焦點議題　Focus Issues

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The Association Between Frailty Status and Different Aspects of Well-Being of Older Adults in Macao: A Community-Based Survey

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[Abstract] Background: Frailty is considered an age-related condition, which can lead to unsatisfactory health outcomes. While many factors contribute to frailty, there is a lack of evidence on which aspect of related factors contribute the most in frailty. The purpose of the present study was to understand the current frailty status of older adults in Macao, and to investigate the association between different aspects of well-being (including physical, psychological, social, cognitive and self-rated health (SRH) and the age difference in frailty. Method: A cross-sectional survey was conducted in a community. Frailty was assessed using the Fatigue, Resistance, Ambulation, Illness, Loss of Weight (FRAIL) scale. Physical, psychological, social, and cognitive well-being were assessed through different tools and questions. Logistic regression models were used to analyze the association of different aspects of well-being with frailty status. Results: Among 572 valid responses, the mean age was 74.6 (range from 65 to 94), 23.77% were in pre-frail/frail status. In models only adjusted for sociodemographic factors, participants with higher PHQ-2 scores (aOR=11.09, $p<0.001$) and poor SRH (aOR=4.36, $p<0.001$) had a significantly higher risk of being in pre-frail/frail status. The results remained after adjusting all aspects of well-being. The effect of psychological well-being on pre-frail/frail was significant higher in the older age group (aOR=20.98, $p<0.001$) than in the younger age group (aOR=8.90, $p<0.001$). The effect of SRH was higher in the younger age group (aOR=5.71, $p<0.001$) than in the older age group (aOR=3.58, $p=0.01$). Conclusions: Older adults in Macao with poor psychological well-being and SRH have higher risk of being frail. Intervention that targets psychological well-being might be an effective way to prevent frailty among older adults in Macao. This finding also encourages public health policy targeting psychological well-being improvement.

[Key Words]　frailty　psychological well-being　self-rated health　older adults　Macao

澳門老年人衰弱狀態與不同面向的幸福感之關係：一個社區研究

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【摘要】 衰弱被視為一種與年齡相關的疾病，可能導致不良的健康結果。 本研究的目的是了解澳門長者現時的衰弱狀況，並探討不同幸福感面向（包括身體、心理、社交、認知及自評健康）與衰弱的關係，以及其中的年齡差異。本研究為使用 FRAIL 量表評估社區長者衰弱程度的橫斷面調查。 透過不同的工具和問題來評估身體、心理、社交和認知健康。 使用邏輯斯迴歸模型分析幸福感的不同面向與虛弱狀態的關聯。 在 572 份有效問卷中，參與者的平均年齡為 74.6 歲（65 歲至 94 歲），23.77% 處於衰弱前期 / 衰弱狀態。 在只調整社會人口學因素的模型中，PHQ-2 得分較高（aOR=11.09，$p<0.001$）和自評健康較差（aOR=4.36，$p<0.001$）的參與者處於衰弱前期 / 衰弱狀態的風險顯著較高。在調整各面向的幸福感後，此結果仍然存在。 心理健康對衰弱前期 / 衰弱的影響在老年組（aOR=20.98，$p<0.001$）顯著高於年輕組（aOR=8.90，$p<0.001$）。 自評健康在年輕組的效果（aOR=5.71，$p<0.001$）高於老年組（aOR=3.58，$p=0.01$）。心理健康狀況和自評健康較差的澳門老年人的衰弱風險較高。 針對心理健康的介入是預防澳門長者衰弱的有效方法。 這項發現也鼓勵針對改善心理健康的公共衛生政策。

【關鍵詞】 衰弱　心理健康　自評健康　老年人　澳門

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1　Background

　　Frailty has been long discussed in clinical and academic settings (Clegg et al., 2013; Rockwood, 2005; Van Kan et al., 2008). However, international societies had not reached a consensus on the operational definition of frailty until 2012, which indicated that physical frailty is a medical syndrome and called for attention from different fields (Morley et al., 2013). Frailty has been considered as the result of age-related physiological decline (Fried et al., 2001; Kirkwood, 2005). People with frailty are characterized as having reduced strength and physical function (Mello et al., 2014; Morley et al., 2013; Niederstrasser et al., 2019), which increases their risk of falls, disability, hospitalization, death (Clegg et al., 2013; Fried et al., 2001; Li et al., 2015; Morley et al., 2013), as well as cognitive impairment (Alencar et al., 2013; Borges et al., 2019; Chong et al., 2015; Kojima, Taniguchi et al., 2016). A systematic review revealed that the prevalence of frailty among community-dwelling older adults increases with age group; from 4% in younger- group (65-69years) to 26% in oldest group (85 years and above) (Collard et al., 2012). The same trend appeared in Asia as well (He et al., 2019; Kojima et al., 2017; Woo et al., 2015). In addition to increased age, risk factors of frailty also include inflammation (Welstead et al., 2020), multimorbidity, lifestyle (i.e. sedentary behavior, smoking, alcohol consumption), obesity and chronic pain (Feng et al., 2017; Hanlon et al., 2018; Mello et al., 2014; Niederstrasser et al., 2019; Vetrano et al., 2019), and frailty lead to lower quality of life among older adults (Kojima, Iliffe et al., 2016).

　　Nevertheless, as the concept of frailty has evolved, frailty is now suggested to be multi-dimensional (Cheung et al., 2021; Frieswijk et al., 2004), psychological and social aspects must be considered as intervention approaches besides the physical aspect. Regarding psychological aspects, older people who have depressive symptoms are at greater risk of being frail (Feng et al., 2017; Gale et al., 2014; Mello et al., 2014).

And those with social vulnerability, including lower socioeconomic status (Mello et al., 2014; Niederstrasser et al., 2019; Szanton et al., 2010), men who live alone (Kojima et al., 2020), and those who feel lonely (Sha et al., 2020), are also at higher risk of being frail.

　　With an increasing older population, the need for early intervention for frailty in Macao will increase. The Macao Special Administrative Region Government (Macao SAR Government) developed a ten-year action plan for the development of older adult services in 2016 of which medical and welfare services is an area of focus (Macao SAR Government, 2016). With the aim of maintaining an independent life among older adults, disease prevention is the main approach emphasized by the government, yet little is known about the characteristics of well-being of the older population from government data (Macao SAR Government, 2020). As chronic disease, both the cause and result of frailty, continues to be the top cause of healthcare seeking and cause of death (Health Bureau of Macao SAR Government, 2021; Statistics and Census Service of Macao SAR Government, 2021), alongside with older adults are the main public healthcare users in Macao (Leong, 2012), there is an urgent need to understand the current health status of older adults, in order to achieve independent living and healthy ageing. However, studies in the subject of older adult frailty are limited in Macao, which could impede the planning and development of reasonable resources allocation. Hence, the aim of this research was to investigate the frailty status and its association with different aspects of health status in the most aged district in Macao. This could provide insight into the frailty status among older adults in Macao and lay foundation for future intervention for frailty prevention.

2　Methods

2.1　Study Design and Participants

　　The current study is a cross-sectional survey conducted in a Macao community. According to the

sample size calculation for survey study (Charan & Biswas, 2013; Pourhoseingholi et al., 2013), this study aimed to recruit at least 384 participants, with the level of significance of 0.5, absolute error of 5% and at type 1 error of 5%. Individuals were eligible if they were 1) Macao resident and living in Sac Pai Van public housing cluster; 2) aged 65 years or above; 3) able to speak and understand Cantonese or Mandarin, and 4) able to understand and give informed consent. Individuals were not included if they were 1) diagnosed with dementia or 2) not able to communicate due to hearing problems or mental illness. Ethical approval was obtained from the Research and Management Department of Kiang Wu Nursing College of Macau. Participants were informed of the study's purpose and their right to withdraw at any time. Informed consent was obtained from all participants agreeing to participate.

2.2 Instrument

The study employed interviews using a structured questionnaire which included four sections. The first section was frailty status. The FRAIL scale, which includes Fatigue, Resistance, Ambulation, Illness, and Loss of Weight, was used to determine the frailty status. The FRAIL scale was proposed by the International Academy on Nutrition and Aging (Van Kan et al., 2008), and has been widely used with good to acceptable reliability and validity (Aprahamian et al., 2017; Dong et al., 2018; Li et al., 2015; Malmstrom et al., 2014; Maxwell et al., 2018; Morley et al., 2012). The Chinese version of the FRAIL scale was utilized in this study. The scale includes five self-reported components, each component was scored 1 or 0 point according to answers from participants. The total score of the scale was 0 to 5, representing different frailty status (0=robust, 1-2=pre-frail, 3-5=frail). Fatigue was assessed by asking "how much time during the past four weeks have you felt tired?" Participants were presented with 5 options of "all of the time", "most of the time", "sometimes", "rarely" and "never". Participants who answered "all of the time" and "most of the time" scored 1 point. Resistance was

determined by asking if the participant had any difficulty walking up 10 steps alone and without aid; those who responded "yes" were scored 1 point. Ambulation was obtained by asking if the participant had any difficulty walking several hundred meters alone and without aid; those who responded "yes" were scored 1 point. Illness was scored 1 point for participants who reported 5 or more illnesses out of 11 options (hypertension, diabetes, cancer [other than a minor skin cancer], chronic lung disease, heart disease [heart attack, congestive heart failure, angina], asthma, arthritis, stroke, kidney disease, hypercholesterolemia, and osteophyte). Loss of weight was scored 1 point for participants who affirmed a weight decline of 5% or greater in the past month.

The second section focused on the well-being of participants. Physical well-being involved physical activities and Body Mass Index (BMI). Physical activity information was obtained from participants by asking whether they had regular exercise a week preceding the interview and were given response options of "Yes" and "No". BMI was measured and recorded using a weight scale with height measurements by a trained interviewer. Psychological well-being was assessed by using the Patient Health Questionnaire-2 (PHQ-2). Two questions were asked that enquired how often participants had been bothered by the following two problems over the past two weeks: 1) little interest or pleasure in doing things; 2) feeling down, depressed or hopeless (Kroenke et al., 2003). Participants were presented with four options for each question: "not at all", "several days", "more than half the days", "nearly every day", and were scored 0 to 3 points respectively. Participants were considered to have depressive mood if the summary score of the PHQ-2 was ≥ 3. The Cronbach's α for the scale was 0.76 among a sample from the general public in Hong Kong (Yu et al., 2011) and 0.89 in the current study. Social well-being was obtained by asking participants whether they had 1) participated in social activities (including any activities hosted by any social associations, religious organizations, community

centers or the government) in the past year, and 2) attended any courses or classes (courses to learn certain skills or knowledge) in the past three years. Participants were given response options of "Yes" and "No" for the two questions. Self-rated health (SRH) was also assessed in this section, using a single question of "In general, would you say your health is?" with options of "very good," "good," "fair," "poor" or "very poor". It has been widely used in general population surveys.

The third section was to collect socio-demographic information including age, gender, living condition, education level, marital status, number of children and religious beliefs.

The last section was to assess cognitive status of the participant. The Mini-Cog was utilized, which includes 3-word recall and a clock-drawing task and has good sensitivity and specificity (Borson et al., 2000; Borson et al., 2003). Trained interviewers first instructed the participant to listen to three words carefully, then asked the participant to repeat immediately and to remember. After immediate 3-word recall, participant was asked to draw a clock that has all the numbers and place it as ten minutes past eleven o'clock on a paper with a preprinted circle. The drawing was assessed by the research team to determine if it was normal. When the clock-drawing task was finished, participants were asked to repeat the three words again, each word recalled correctly without any hints was considered a success. Participants with 3 words recalled (no need to consider the clock-drawing result) and those with 1 to 2 words recalled and a normal clock were also considered passing the Mini-Cog assessment, suggesting no cognitive impairment. Participants who recalled 1 to 2 words but had an abnormal clock, and those with 0 words recalled were considered failing the Mini-Cog assessment. Those who failed the Mini-Cog assessment were further administered the Montreal Cognitive Assessment (MoCA) assessment to determine the cognitive status of the participant. Participants with MoCA result of >16th percentile were considered to

have no cognitive impairment and those with MoCA result of ≤16th percentile were considered to have cognitive impairment.

2.3 Recruitment/ Data collection

We recruited participants from a community center for older adults in Sac Pai Van public housing cluster. There were about 300,000 persons living in the community in 2020 (Islands District Community Service Advisory Committee of Macao SAR, 2020). The community center has a mass member network of older people living in the community, which has more than 1,800 members over the age of 55. An invitation letter was distributed to the mailbox to selected units, inviting those who met the inclusion criteria to contact the community center and schedule an interview time. Participants were individually interviewed by a trained interviewer in the older adult community center. Verbal consent was obtained from all participants prior to the face-to-face interview. Participants were informed that they could stop the interview at any time or skip questions they did not want to answer. Data was collected from September 2019 to October 2020 (recruitment was temporary ceased between January and April 2020 due to the COVID-19 pandemic).

2.4 Statistical Analysis

Raw data were coded in Microsoft Office Excel 2013 and transferred to the Statistical Package for the Social Sciences Version 22 (SPSS, v22) for data manipulation and statistical analyses. Univariate analysis was performed to summarize the socio-demographic characteristics, physical, psychological, social well-being, cognitive status and frailty status (robust and pre-frailty/frailty) of participants. Chi-square or Fisher's exact tests were performed for categorical variables. To investigate the associated factors of frailty status, logistic regressions were performed, adjusting for socio-demographic characteristics. Associations of frailty outcomes with physical, psychological, social and cognitive well-being were estimated using odds ratio (OR) with their 95%

confidence intervals. The regression models were built by first adding demographic characteristics, and subsequently adding physical, psychological, social and cognitive well-being to examine the separate contribution of each variable to frailty status (0=robust; 1=pre-frail/frail). Only data from participants who finished all assessments were entered in the regression models. The level of statistical significance of all tests was set at $p<0.05$.

2.5　Ethical approval

Ethical approval for the study was obtained from the Research Management and Development Department of Kiang Wu Nursing College of Macau (reference: 2019MAY01). Participatns were informed of the study's purpose and their right to withdraw at any time. Informed consent was obtained from all participants agreeing to participate.

3　Result

3.1　Participant characteristics

We received 662 responses, of which 572 were valid. Responses were regarded as invalid if they did not meet the inclusion criteria. Among the valid responses, almost 70% of participants were female, participants were aged between 65 and 94 years (mean age 74.6±6.00 years). Most had a primary school or below education level, were married or cohabited, had children, did not have religious beliefs, and were living with others. Regarding physical well-being, over 85% of participants had regular exercise in the past week, almost 50% of participants had normal BMI; however, 47% of participants were overweight or obese. Over 90% of participants did not have depressive mood (based on the PHQ-2 scores) at the time of the investigation. Most of the participants had participated in at least one social activity in the past year, only 26% attended course/class in the past three years. Regarding cognition and SRH, 13% of participants had cognitive impairment and over 70% rated their health as fair, bad or very bad (Table 1).

3.2　Prevalence of frailty

According to the FRAIL scale assessment, about a quarter of the participants were in pre-frail or frail state, and most of them did not have cognitive impairment (mean scores 0.31±0.62). Among the 5 components of the FRAIL scale, the most prevalent component was fatigue. None of the participants had lost weight 5% or over in the past month. Among all variables, gender, education, PHQ-2 score and SRH were significantly correlated with frailty status (Table 1).

3.3　Factors associated with frailty status

The results of multiple logistic regression revealed that the score of PHQ-2 and SRH were associated with frailty status. Participants with higher PHQ-2 score were 11 times more likely to be in pre-frail/frail status (aOR=11.09, $p<0.001$) when compared to their counterparts with lower scores. Moreover, those who rated their health as not good were 4 times more likely to be in pre-frail/frail status (aOR=4.36, $p<0.001$) than those who rated their health as good. After accounting for other well-being variables, the results remained the same (aOR=11.49 for PHQ-2 score, $p<0.001$; aOR=4.19 for SRH, $p<0.001$) All other variables were not statistically significant (Table 2).

According to the references reviewed, prevalence of frailty varies in different age groups. Also, age differences were observed in factors associated with frailty status. The categorization of younger and older age groups in this study was determined by the age distribution of recruited participants. For participants with depressive mood, the risk of being frail/pre-frail among those aged 65 to 74 years was substantially lower than those aged 75 years and above (aOR=8.90 vs. aOR=20.98). The influence of SRH on frailty status was higher in those 65 to 74 years of age than those aged 75 years and above (aOR=5.71 vs. aOR=3.58) (Table 3). Due to small sample of male participants, sex stratification analysis was not performed.

Table 1　General characteristics and well-being of participants

Variables	Total (N=572) n	%	Robust (N=436) n	%	Pre-frail/ Frail (N=136) n	%	p-value
Gender							0.03
Male	174	30.42	143	32.80	31	22.79	
Female	398	69.58	293	67.20	105	77.21	
Age (year)							0.62
65-74	309	54.02	238	54.59	71	52.21	
75-84	222	38.81	165	37.84	57	41.91	
≥85	41	7.17	33	7.57	8	5.88	
Education							0.01
None	96	16.78	71	16.28	25	18.38	
Primary school or below	310	54.20	225	51.61	85	62.50	
Junior high or higher	166	29.02	140	32.11	26	19.12	
Marital status							0.23
Married/ cohabited	325	56.82	254	58.26	71	52.21	
Not married*	247	43.18	182	41.74	65	47.79	
Living							0.42
Alone	244	42.66	186	42.66	58	42.65	
With spouse	261	45.63	203	46.56	58	42.65	
With others†	67	11.71	47	10.78	20	14.71	
Children							0.14
No children	44	7.69	38	8.72	6	4.41	
Have children	528	92.31	398	91.28	130	95.59	
Religious belief							0.84
Yes	223	38.99	169	38.76	54	39.71	
None	349	61.01	267	61.24	82	60.29	
Exercise in the past week							0.11
Yes	495	86.54	383	87.84	112	82.35	
No	77	13.46	53	12.16	24	17.65	
Physical activities in the past week							0.51
Yes	61	10.66	47	10.78	14	10.29	
No	511	89.34	389	89.22	122	89.71	
BMI							0.38
Normal (18.5-24.9)	280	48.95	220	50.46	60	44.12	
Underweight (<18.5)	23	4.02	18	4.13	5	3.68	
Overweight/ obesity (≥25.0)	269	47.03	198	45.41	71	52.21	
PHQ-2 score							0.00
0-2	521	91.08	423	97.02	98	72.06	
3-6	51	8.92	13	2.98	38	27.94	
Participated in social activities in the past year							0.59
Yes	407	71.15	313	71.79	94	69.12	
No	165	28.85	123	28.21	42	30.88	
Attended course in the past 3 years							0.74
Yes	150	26.22	116	26.61	34	25.00	
No	422	73.78	320	73.39	102	75.00	
Self-rated health							0.00
Good	159	27.80	145	33.26	14	27.80	
Not good	413	72.20	291	66.74	122	72.20	
Cognitive impairment (N=506)							0.88
No	439	86.76	331	86.88	108	86.40	
Yes	67	13.24	50	13.12	17	13.60	
FRAIL scale score							-
Robust (score 0)	436	76.22	-	-	-	-	
Pre-frail (score 1-2)	131	22.90	-	-	-	-	
Frail (score 3-5)	5	0.87	-	-	-	-	
FRAIL Scale components							-
Fatigue	105	18.4	-	-	-	-	
Resistance	42	7.3	-	-	-	-	
Ambulation	20	3.5	-	-	-	-	
Illness	11	1.9	-	-	-	-	
Loss of weight	0	0	-	-	-	-	

* Including unmarried, separated, divorced, and widowed.
†With children, spouse and children, domestic helper, and/or relatives.

Table 2　Multiple logistic regression models of frailty status (0=robust; 1=pre-frail/frail) (*N*=506)

Variables	Sociodemographic-adjusted model[*]							Fully adjusted model[†]						
	B	SE	Wald	*p*-value	Exp (*B*)	95% CI for Exp (*B*) Lower	Upper	*B*	SE	Wald	*p*-value	Exp (*B*)	95% CI for Exp (*B*) Lower	Upper
Constant								-3.76	0.93	16.41	0.00	0.02		
Sociodemographic factors														
Gender (ref.: Male)														
Female	0.31	0.26	1.44	0.23	1.37	0.82	2.28	0.13	0.30	0.19	0.67	1.14	0.63	2.06
Age (year) (ref.: 65-74)														
75-84	0.13	0.21	0.37	0.54	1.14	0.75	1.74	0.18	0.25	0.51	0.48	1.20	0.73	1.95
≥85	-0.46	0.44	1.08	0.30	0.63	0.27	1.50	0.19	0.52	0.13	0.72	1.21	0.44	3.33
Living (ref.: Alone)														
With spouse	0.47	0.40	1.38	0.24	1.60	0.73	3.49	0.12	0.47	0.06	0.80	1.12	0.45	2.80
With others	0.51	0.35	2.11	0.15	1.66	0.84	3.31	0.38	0.43	0.78	0.38	1.47	0.63	3.44
Education (ref.: None)														
Primary school or below	0.15	0.28	0.28	0.60	1.16	0.67	2.01	0.16	0.35	0.22	0.64	1.18	0.59	2.34
Junior high or higher	-0.49	0.34	2.01	0.16	0.62	0.31	1.20	-0.29	0.41	0.50	0.48	0.75	0.33	1.68
Marital status (ref.: Married/ cohabited)														
Not married	0.55	0.38	2.11	0.15	1.73	0.83	3.60	0.28	0.44	0.41	0.52	1.32	0.56	3.12
Children (ref.: No children)														
Have children	0.68	0.47	2.08	0.15	1.97	0.78	4.94	0.55	0.53	1.08	0.30	1.73	0.62	4.84
Religious belief (ref.: Yes)														
None	0.00	0.21	0.00	0.99	1.00	0.67	1.50	-0.13	0.24	0.29	0.59	0.88	0.55	1.41
Physical well-being														
Exercise in the past week (ref.: Yes)														
No	0.47	0.28	2.79	0.10	1.61	0.92	2.80	-0.17	0.38	0.20	0.66	0.85	0.40	1.78
Physical activities in the past week (ref.: Yes)														
No	-0.02	0.33	0.00	0.96	0.98	0.51	1.88	0.18	0.39	0.22	0.64	1.20	0.56	2.57
BMI (ref.: normal)														
Underweight	0.01	0.54	0.00	0.99	1.01	0.35	2.93	-0.05	0.64	0.01	0.94	0.95	0.27	3.37
Overweight/ obesity	0.21	0.21	1.01	0.31	1.24	0.82	1.86	0.28	0.24	1.32	0.25	1.32	0.82	2.12
Psychological well-being														
PHQ-2 score (ref.: 0-2)														
3-6	2.41	0.35	48.41	0.00	11.09	5.63	21.83	2.44	0.41	35.76	0.00	11.49	5.16	25.56
Social well-being														
Participated in social activities in the past year (ref.: Yes)														
No	0.22	0.23	0.95	0.33	1.25	0.80	1.96	0.04	0.27	0.03	0.87	1.04	0.61	1.79
Attended course in the past 3 years (ref.: Yes)	0.06	0.24	0.06	0.80	1.06	0.66	1.70	0.18	0.28	0.44	0.50	1.20	0.70	2.07
No														
Cognitive well-being														
Cognitive impairment (n=506) (ref.: No)														
Yes	-0.16	0.33	0.22	0.64	0.85	0.45	1.64	-0.25	0.38	0.44	0.51	0.78	0.37	1.64
Self-rated health (ref.: Good)														
Not good	1.47	0.31	23.12	0.00	4.36	2.39	7.93	1.43	0.34	17.39	0.00	4.19	2.14	8.20

*Adjusted for sociodemographic factors and in each aspect of well-being.
†Adjusted for sociodemographic factors and all aspect of well-being.

Table 3　Multiple logistic regression models of frailty status (age stratification) (0=robust; 1=pre-frail/frail) (*N*=506)

Variables	Aged 65-74 (*N*=278)							Aged ≥75 (*N*=228)						
	B	SE	Wald	*p*-value	Exp (*B*)	95% CI for Exp (*B*)		*B*	SE	Wald	*p*-value	Exp (*B*)	95% CI for Exp (*B*)	
						Lower	Upper						Lower	Upper
Constant	-4.22	1.32	10.19	0.00	0.01			-3.77	1.62	5.43	0.02	0.02		
Sociodemographic factors														
Gender (ref.: Male)														
Female	0.05	0.40	0.02	0.89	1.06	0.49	2.29	0.24	0.51	0.23	0.63	1.28	0.47	3.47
Living (ref.: Alone)														
With spouse	0.62	0.74	0.69	0.41	1.85	0.43	7.94	0.33	0.76	0.18	0.67	1.38	0.31	6.17
With others	1.38	0.75	3.36	0.07	3.99	0.91	17.51	-0.47	0.66	0.51	0.48	0.62	0.17	2.28
Education (ref.: None)														
Primary school or below	0.06	0.57	0.01	0.92	1.06	0.35	3.23	0.16	0.48	0.12	0.73	1.18	0.46	3.00
Junior high or higher	-0.31	0.63	0.24	0.62	0.73	0.21	2.54	-0.49	0.59	0.68	0.41	0.61	0.19	1.95
Marital status (ref.: Married/ cohabited)														
Not married	0.57	0.70	0.65	0.42	1.76	0.45	6.98	0.73	0.72	1.02	0.31	2.08	0.50	8.54
Children (ref.: No children)														
Have children	0.41	0.61	0.46	0.50	1.51	0.46	5.01	0.49	1.15	0.19	0.67	1.64	0.17	15.49
Religious belief (ref.: Yes)														
None	-0.32	0.34	0.91	0.34	0.73	0.38	1.40	0.13	0.38	0.12	0.73	1.14	0.54	2.43
Physical well-being														
Exercise in the past week (ref.: Yes)														
No	0.05	0.54	0.01	0.92	1.06	0.37	3.02	-0.45	0.60	0.57	0.45	0.64	0.20	2.05
Physical activities in the past week (ref.: Yes)														
No	0.33	0.51	0.40	0.53	1.38	0.51	3.80	0.12	0.63	0.04	0.85	1.13	0.33	3.84
BMI (ref.: normal)														
Underweight	0.45	1.05	0.18	0.67	1.56	0.20	12.17	-0.34	0.85	0.16	0.69	0.71	0.13	3.74
Overweight/ obesity	0.18	0.33	0.29	0.59	1.19	0.62	2.28	0.26	0.38	0.48	0.49	1.30	0.62	2.74
Psychological well-being														
PHQ-2 score (ref.: 0-2)														
3-6	2.19	0.53	17.33	0.00	8.90	3.18	24.91	3.04	0.71	18.21	0.00	20.98	5.18	84.93
Social well-being														
Participated in social activities in the past year (ref.: Yes)														
No	-0.30	0.38	0.59	0.44	0.74	0.35	1.58	0.56	0.42	1.82	0.18	1.76	0.77	4.00
Attended course in the past 3 years (ref.: Yes)														
No	0.32	0.38	0.70	0.40	1.38	0.65	2.92	-0.02	0.42	0.00	0.96	0.98	0.43	2.24
Cognitive well-being														
Cognitive impairment (*N*=506) (ref.: No)														
Yes	-0.82	0.67	1.48	0.22	0.44	0.12	1.64	-0.12	0.52	0.06	0.81	0.88	0.32	2.43
Self-rated health (ref.: Good)														
Not good	1.74	0.54	10.57	0.00	5.71	2.00	16.34	1.28	0.47	7.50	0.01	3.58	1.44	8.93

4 Discussion

To our knowledge, this is the first study examining the association between different aspects of well-being (i.e. physical, psychological, social and cognitive) and frailty status among community-dwelling older adults in Macao. The FRAIL scale was utilized in the current study since it is recommended as a screening tool in community settings (Dong et al., 2018; Li et al., 2015; Malmstrom et al., 2014; Morley et al., 2012). Over 75% of participants in the current study were in robust status. The prevalence of frailty in the current sample was lower than studies conducted in communities using the same measurement (Dong et al., 2018; Woo et al., 2015).

Our study revealed that psychological well-being was an independent factor associate with frailty in older adults in Macao, which is similar to previous studies (Feng et al., 2017; Gale et al., 2014; Mello et al., 2014). Aprahamian et al. (2017) suggested that the FRAIL scale has two dimensions, physical performance (resistance and ambulation) and health status (fatigue, illnesses, and weight loss), the later was more associated with depressive symptoms (Aprahamian et al., 2017). In our sample of participants, almost 20% were positive in the fatigue component, this may contribute to the significant effect of psychological well-being on frailty status. Frailty and depressive symptoms are common among older adults, there are discussions about the reciprocal relationship between the two conditions (Buigues et al., 2015; Collard et al., 2017; Collard et al., 2015; Soysal et al., 2017). A previous study also proposed that specific types of depression, i.e. vascular depression, is an early symptom for frailty (Paulson & Lichtenberg, 2013). Although we did not observe significant associations between age and frailty status in the pooled analysis, there were age differences regarding the effects of psychological well-being on frailty status. Participants aged 75 years and above who scored higher in PHQ-2 had significant higher risk of being in pre-frail/frail status. This finding indicates that interventions regarding psychological health for frailty may be more effective, especially among older age groups in Macao.

SRH is a valid measure of health status and a predictor of subsequent health outcomes in older adults, such as functional decline, frailty, mortality, and hospital utilization (Desalvo et al., 2006; Gijzel et al., 2017; Gyasi & Phillips, 2018; Idler & Benyamini, 1997; Viljanen et al., 2021). However, studies suggest that the relationship between SRH and frailty is bidirectional (Abu et al., 2020; Chu et al., 2021; Ocampo-Chaparro et al., 2013). The results of this present study revealed that poor SRH was associated with frailty status, especially in younger age groups (64 to 75 years) in our sample. Poorer SRH is associated with elevated inflammatory markers and dysfunction among older adults (Christian et al., 2011; Martin, 2014), which could explain the mechanism of the relationship of poor SRH and frailty (Welstead et al., 2020). To identify frailty early, therefore, attention is warranted with poor SRH older adults.

Although frailty is multi-dimensional (Cheung et al., 2021; Frieswijk et al., 2004), we did not observe the effect of physical, social and cognitive well-being on the risk of frailty status. Low physical functioning is a characteristic of frailty; physical activities, therefore, are considered to reduce frailty (Mello et al., 2014; Morley et al., 2013; Niederstrasser et al., 2019). The result of no association between physical activity or exercise in this study might be due to the low frailty rate in this study. Furthermore, over 95% of those who exercised in the past week were engaged in low-intensity exercise, which is not adequate according to World Health Organization guidelines (World Health Organization, 2020). Nevertheless, lifestyle intervention such as physical activity and exercise are effective strategies to counteract frailty-related physical impairment among older adults (Angulo et al., 2020). On the other hand, BMI was not found to be associated with frailty. In Amiri et al. (2020)'s study, only self-reported BMI was associated with increased frailty risk. Studies reported that there is a difference between self-reported and

measured BMI (Maukonen et al., 2018), this could explain the insignificant relationship between BMI and frailty because we measured BMI using standard weight scale with height measurement.

The effect of social participation on frailty is inconsistent. While several studies revealed that social participation may decrease the risk of frailty (Kwan et al., 2019; Wang et al., 2021), others did not predict future frailty (Kamiya & Kenny, 2017). Since social participation takes various forms based on levels of individuals involvement and goals of participation (Levasseur et al., 2010), frequent participation and diverse types of participation have more positive effects on frailty (Xie & Ma, 2021). We assessed social participation with the questions of one-year social activity and three-year course participation, the lengthy time frame of the question may contribute to the result of insignificant relationship between social participation and frailty.

Cognitive impairment was not an associated factor of frailty in this study, which is not consistent with previous studies that have demonstrated higher cognitive impairment rates in population with frailty (Jürschik et al., 2012; Yassuda et al., 2012). Ní Mhaoláin et al. (2011)'s study also showed no association between cognitive impairment and frailty, suggesting that frailty and cognitive impairment may have different physiological pathways. Although no significant association between cognitive well-being and frailty status was found in the current study, previous studies suggest that frailty predicts increased rate of cognitive decline in older adults (Boyle et al., 2010; Buchman et al., 2007; Buchman et al., 2008). Hence, cognitive well-being among older adults is worth noting.

Since disease prevention is the main approach to maintaining independence functioning of older adults in Macao, frailty screening can offer an opportunity for the early detection of frailty. In addition, studies indicate that frailty among older people is a dynamic process. The frailty state of an individual can changes over time,

whether regressing, remaining or progressing, due to different aforementioned risk factors that an individual may possess (Chong et al., 2015; Gill et al., 2006; Hardy et al., 2005; Setiati et al., 2019). Therefore, by conducting community frailty screenings, early interventions targeting the mental health of older adults can be offered, which may improve, or at least maintain, the frailty state and could offer older people a better quality of life (Gobbens & Van Assen, 2014), and reduce government's healthcare expenditure (Ensrud et al., 2018; Ensrud et al., 2020).

4.1 Limitation

Limitations of the study include its cross-sectional and self-reported nature. The results need to be validated by longitudinal studies. Since cross-sectional study could only provide correlation between variables, while longitudinal design could provide more information about the causes of frailty. Self-reported measurements might cause participants to withhold information, which could lead to reporting bias. Also, the interruption in the data collection due to the COVID-19 pandemic lockdown may have affected the nature of responses from participants. For example, some people experienced greater mental health problems during the COVID-19 pandemic lockdown, especially among older people who may have experienced isolation. Furthermore, reporting bias could have occurred because participants responded to the interview voluntarily. Most of the data were collected through self-report, rather than in-home survey, which may have reduced the availability of frail individuals who could not participate because they were homebound. Another issue involves the limitation of the generalizability of our results to a larger population because the results come from only one community. Further study is needed to measure data objectively across different communities in Macao. Although this study identified psychological well-being and SRH were associated with increased risk of frailty, confounding factors are needed to be considered in future studies, such as family

relationship and social support, which were not included in the study.

5　Conclusion

The current study showed that psychological well-being and SRH were associated with the frailty status among community-dwelling older adults in Macao, the result is more profound in the older age group (75 years of age or older). The evidence highlights the importance of strategies to improve the psychological well-being among older adults, in order to prevent frailty and to better support older adult services in an aging society.

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