefracture general mental health; *model 4:* adjusted for age, gender, ethnicity, chronic disease counts, type of fracture, type of surgery, past falls, and time, assuming the association is time-invariant for prefracture psychological resilience and time-varying for general mental health in a single model.

*This is the *P* value for the interaction term between each variable of interest and time.

adjustment for age, gender, ethnicity, chronic disease counts, type of fracture, type of surgery, and past fall (model 2; Table 3). When we added an interaction term between each independent variable of interest and time (model 3; Table 3), the interaction term between prefracture psychological resilience and time had $P > .05$ whereas that between prefracture general mental health and time had $P < .05$, indicating that the former had a time-invariant association and the latter a time-varying association with physical function.

Thus, in the parsimonious model (model 4; Table 3), we included prefracture psychological resilience without an interaction with time, and prefracture general mental health with an interaction with time. In this model, a 1-unit increase in prefracture psychological resilience score was associated with 1.15 units (95% CI 0.71, 1.59) higher physical function score at all 4 time points. In contrast, a 1-unit increase in prefracture general mental health score was associated with 0.42 units (95% CI 0.18, 0.66) higher physical function score at prefracture, 0.02 units (95% CI −0.18, 0.22) lower at 1.5 months, 0.23 units (95% CI −0.03, 0.49) higher at 3 months, and 0.39 units (95% CI 0.09, 0.68) higher at 6 months after surgery; that is, the association varied across time.

Figure 1 A and B illustrate the trajectories of physical function over time for patients with first quartile, median, and third quartile of prefracture psychological resilience and prefracture general mental health scores separately. Figure 2 A and B compare the trajectories of physical function for patients with different combinations of prefracture psychological resilience and prefracture general mental health scores. Compared to patients with lower prefracture psychological resilience and lower prefracture general mental health (dot-dash line), those with higher prefracture psychological resilience score alone (solid line) have more favorable trajectories than those with higher prefracture general mental health scores alone (dash line).

Sensitivity Analyses

The estimates were similar in direction and strength to those in the main analyses among study samples with complete data and incomplete data (Supplementary Table 2) as well as those ≥60 years old (Supplementary Table 3), suggesting that our findings were robust. When we replaced SF-36 PF with PCS as the dependent variable and MH with MCS as the independent variable, the associations of prefracture psychological resilience and prefracture general mental health were still in the expected directions (Supplementary Table 4); the interaction between prefracture general mental health and time persisted to be significant although the *P* value for psychological resilience increased to > .05.

Discussion

Consistent with our hypothesis, we found that prefracture psychological resilience had positive associations with physical function prefracture at 1.5, 3, and 6 months after hip fracture surgery, and the associations were independent from prefracture general mental health. Our data also suggest that improving prefracture psychological resilience would produce more favorable trajectories of physical function than improving prefracture general mental health. To our knowledge, the present study is the first to provide evidence for the associations between psychological resilience and physical function up to 6 months after hip fracture surgery while simultaneously considering the effect of general mental health with longitudinal data.

Notably, the associations between prefracture psychological resilience and physical function did not vary between the 4 time points of observation, unlike those for prefracture general mental health, for which the association was stronger at prefracture and at 6 months after surgery but the weakest at 1.5 months. Adjusting for changes in general mental health scores between prefracture and 6 months in a post-hoc model did not substantively change the significance of prefracture psychological resilience and prefracture general mental health (Supplementary Table 5). This underscores the importance of psychological resilience as an internal resource for older adults coping with an acute health condition such as hip fracture. As postulated by the Proactivity Model of Successful Aging[25] and demonstrated in empirical studies among community-dwelling older adults,[26] internal resources may facilitate proactive coping behavior such as engaging in

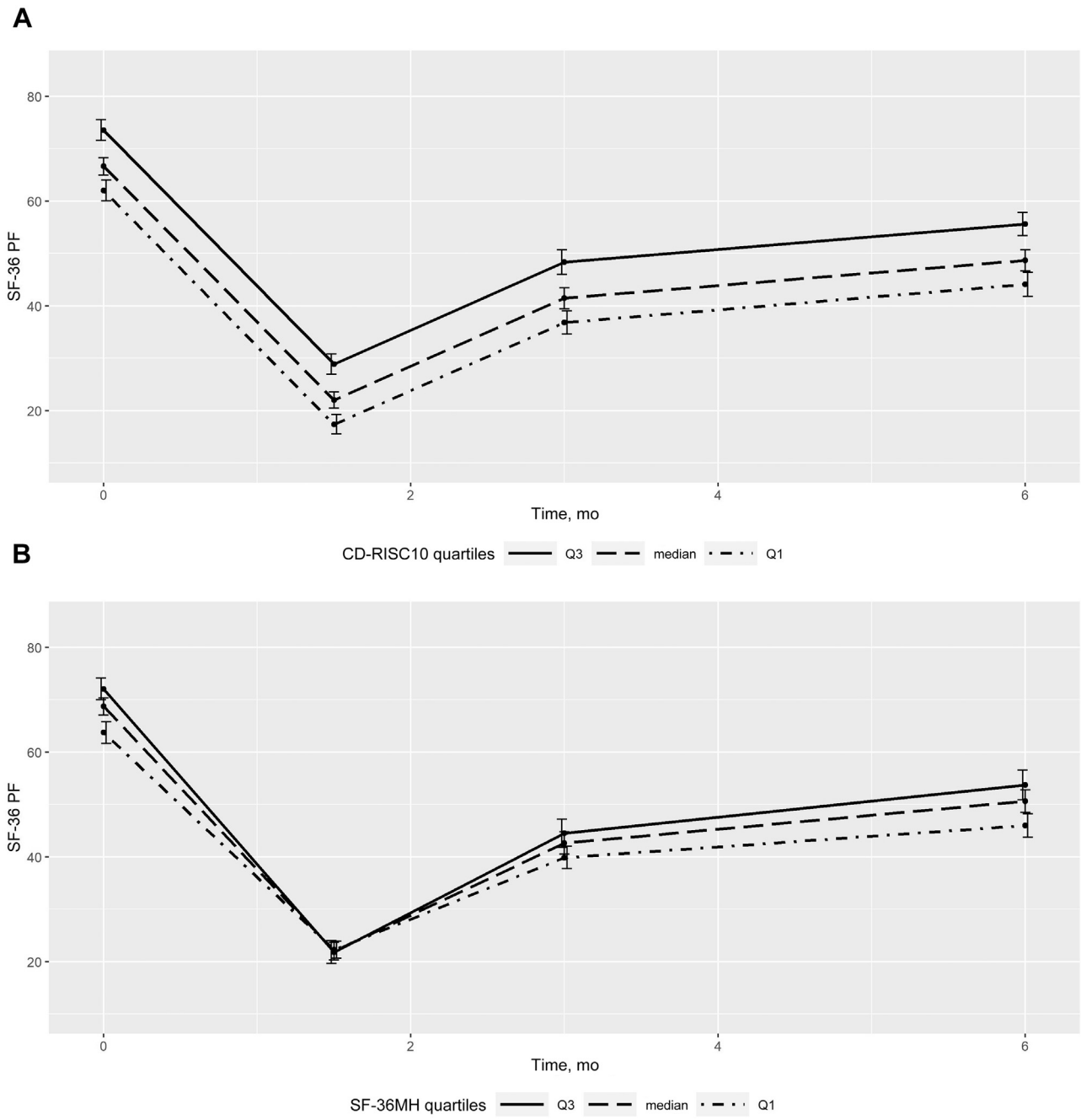

Fig. 1. (A) Modeled trajectories of physical function for first quartile (Q1), median, and third quartile (Q3) of prefracture psychological resilience. (B) Modeled trajectories of physical function for first quartile (Q1), median, and third quartile (Q3) of prefracture general mental health scores.

exercise and mobilizing social resources, which in turn translates to better quality of life. In the case of hip fracture, older adults with higher psychological resilience may be more willing to engage in rehabilitation or other recovery-promoting activities, leading to better physical function. Because of the lack of data, our study was unable to explore whether engagement in rehabilitation mediates or moderates the associations between psychological resilience and physical function, which could be a topic for future study.

Our findings were robust to sensitivity analyses, except when we used SF-36 PCS and MCS instead of SF-36 PF and MH, which yielded a positive yet nonsignificant association between psychological resilience and physical function. This may be due to higher correlation of psychological resilience with SF-36 MCS than with SF-36 MH (Pearson correlation 0.44 vs 0.35), which may require larger sample size to achieve statistical significance.

Our study has several limitations. First, because of the unexpected nature of a hip fracture, prefracture physical function was based on recall. Nevertheless, retrospective collection of patient-reported outcomes for pre-event health status has been shown to be comparable with prospective collection.[27] Second, although the recovery of physical function may take beyond a year, our follow-up ended at 6 months after hip fracture surgery, as systematic reviews[1,2] have shown that most recovery of physical function happens within the first 6 months. Third, although our study conceptualized psychological resilience as a distinct construct, many of its determinants are likely to include features of mental health. Without attempting to disentangle

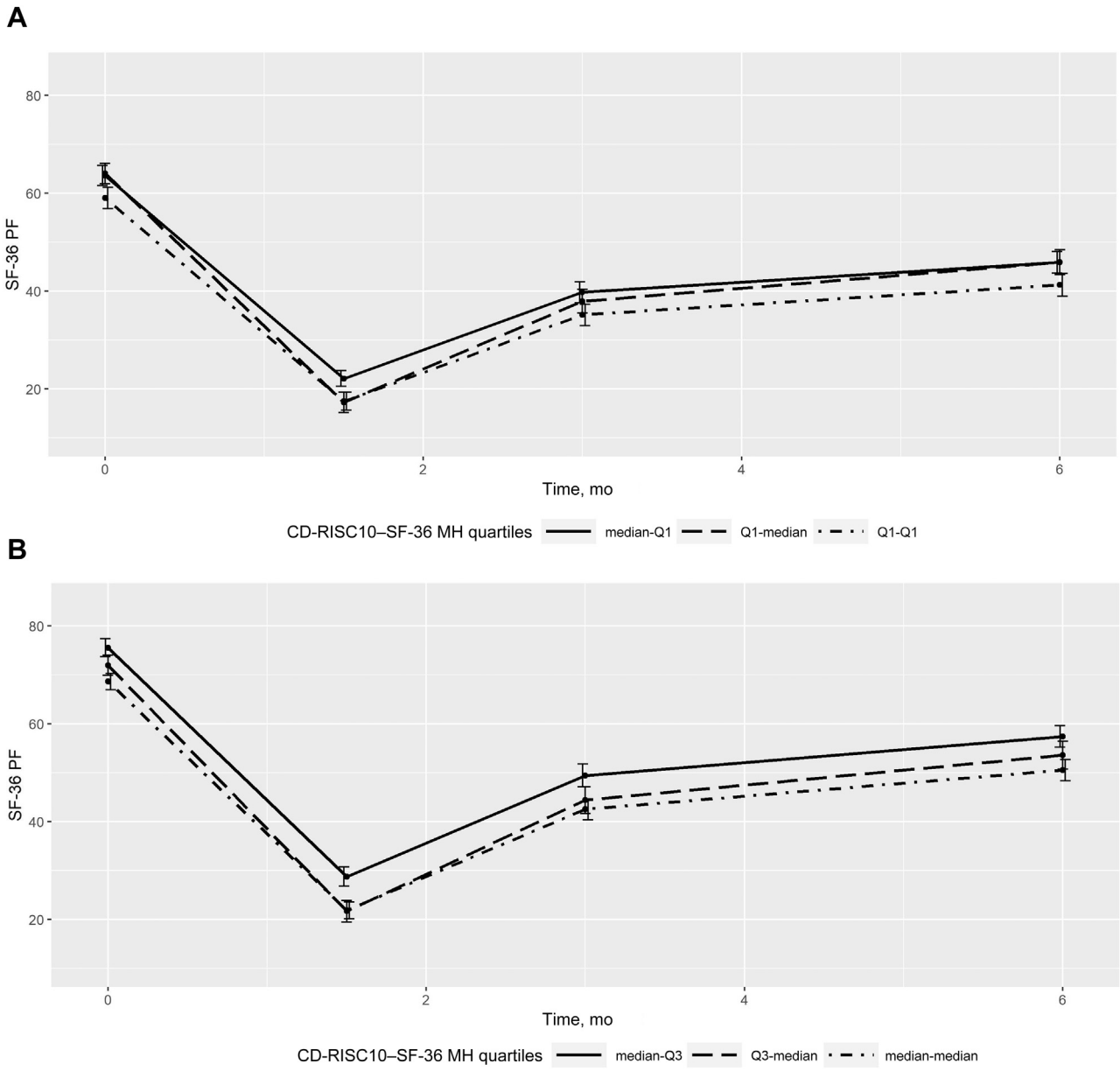

Fig. 2. (A) Modeled trajectories of physical function for (1) median prefracture psychological resilience and first quartile (Q1) of prefracture mental health (solid line); (2) Q1 prefracture psychological resilience and median prefracture mental health (dashed line); (3) Q1 prefracture psychological resilience and Q1 prefracture mental health (dot-dashed line). (B) Modeled trajectories of physical function for (1) third quartile (Q3) prefracture psychological resilience and median prefracture mental health (solid line); (2) median prefracture psychological resilience and Q3 prefracture mental health (dashed line); (3) median prefracture psychological resilience and median prefracture mental health (dot-dashed line).

these latent relationships, we adjusted for general mental health based on the SF-36. Our data were also limited to patients who returned or were contactable for follow-up. The reasons for loss to follow-up were unknown, but likely because of multiple reasons such as reliance on caregivers for mobility, patients not perceiving the values of follow-up, or death.[28] Previous local studies[29,30] reported a 1-year mortality rate of 27%. As survival status was unknown for patients lost to follow-up, our analyses were also unable to account for competing risk of death. Thus, our findings would only be applicable to those who survived. It should be noted that although there are various ways the term "resilience" is used in the literature, our focus here is on "psychological resilience" as a characteristic that fosters the ability to adapt positively to adverse life circumstances, measured here by CD-RISC10. Some researchers also define resilience as a trait (a fixed attribute) or "recovery"[31]; our findings may not be applicable to these definitions. We also focused on prefracture psychological resilience and prefracture general mental health to examine whether these factors may be worthwhile interventional targets at baseline (during admission) to improve physical function. It would be useful for future studies to examine the mechanisms by which high psychological resilience confers benefits in physical function among older adults with hip fracture, as well as to disentangle the relationships between psychological resilience and related constructs such as coping.

Our findings have several clinical and policy implications. They highlight the importance of psychological factors, specifically prefracture psychological resilience and prefracture general mental health on physical function recovery after hip fracture surgery. Psychological resilience has been shown to be amenable by interventions[32]; this suggests that targeting psychological resilience

may also benefit the physical function of older adults with hip fracture. For older adults with hip fracture, such interventions may comprise psychoeducation and cognitive behavioral therapy and could be provided by trained nurses, therapists, or dedicated psychologists as part of the multidisciplinary management in acute setting and beyond discharge.[32,33] Although not designed to improve psychological resilience, a recent study among older adults with hip fracture[34] illustrates the possibility to incorporate psychological intervention alongside rehabilitation program for this patient group. It would also be valuable to measure and to compare the behaviors of those with different levels of psychological resilience. Whether or not psychological resilience can be improved, it could be useful to understand the behaviors that are associated with psychological resilience; incentivizing these behaviors alone may also improve physical function after hip fracture.

Conclusions and Implications

Prefracture psychological resilience had an association with physical function up to 6 months after hip fracture surgery, independent of prefracture general mental health. This points to the importance of psychological resilience among older adults at risk of acute adversity such as hip fracture. Besides highlighting the potential for interventions targeting psychological resilience among older adults receiving hip fracture surgery, our findings also call for more studies on psychological factors affecting physical function recovery after hip fracture surgery.

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Appendix

Supplementary Table 1
Characteristics of Patients With and Without Complete Data

Characteristics	Mean ± SD or Count (%)	
	Complete Data (n = 105)	Incomplete Data (n = 47)
Age,* y	74.4 ± 9.0	77.8 ± 7.3
Gender		
Male	30 (28.6)	12 (25.5)
Female	75 (71.4)	35 (74.5)
Ethnicity		
Chinese	96 (91.4)	43 (93.1)
Malay	4 (3.8)	2 (4.3)
Indian	5 (4.8)	2 (4.3)
Type of fracture		
Neck of femur	69 (65.7)	32 (68.1)
Intertrochanteric	29 (27.6)	12 (25.5)
Others	7 (6.7)	3 (6.4)
Type of treatment		
Internal fixation	58 (55.2)	19 (40.4)
Arthroplasty	47 (44.8)	28 (59.6)
Fallen in the past 1 y		
No	81 (77.1)	31 (66.0)
Yes	24 (22.9)	16 (34.0)
Chronic disease count	0.7 ± 0.9	0.6 ± 0.7
Prefracture psychological resilience*,†	28.9 ± 5.9	26.4 ± 7.9
Prefracture general mental health*,‡	87.1 ± 14.6	87.6 ± 16.4

*Significantly different between samples with and without complete data.
†Measured by the 10-item Connor-Davidson Resilience Scale (CD-RISC10).
‡Measured by SF-36 mental health subscale (SF-36 MH).

Supplementary Table 2
Association of Prefracture Psychological Resilience and Prefracture General Mental Health (Measured by SF-36 MH) With Physical Function (Measured by SF-36 PF) at Prefracture and 1.5, 3, and 6 Months After Hip Fracture Surgery, for Subset of Patients With Complete (n = 105) and Incomplete Data (n = 47)

Variables of Interest	Complete Data (n = 105)			Incomplete Data (n = 47)		
	Estimate	95% CI	*P* Value	Estimate	95% CI	*P* Value
Prefracture psychological resilience (time-invariant estimates)	1.04	0.46, 1.61	<.001	0.95	0.28, 1.63	.006
Prefracture general mental health (time-varying estimates)			<.001*			<.001*
Prefracture	0.41	0.10, 0.72	.009	0.58	0.28, 0.88	<.001
1.5-mo	0.06	−0.22, 0.34	.69	0.02	−0.25, 0.30	.88
3-mo	0.25	−0.08, 0.58	.13	0.26	−0.22, 0.75	.29
6-mo	0.40	0.04, 0.76	.028	0.47	0.09, 0.86	.016

Adjusted for age, gender, ethnicity, chronic disease counts, type of fracture, type of surgery, past falls, and time, assuming the association is time-invariant for psychological resilience and time-varying for mental function in a single model.
*This is the *P* value for the interaction term between general mental health and time.

Supplementary Table 3
Association of Prefracture Psychological Resilience and Prefracture General Mental Health (Measured by SF-36 MH) With Physical Function (Measured by SF-36 PF) at Prefracture and 1.5, 3, and 6 Months After Hip Fracture Surgery Among Those ≥60 Years Old (n = 146)

Variables of Interest	Among Those ≥60 y Old		
	Estimate	95% CI	*P* Value
Prefracture psychological resilience (time-invariant estimates)	1.11	0.67, 1.55	<.001
Prefracture general mental health (time-varying estimates)			<.001*
Prefracture	0.43	0.19, 0.67	<.001
1.5-mo	−0.01	−0.22, 0.19	.90
3-mo	0.23	−0.03, 0.50	.09
6-mo	0.42	0.12, 0.72	.006

Adjusted for age, gender, ethnicity, chronic disease counts, type of fracture, type of surgery, past falls, and time, assuming the association is time-invariant for psychological resilience and time-varying for mental function in a single model.

*This is the *P* value for the interaction term between general mental health and time.

Supplementary Table 4
Association of Prefracture Psychological Resilience and Prefracture General Mental Health (Measured by SF-36 MCS) With Physical Function (Measured by SF-36 PCS) at Prefracture and 1.5, 3, and 6 Months After Hip Fracture Surgery (N = 152)

Variables of Interest	SF-36 PCS as Measure of Physical Function		
	Estimate	95% CI	*P* Value
Prefracture psychological resilience (time-invariant estimates)	0.14	−0.04, 0.32	.12
Prefracture general mental health (time-varying estimates)			<.001*
Prefracture	0.14	−0.01, 0.28	.07
1.5-mo	−0.07	−0.23, 0.08	.36
3-mo	0.26	0.09, 0.43	.003
6-mo	0.25	0.10, 0.39	.001

Adjusted for age, gender, ethnicity, chronic disease counts, type of fracture, type of surgery, past falls, and time, assuming the association is time-invariant for psychological resilience and time-varying for mental function in a single model.

*This is the *P* value for the interaction term between general mental health and time.

Supplementary Table 5
Association of Prefracture Psychological Resilience and Prefracture General Mental Health (Measured by SF-36 MH) With Physical Function (Measured by SF-36 PF) at Prefracture and 1.5, 3, and 6 Months After Hip Fracture Surgery, Adjusting for Changes in General Mental Health Between Prefracture and 6-Month Follow-up (N = 152)

Variables of Interest	SF-36 PF as Measure of Physical Function		
	Estimate	95% CI	*P* Value
Prefracture psychological resilience (time-invariant estimates)	1.15	0.70, 1.60	<.001
Prefracture general mental health (time-varying estimates)			<.001*
Prefracture	0.42	0.17, 0.68	.001
1.5-mo	−0.01	−0.23, 0.20	.91
3-mo	0.24	−0.03, 0.50	.08
6-mo	0.39	0.09, 0.69	.010
Change in general mental health† (time-invariant estimates)	0.15	−0.28, 0.59	.49

Adjusted for age, gender, ethnicity, chronic disease counts, type of fracture, type of surgery, past falls, changes in general mental health, and time, assuming the association is time-invariant for psychological resilience and time-varying for mental function in a single model.

*This is the *P* value for the interaction term between general mental health and time.

†Change in general mental health score per month (regression coefficient), estimated by regressing general mental health score at prefracture and 1.5, 3, and 6 months against follow-up time.