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ORIGINAL RESEARCH

Distinct Trajectories of Fatigue Among Families with Post-Intensive Care Syndrome

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Purpose: This study investigated the trajectories of fatigue symptoms in post-intensive care syndrome among family members (PICS-F) and aimed to explore the sociodemographic and clinical factors related to these trajectories.

Patients and Methods: This was a longitudinal observational study conducted in an intensive care unit (ICU) of a tertiary hospital in Xiamen, China. Data were collected when adult patients were transferred from the ICU to the ordinary ward of the hospital or discharged, and at 1 month, 2 months, and 3 months later. Fatigue symptoms were assessed using the Fatigue Severity subscale, and sociodemographic and clinical information was collected. The study used latent growth mixture modelling to construct the trajectories of fatigue symptoms, and logistic regression was used to identify the factors associated with fatigue.

Results: A total of 133 family members with PICS-F were included. Four trajectories of fatigue symptoms were identified and attributed to two groups. Controlling for individual's age and severity of illness, the length of stay in the ICU and in the hospital increased the odds of belonging to the fatigue group, whereas a lower level of dependence (higher Barthel index score) was a protective factor for the non-fatigue group.

Conclusion: Four distinct trajectories of fatigue symptoms were identified. Longer ICU stays and hospitalization durations of patients may increase the risk of fatigue of PICS-F, while a lower level of dependence has the potential to reduce the risk of fatigue. Further multicenter studies with larger sample sizes and diverse populations are needed to validate this hypothesis.

Keywords: fatigue, latent growth mixture modelling, longitudinal study, post-intensive care syndrome-family

Introduction

Post-intensive care syndrome (PICS) is a new concept proposed by the Society of Critical Care Medicine in 2010,[1] and it has been used to characterize new or worsening impairments (including physical, cognitive, or mental health status) in adult patients with critical illness persisting beyond acute care hospitalization. However, apart from the effects on patients, patient critical illnesses can also influence their family members. Indeed, family members may also experience significant psychological impairments (anxiety, depression, or post-traumatic stress disorder), triggered by emotional burdens resulting from patient admission to the intensive care unit (ICU),[2] as well as physical impairments (sleep disorders or fatigue).[3,4] This phenomenon is known as post-intensive care syndrome–family (PICS-F).[1] Most studies have focused on psychological impairments in PICS-F, whereas there has been little attention to physical impairments.[5] A recent cross-sectional study in China reported a 54.8% incidence of psychological disorders among family members of ICU elderly patients; however, physical symptoms, as an important part of PICS-F, were not addressed.[6] Fatigue is a prevalent and debilitating physical symptom that occurs in 15–80% of individuals with PICS-F.[5,7] It has a negative impact on the everyday lives of family members and their ability to care for patients and support them.[8]

ICU patients often experience complex and unpredictable trajectories of recovery.[9] First, they undergo variety of invasive tests in the ICU, then they are transferred to a general ward for follow-up treatment and care once their condition

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stabilizes. This process imposes both emotional and physical burdens on their family members. Previous studies have suggested that there may be different underlying fatigue patterns of PICS-F,[10] and onset, duration, and severity of fatigue may be affected by individual characteristics.[11,12] However, past longitudinal studies used single-item analysis methods or were cross-sectional. Thus, these studies might not accurately reflect the nature of family members of ICU patients because they hypothesize that all subjects have the same development trends.[13] Unlike traditional analyses, the latent growth mixture model (LGMM) can classify a population into several latent classes based on distinct characteristics.[14] However, it has not been applied to fatigue symptoms in PICS-F. A recent narrative review has summarized risk factors for PICS,[15] including sociodemographic characteristics, ICU admission, and experience during the ICU stay, and reported that sociodemographic factors (female gender and younger age) are risk factors for depression symptom of PICS-F. However, the effect of clinical factors of patients has been ignored. Therefore, studies on PICS-F and its symptom progression over time, particularly in fatigue symptom, are still needed.

To address the limitations of past studies, the aims of this study were as follows: 1) to examine the trajectories of PICS-F's fatigue symptoms over 3 months and 2) to examine the associations of sociodemographic and clinical information with fatigue trajectories.

Materials and Methods

Study Design

We employ a single-center, longitudinal observational study, performed from January 2023 to June 2024.

Site and Samples

This study was conducted in an 18-bed ICU of a tertiary hospital in Xiamen, a city in China with a population of 5.35 million and an urbanization rate of 91.01% at the end of 2024. The inclusion criteria were as follows: 1) age above 18 years; 2) family members (including spouses, children, parents, or other next of kin) of patients who were transferred out from the ICU after at least 24-hour treatment in the ICU; 3) family members who spent most time caring for patients, as assessed by interview with family members and confirmed by the patients; 4) family members meeting the diagnostic criteria of PICS-F,1 and who had new or worsening psychological or physical impairments (ie, any score on a scale measuring anxiety, depression, post-traumatic stress disorder [PTSD], sleep disorders, or fatigue that exceeded the threshold); and 5) the participants provided their informed consent and participated voluntarily. The exclusion criteria were as follows: 1) clinical anxiety, depression before baseline assessment, or previous history of mental disease; 2) any disorder of reading, hearing, or expression; 3) revoked informed consent or lack of cooperation.

Data Collection

The participants were recruited by contact via telephone at the time of the patients' transfer out from the ICU (T1); then, an appointment was scheduled to meet in the hospital. After informing family members about the contents of the research and obtaining their consent to participate, all investigators—who were nurses with at least 3 years of experience in the ICU—were uniformly trained by an ICU nurse with more than 5 years of experience. The training covered the correct use of scales and questionnaires, allowing investigators to assist participants in completing all required assessments. It also included both theoretical instruction on study questionnaires practical exercises to develop proficiency in their administration. All participants were assessed based on whether they were in accordance with the PICS-F criteria. If the family members met the PICS-F criteria, they additionally completed demographic questions, and the patients' sociodemographic and clinical information was collected through the Hospital Information System (HIS). Subsequently, the Fatigue Severity subscale was administered at three time points, namely at 1 month (T2), 2 months (T3), and 3 months (T4) after the patients' transfer out from the ICU. The follow-up for PICS-F was conducted on the ward if patients were transferred to an ordinary ward in the hospital, or through telephone if they were discharged. The investigators reviewed data for completeness after the participants completed the survey. The participants were able to opt out at any time.

Measurement

Family members completed the sociodemographic section of the survey, which included age, gender, parent–child relationship (which included four relationships: father-son, mother-daughter, father-daughter, and mother-son), marital status, level of education, and location. The patients' sociodemographic and clinical information, including their medical diagnoses, age, payment method for medical expenses, method of admission (emergency or nonemergency), severity of illness during ICU stay, level of dependence, the length of ICU stay, and the duration of hospitalization, was collected through the HIS.

In this study, the Acute Physiology and Chronic Health Evaluation II (APACHE II),[16] which includes 34 physiological variables, was used to determine the severity of illness. The scores ranged between 0 and 71, and a higher APACHE II score indicated higher illness severity. The 34 physiological variables needed for APACHE II evaluation were obtained from the HIS. The Barthel index [BI][17] was used to assess the dependence level of the patients. BI ranges between 0 and 100, where a higher score indicates a lower level of dependence in the activities of daily living. At present, there are no accepted specific assessment and diagnostic tools for PICS-F, but the following scales have frequently been used to assess PICS-F: 1) the Hospital Anxiety and Depression Scale (HADS), commonly considered for measurement of anxiety and depression,[18] includes 14 items that cluster into two subscales (the Anxiety and the Depression subscale),[19] where scores ≥8 of either subscale suggests the presence of anxiety or depression;[20] 2) the Impact of Event Scale-Revised (IES-R), used to measure PTSD,[21] contains 22 items on three dimensions, with a score range between 0 and 4, where scores ≥1.6 suggest PTSD;[20] 3) the Pittsburgh Sleep Quality Index (PSQI), which assesses sleep disorder, contains 19 questions on seven dimensions, and has a score range between 0 and 21, where scores >5 indicate the presence of sleep disorder;[22] 4) the Fatigue Severity subscale, for assessing fatigue, contains 11 items, and scores range between 0 and 7, where scores ≥4 indicate the presence of fatigue.[23] If any of these scores exceeded the threshold, the participants were considered PICS-F in this study. In this study, the primary outcome measure was fatigue severity as assessed by the Chinese version of the Fatigue Severity subscale. Independent translation and back-translation were conducted by a Chinese scholar with foreign living experience, and the text showed a high back-translation rate (95%) and good reliability and validity (Cronbach's α score: 0.929).[24] The remaining scales in this study, namely BI (Cronbach's α score: 0.93),[25] HADS (Cronbach's α score: 0.81 for anxiety subscale, 0.74 for depress subscale),[26] IES-R (Cronbach's α score: 0.857),[27] and PSQI (Cronbach's α score: 0.852)[28] scales, were used in their Chinese versions, which had been in clinical use for many years and demonstrated good reliability and validity.

Statistical Analysis

First, the missing values of the variables were processed. When the proportion of follow-up missing and data missing rates smaller than 10%, the data were regarded as missing at random. The mean value for all variables, except for fatigue, was then used to fill in any missing data points. As for the age of the family members, there were six (4.5%) cases with missing values, which were imputed from the mean of the sample.

Second, we used Mplus software version 8.10 (Mplus, Los Angeles, CA, https://www.statmodel.com/index.shtml). LGMM was used to explore different development trajectories of fatigue symptoms of PICS-F. Tolvanen[29] showed that a sample size of more than 100, with four waves of measures, were appropriate for this study. For the Fatigue Severity subscale score, there were five (3.8%) cases with missing values at T3 and 11 (8.3%) cases with missing values at T4. The missing data were addressed by the default option in Mplus, namely the full information maximum likelihood. Although the data were not normally distributed (see Figure S1), when the absolute value of skewness was <2 and that of kurtosis was <7, the model estimated by the Maximum Likelihood estimation (the default method of parameter estimation in Mplus when the dependent variable is a continuous variable) was also acceptable.[30] The factor loadings were fixed at 0, 1, 2, and 3 to represent equidistant time points between four time measures. The first step was to determine linear or nonlinear trajectories. Namely, we fit an unconditional linear latent growth curve model (LGCM) and an unconditional nonlinear LGCM. The following fit indicators were considered to assess the goodness of fit of the two models: root mean square error of approximation (RMSEA) ≤0.05–0.1, both comparative fit index (CFI) and Tucker–Lewis Index (TLI) ≥0.90–0.95, and standardized root mean square residual (SRMR) ≤0.05–0.08.[31,32] Step 2 was to

determine the relative best model (the Mplus syntax). The intercept and slope were allowed to be freely estimated. The model was estimated from one latent class with random starting values at 200, until the proportions in one of the latent classes were <5%. We used the following criteria to select the number of classes: 1) the smaller values of Akaike information criterion (AIC),[33] Bayesian information criterion (BIC),[34] and sample size-adjusted BIC (aBIC)[35] were, the better the fit of the model; 2) the Entropy range from 0 to 1.0 but at least 0.80, where the largest entropy indicated the higher classification accuracy;[36] 3) both the Vuong-Lo-Mendell-Rubin test (VLMR) and the bootstrap likelihood ratio test (BLRT), where a p value lower than 0.05 for these two indicators indicated that k − 1 classes should be rejected.[37] Finally, theoretical interpretability of the latent classes was also taken into account.

The individuals were then allocated to the latent classes according to their highest posterior probability. According to the rule of 5 to 10 events per variable,[38,39] we limited the number of groups in the subsequent analysis. Classes with fatigue symptom were attributed to the fatigue group, while those without fatigue symptom were attributed to the non-fatigue group. Methods of description (mean and standard deviation, median and interquartile range, or number of cases and percentages) and analysis (Student's *t* test, Mann−Whitney *U*-test, or chi-square analysis and Fisher's exact test) were chosen depending on the types of variables and normality of data distribution. The association between the demographic characteristics of the family members and patients and the clinical data of the patients was tested using binary logistic regression. Description and analysis were performed using the R software version 4.3.1 (R Foundation for Statistical Computing, https://www.r-project.org/), and p values below 0.05 were considered significant.

Ethics Approval Details

The study was registered in the Chinese Clinical Trial Registry (Number: ChiCTR2200067138) and approved by the Ethics Committee of Xiamen Haicang Hospital (Number: KY-2022001). All family members and patients signed a written informed consent form. If a patient was unable to sign, a family member or a legal guardian signed the consent form.

Results

Characteristics of Participants

In total, 275 family members (including spouses, children, parents, and other next of kin) of ICU patients were recruited via convenience sampling, of whom 133 met the inclusion criteria. The mean age of the family members was 48.1 ± 14.1 years, and 63.9% were male (Table 1). At the second follow-up, five individuals were lost because of patient death, and 11 individuals were lost in the next round of follow-up because of patient death or unsuccessful contact via telephone. The follow-up process and participant retention are shown in Figure 1.

Table 1 Characteristics of Participants (N = 133)

Variables	N/mean/Median	Percentage (%)/SD/IQR
Information of family members		
Age of family members (years), mean (SD)	48.1	14.1
Male sex, N (%)	85	63.9
Parent–child relationship, N (%)	82	61.7
Spouses, N (%)	45	33.8
Married, N (%)	124	93.2
Educational status ≥ high school, N (%)	57	42.9
Living in cities or towns, N (%)	69	51.9
Information of patients		
Age of patients (years), mean (SD)	61.7	18.0

(*Continued*)

Table 1 (Continued).

Variables	N/mean/Median	Percentage (%)/SD/IQR
Medical diagnoses		
Respiratory-related diseases, N (%)	34	25.6
Circulatory-related diseases, N (%)	34	25.6
Digestive-related diseases, N (%)	27	20.3
Other diseases, N (%)	38	28.6
Out-of-pocket medical expenses, N (%)	42	31.6
Emergency, N (%)	47	35.3
Treatment information		
Surgery, N (%)	49	36.8
Mechanical ventilation, N (%)	80	60.2
CRRT, N (%)	13	9.8
APACHE II scores, mean (SD)	20.5	8.6
Level of dependence, median (IQR)	30.0	32.5
Length of ICU stay (days), median (IQR)	5.0	5.0
Duration of hospitalization (days), median (IQR)	19.0	20.0

Abbreviations: N, number; SD, standard deviation; IQR, interquartile range; CRRT, continuous renal replacement therapy; APACHE II, Acute Physiology and Chronic Health Evaluation II; ICU, intensive care unit.

Trajectories of Fatigue

The fit indexes of the unconditional linear LGCM and nonlinear LGCM are shown in the Table S1. Unconditional linear LGCM provided a better fit than nonlinear LGCM (RESMA: 0.099 vs 1.102), indicating that the fatigue data were closer to a linear distribution.

Table 2 presents the model fit indexes of LGMM. The five-class solution was excluded because p values of VLMR and BLRT of that solution were ≥0.05, and the solution had one class with a proportion of 2.2% (less than 5%). The entropy values of the two-class to four-class solutions suggested that the three solutions had good latent classification quality (all values >0.80). The three solutions were significant (VLMR: $p < 0.05$; BLRT: $p < 0.05$), but the AIC, BIC, and aBIC values suggested that the four-class solution had the best fit for fatigue data. As shown in the Table S2, the positive predictive values of the four-class solution ranged from 0.902 to 0.983, which suggested that classification accuracy was acceptable.[37] Thus, after overall consideration, the four-class solution was chosen.

The intercepts, slopes, and trajectories of the four-class solution are shown in Figure 2 and Table S3. Specifically, class 1 (increasing group) had an estimated mean Fatigue Severity subscale baseline score of 4.65, which increased to 6.54 after 3 months. Class 2 (ongoing group) was characterized by fatigue symptoms at each of the measured time points, and severity of symptoms was generally similar (with scores ranging from 4.66 to 4.79). Class 3 (decreasing group) had an estimated mean of Fatigue Severity subscale baseline score of 4.19, which then decreased gradually to 3.97 after 1 month, and entered maintenance (no fatigue symptoms in the remaining time points). Class 4 (non-fatigue group) was characterized by no fatigue symptoms at any of the measured time points (all scores <4) and showed a decreasing trend.

Univariate Analysis and Binary Logistic Regression

The results of univariate analysis are shown in Table 3. The age of the family members and patients, parent–child relationship, marital status, emergency, APACHE II score, level of dependence, length of ICU stay, and duration of hospitalization were significantly different between the groups (all p values <0.05). Based on the univariate analysis, nine variables were included in the binary logistic regression (Table 4). We found that relative to the non-fatigue group, the risk factors for the fatigue group were length of ICU stay (odds ratio [OR]: 1.157; 95% confidence interval [CI]: 1.016–1.318; $p = 0.028$) and duration of hospitalization (OR: 1.356; 95% CI: 1.176–1.564; $p < 0.001$), whereas level of dependence was a protective factor (OR: 0.940; 95% CI: 0.903–0.979; $p = 0.003$).

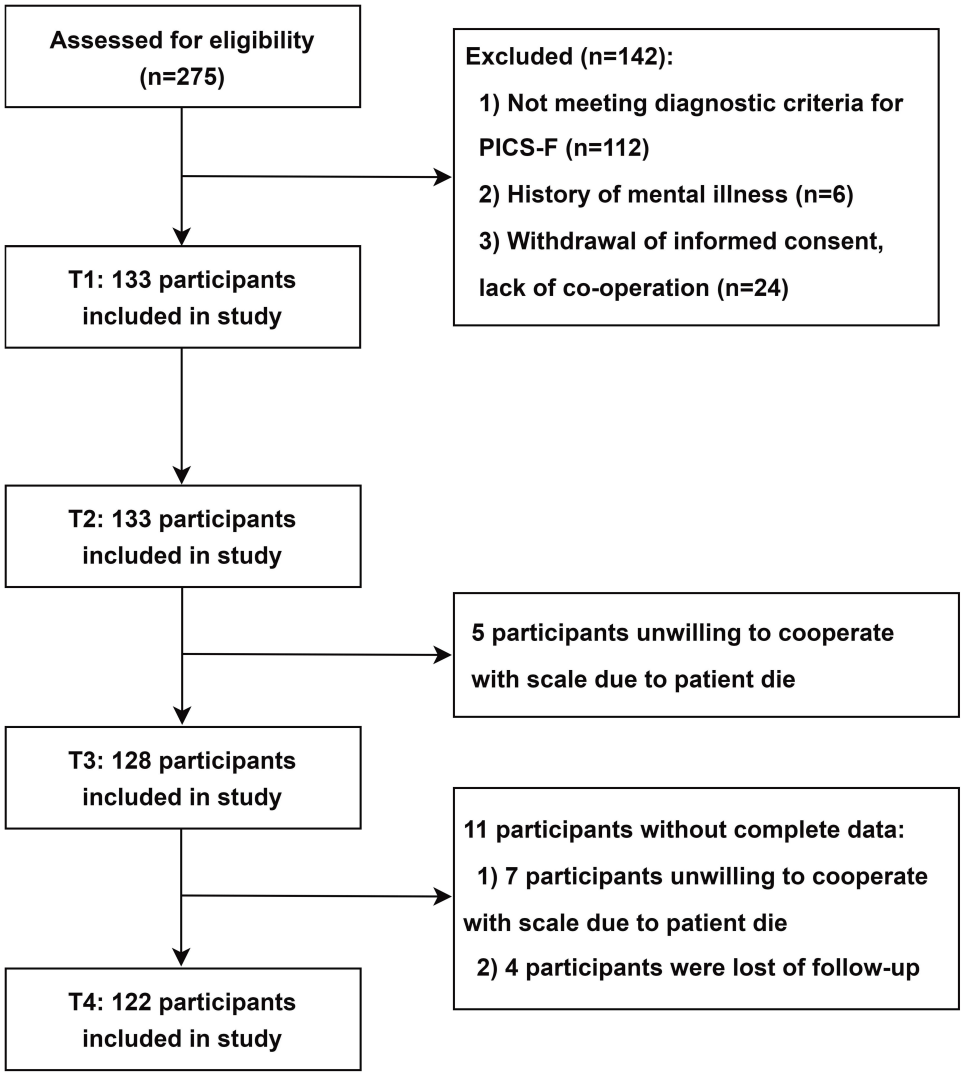

Figure 1 Participant flowchart.
Abbreviation: PICS-F, post-intensive care syndrome-family.

Discussion

The present study evaluated the trajectory of fatigue symptom in PICS-F and its influencing factors, and the results will lay the foundation for subsequent research. In the present study, nearly half of the family members were in a non-fatigue state at the time of the patients' transfer out from the ICU (the Fatigue Severity subscale score <4 at baseline). This suggests that more than half of the family members were at risk of developing fatigue symptoms during that time.

Table 2 Fit Indexes of the LGMM Models of the Fatigue Severe Subscale, for Increasing Number of Classes (1 to 5)

Classes	Number of Free Parameters	AIC	BIC	aBIC	Entropy	VLMR	BLRT	Number per Class
1	9	1152.268	1178.282	1149.813	–	–	–	133
2	12	1120.317	1155.001	1117.043	0.867	< 0.001	< 0.001	32/101
3	15	1033.547	1076.902	1029.455	0.975	< 0.001	< 0.001	44/63/26
4	18	1009.027	1061.053	1004.117	0.955	0.023	< 0.001	24/11/37/61
5	21	1010.391	1071.088	1004.662	0.956	0.2150	0.3750	37/61/9/23/3

Abbreviations: AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, sample size-adjusted BIC; VLMR, Vuong-Lo-Mendell-Rubin test; BLRT, bootstrap likelihood ratio test.

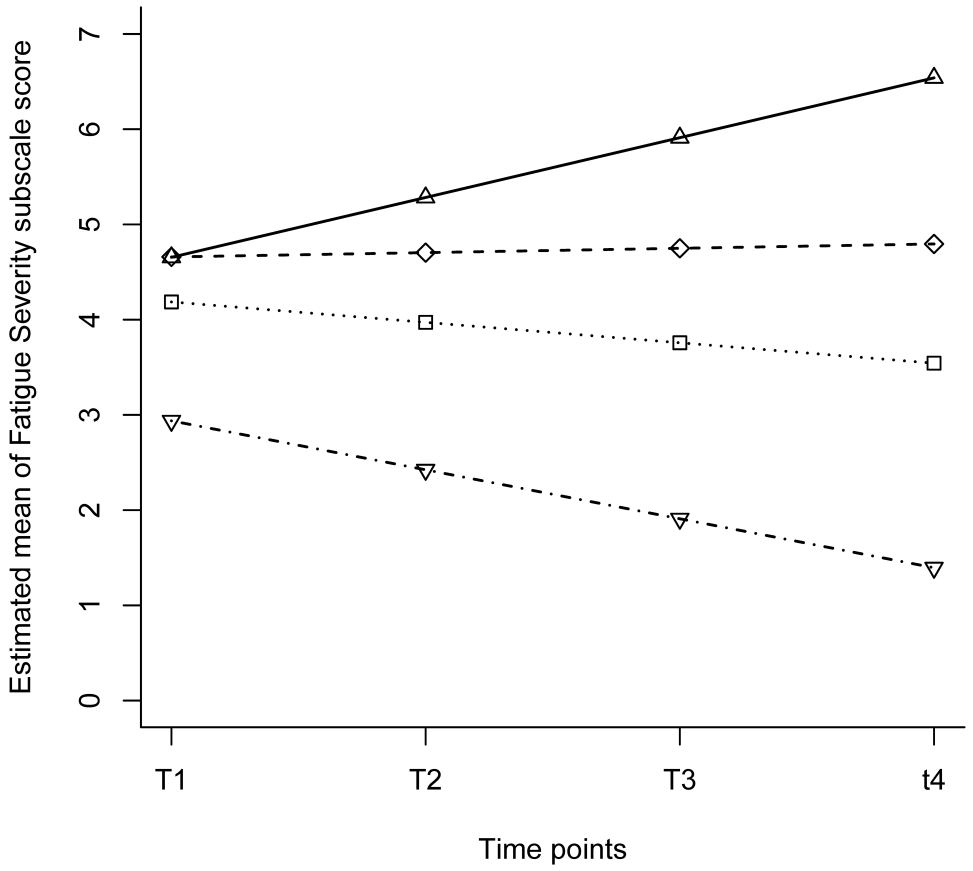

Figure 2 Estimated means for 4-class solution of the Fatigue Severity subscale (n = 133).
Notes: Triangle and solid line, Class 1 (18.2%); diamond and dashed line, Class 2 (8.1%); square and dotted line, Class 3 (26.9%); inverted triangle and dotted-dashed line, Class 4 (46.8%). T1, the time of patients transferred out from the intensive care unit, T2, T3, and T4, at 1 month, 2 month, and 3 month after patients transferred out from the intensive care unit, respectively.

However, this finding may be not be generalizable to family members across different hospitals or countries, as this was a single-center study, and the methods employed to measure fatigue in family members were not fully tested for reliability or validity. Despite these limitations, our findings align with previous studies that have reported similar trends in family member fatigue.[7,10,40] For example, Choi at al.[10] reported that 43–53% of family caregivers had fatigue symptom using a different assessment tool for fatigue. Fang et al[41] used the full, 29-item fatigue assessment instrument (FAI) and showed that the percentage of mild to severe fatigue was 69.5%, which is consistent with results of the present

Table 3 Univariate Analyses of Characteristics Between the Fatigue Group and the Non-Fatigue Group

Variables	Fatigue Group (N = 72)	Non-Fatigue Group (N = 61)	$t/x^2/F/z$	*P* value
Information of family members				
Age of family members (years), mean (SD)	51.4 (13.6)	44.3 (13.7)	−2.823	0.006[a]
Male, N (%)	46 (63.9)	39 (63.9)	< 0.001	0.996[b]
Parent–child relationship, N (%)	50 (69.4)	32 (52.5)	4.030	0.045 [b]
Spouses, N (%)	20 (27.8)	25 (41.0)	2.572	0.109[b]
Married, N (%)	71 (98.6)	53 (86.9)	-	0.012[c]
Educational status ≥ high school, N (%)	28 (38.9)	29 (47.5)	1.009	0.315[b]
Living in cities or towns, N (%)	41 (56.9)	34 (55.7)	0.020	0.889[b]

(*Continued*)

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Table 3 (Continued).

Variables	Fatigue Group (N = 72)	Non-Fatigue Group (N = 61)	$t/x^2/F/z$	*P* value
Information of patients				
Medical diagnoses			3.595	0.309[b]
Respiratory-related diseases, N (%)	17 (23.6)	17 (27.9)		
Circulatory-related diseases, N (%)	20 (27.8)	14 (23.0)		
Digestive-related diseases, N (%)	18 (25.0)	9 (14.8)		
Other diseases, N (%)	17 (23.6)	21 (34.4)		
Age of patients (years), mean (SD)	65.6 (16.3)	57.0 (16.3)	−2.970	0.004[a]
Out-of-pocket medical expenses, N (%)	23 (31.9)	19 (31.1)	0.010	0.922[b]
Emergency, N (%)	20 (27.8)	27 (44.3)	3.927	0.048[b]
APACHE II scores, mean (SD)	22.9 (8.8)	17.6 (7.2)	−3.784	< 0.001[a]
Level of dependence, median (IQR)	15.0 (20.0)	45.0 (30.0)	−6.670	< 0.001[d]
Length of ICU stay (days), median (IQR)	8.0 (9.0)	4.0 (2.5)	−5.973	< 0.001[d]
Duration of hospitalization (days), median (IQR)	30.5 (25.5)	12.0 (7.0)	−8.668	< 0.001[d]

Notes: [a]Student's *t* test; [b]Chi-square analysis; [c]Fisher's exact test; [d]Mann–Whitney *U*-test.
Abbreviations: N, number; SD, standard deviation; APACHE II, Acute Physiology and Chronic Health Evaluation II; IQR, interquartile range; ICU, intensive care unit.

Table 4 Binary Logistic Regression of Two Groups (Reference Group: the Non-Fatigue Group)

Variables	OR	95% CI	*P* value
Age of family members	1.018	0.970–1.068	0.474
Parent–child relationship	1.005	0.965–1.047	0.811
Married	1.012	0.923–1.110	0.797
Age of patients	1.007	0.969–1.046	0.772
Emergency	1.173	0.288–4.775	0.083
APACHE II scores	1.020	0.935–1.114	0.654
Level of dependence	0.940	0.903–0.979	0.003
Length of ICU stay	1.157	1.016–1.318	0.028
Duration of hospitalization	1.356	1.176–1.564	< 0.001

Abbreviations: OR, odds ratio; CI, confidence interval; APACHE II, Acute Physiology and Chronic Health Evaluation II; ICU, intensive care unit.

study (more than 50% individuals had fatigue symptoms). This consistency suggests that the phenomenon of family fatigue in the context of critical care is a pertinent issue requiring further exploration. However, there were some differences compared with the findings of the present study; namely our incidence rates were slightly lower than theirs. Given that fatigue is known to be related to age and gender,[15,42] the lower incidence in our study may reflect the lower number of individuals older than 60 years (15.0% vs 20.6%) and lower proportion of female individuals (36.1% vs 72%) compared with the study by Fang et al. Thus, we posit that the difference in incidence may be explained by the differences in age and gender. In conclusion, some family members consistently bear a substantial caregiving burden after patients transition from the ICU to the general ward. As a result, they inevitably experience fatigue, which may lead to a decreased quality of life,[43] and, subsequently, a decline in patient safety during care.[44] Therefore, exploring the root causes of fatigue and developing targeted support strategies for family members of ICU patients will be essential for improving their overall well-being, and, consequently, patient care outcomes.

The present study is the first LGMM-based longitudinal study to explore the heterogeneity of fatigue symptoms in family members. Our findings indicate that the course of fatigue of PICS-F can be classified into four subgroups based on the increasing, ongoing, decreasing, and non-fatigue groups. That is, four trajectories of fatigue were identified in our research. Previous studies have reported that fatigue symptoms in patients with COVID-19,[45] after stroke,[46] and with

acquired brain injury[47] shows a single, similar change over time in each individual. Those studies used the same tools for fatigue assessment as the present study (the Fatigue Severity subscale with 9 items or 11 items) but were not based on the LGMM method. However, other studies reached the opposite conclusions and suggested that the development of fatigue symptom is not a single trajectory but has latent subgroups. For example, Zhu and Xia[11] reported the existence of increasing and decreasing trajectories in women from late pregnancy to 6 months after delivery. A study by Li et al[48] found that patients with colorectal cancer had high, moderate, and low fatigue trajectories. A study by Bean et al[49] reported the existence of four trajectories (including persistently very high, high, stable low, and very low) in patients with breast cancer. Those studies were all based on LGMM or its variant model, similar to the present study, but used other assessment tools for fatigue. Overall, previous studies have demonstrated the heterogeneity of fatigue symptoms, ie, the number of trajectories varied with the disease, measurement times, and clinical features.

In a recent cross-sectional study,[50] longer disease duration was associated with more serious fatigue. In a study by Koyu and Arslan,[51] it was also suggested that duration of treatment could affect caregiver burden. In another study, the dependence was directly related to caregiver burden.[52] The findings of the present study are consistent with those results, where compared with the non-fatigue group, a longer length of ICU stay and duration of hospitalization of patients were correlated with a higher risk to belong to the fatigue group of family members. A lower level of dependence in the activities of daily living in the patients was correlated with a lower risk a to belonging to the fatigue group of family members. This is possibly because the longer course of disease and the higher level of dependence indicates that caregivers must dedicate more time to the patients' care: the greater the caregiver's burden, the greater their fatigue.[53]

This study has several limitations, as follows: 1) the lack of a standardized evaluation tool for assessing fatigue in PICS-F and the study's single-center design, which may limit the generalizability of the results; therefore, future studies should aim to utilize validated measurement tools and consider multi-center designs to enhance generalizability; 2) the sample size was too small for 4-group analysis; 3) we only considered fatigue data of family members within 3 months after patients' transfer out from the ICU; future studies should incorporate more measurements and longer follow-up time to fully characterize the trends of fatigue of PICS-F; 4) the level of dependence was assessed at T1 and was not updated at T2–T4; 5) a total of 11 participants did not have complete data at all measurement time points (Figure 1), so missing values were imputed; 6) the sociodemographic and clinical information collected in this research was not comprehensive; therefore, other unmeasured latent influencing factors (such as religious faith and family income) should be incorporated into future studies.

Conclusion

Four different growth trajectories of fatigue in family members with PICS-F were estimated, and we further assessed the factors associated with these trajectories. We found that a lower level of dependence was a protective factor for non-fatigue, while longer length of ICU stays and duration of hospitalization were risk factors for fatigue. This information could guide the development of interventions for fatigue alleviation in family members and should be considered an important aspect in future research.

Data Sharing Statement

The data will be shared on reasonable request to the corresponding author.

Ethics Approval and Informed Consent

All procedures performed in this study adhered to the ethical standards of the Xiamen Haicang Hospital and the 1964 helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all participants included in the study.

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Disclosure

The authors declare that they have no conflicts of interest related to this work.

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