

Distinct Dyadic Quality of Life Profiles Among Advanced Lung Cancer Patient-Caregiver Dyads: A Latent Profile Analysis

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Research Article

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Abstract

Purpose

This study aimed to identify the heterogeneity of dyadic quality of life (QoL) profiles, determine whether these profiles differ in terms of demographic and medical factors, neuroticism, resilience, and family functioning, and explore the combined effect of patient and caregiver neuroticism, resilience, and family functioning on dyadic QoL profiles.

Methods

A cross-sectional study was conducted with 304 advanced lung cancer patient-caregiver dyads enrolled from radiotherapy and chemotherapy departments at three tertiary hospitals. Self-report questionnaires were administered to patient-caregiver dyads to assess demographic and medical characteristics, neuroticism, resilience, family functioning and QoL.

Results

The latent profile analysis identified four subgroups of dyadic QoL: patient low-caregiver high profile (38.82%), patient high-caregiver high profile (22.37%), patient high-caregiver low profile (19.74%), and patient low-caregiver low profile (19.08%). Additionally, when both patients and their caregivers had a high level of neuroticism or low level of resilience, and low family functioning, compared with only member having them, there was a higher risk of poorer dyadic QoL.

Conclusions

Our study identified the four heterogeneities of dyadic QoL profiles among advanced lung cancer patient-caregiver dyads. Future dyadic interventions should consider the heterogeneity of dyadic QoL in this population and prioritize patient-caregiver dyads who are at risk of poor dyadic QoL. Furthermore, when high neuroticism, low resilience, or family functioning coexist between patients and their caregivers, both parties exhibit much lower dyadic QoL.

Introduction

In China, lung cancer is the most common cancer and the leading cause of cancer-related deaths. Approximately 810,000 people were newly diagnosed with lung cancer, and 710,000 people died of lung cancer in 2020 [1]. Significantly, the majority of new lung cancer cases are diagnosed at an advanced stage, with 57% developing distant metastases [2, 3].

The challenges or adversities caused by cancer can lead to lower quality of life (QoL) in both patients and their caregivers. As lung cancer and its treatment have negative effects on both the patients and their caregivers, the main focus of cancer care and its research has shifted from the individual to the dyadic level of patient-caregiver dyads [4]. Furthermore, the interdependence theory [5] and empirical research have confirmed the interdependence of QoL in patient-caregiver dyads, calling for treating the patient-caregiver dyad as a unit both conceptually and methodologically [6, 7].

The traditional method of studying dyadic QoL is a variable-centered approach, which is useful for clarifying associations among variables and unraveling contributors to specific QoL outcomes but is limited in terms of capturing the heterogeneity in QoL within patient-caregiver dyads [8]. For example, research using global indicators of QoL found that patients had a lower QoL than their caregivers [9, 10]; however, it seems unsuitable as it arbitrarily regards all patients as having poorer QoL than their caregivers. Distinct dyadic QoL profiles among patient-caregiver dyads may be unidentified. Specifically, prior studies indicated that cancer patients and their caregivers experienced positive (e.g., better family closeness and healthier lifestyles) and negative aspects (e.g., disease progress and increasing caregiving demands) in the process of adapting to cancer [11–13], which had different effects on their QoL. However, not each dyad has the same experiences, which leads to variations in specific QoL dimensions across dyads. For instance, Lee and Lyons (2019) found a congruent pattern between patients and caregivers of non-small cell lung cancer, which was characterized by an almost identical moderate mental health in patient-caregiver dyads and a disparate pattern characterized by the better mental health of the patients compared with the caregivers [14]. Increasing evidence [14, 15] acknowledges heterogeneity existing across dyads;

however, the specific profiles of dyadic QoL are still unclear. Identifying the heterogeneity of these dyadic QoL profiles can ascertain vulnerable subgroups, and identify their risk and protective factors.

According to the transactional stress theory [16], personal and environmental characteristics affect an individual's adaptive outcomes (i.e., QoL) when exposed to adversity. Neuroticism, as a crucial personal characteristic, is characterized by more stress, negative emotions, and emotional instability [17]. Accumulative evidence suggests that cancer patients and caregivers with higher neuroticism scores have an increased risk of poor QoL [18, 19]. Resilience, another important personal characteristic, is defined as the individuals' ability to recover from challenges and major traumatic events [20]. Cancer patients' and caregivers' resilience have been positively linked to their own increased QoL [21, 22]. Family functioning is a crucial environmental protective characteristic [23]. Individuals living in families with positive family functioning are prone to feel loved, accepted, and gain more positive resources, and has been revealed as an important predictor of better QoL among cancer patients and caregivers [24, 25]. Given that the above-mentioned personal (i.e., neuroticism, resilience) and environmental characteristics (i.e., family functioning) play important roles in predicting QoL, it is helpful to examine the independent effects of these factors on the distinct dyadic QoL profiles. Additionally, when high neuroticism coexists between patients and their caregivers, both parties are more reactive to stress and emotions, which degrades their QoL. In contrast, when high resilience or family functioning coexists between patients and their caregivers, both parties show positive adaption in the face of adversity or acquire more intra- and extra-family resources for better adaption, which underpins their QoL. The question arises whether there is a higher risk of poorer dyadic QoL profiles when both the patients and caregivers have high levels of neuroticism or low levels of resilience or family functioning, simultaneously, compared with only one party having them. However, a relative dearth of research explored the combined effect of these factors (e.g., the transactional effect of one patient's high resilience and the caregiver's low resilience) on dyadic QoL profiles.

This study aimed to: (1) identify heterogeneity of dyadic QoL profiles among advanced lung cancer patient-caregiver dyads, (2) determine whether these profiles differ in terms of demographic and medical factors, personal characteristics (i.e., neuroticism and resilience), and environmental characteristics (i.e., family functioning); and (3) explore the combined effect of patients' and caregivers' neuroticism, resilience, and family functioning on dyadic QoL profiles.

Methods

Study design and participants

A cross-sectional survey was conducted at the departments of radiotherapy and chemotherapy at three tertiary hospitals in Jinan, Shandong Province, China, from March 2019 to February 2020. Patient and caregiver inclusion criteria included: age 18 years or older, fluent in written or spoken Chinese, diagnosed at lung cancer stages III or IV, and caregiver identified by the patient as the primary caregiver. The exclusion criteria included unwillingness to participate in this study, psychiatric disorders, or cognitive disorders. Of the 380 patient-caregiver dyads eligible for the study, 29 refused to participate and 47 failed to complete the questionnaires. Thus, 304 patient-caregiver dyads were included in this study. This study was approved by the university ethics committee and was conducted following the tenets of the Declaration of Helsinki. Informed consent was obtained from all participants included in this study.

Measures

Neuroticism

The 8-item Neuroticism subscale of the 44-item Big Five Inventory (BFI) [26] was used to assess neuroticism. Responses were rated on a five-point Likert scale ranging from "strongly disagree" = 1 to "strongly agree" = 5. Higher scores were related to higher levels of neuroticism. Cronbach's α for the subscales were 0.79 in patients, and 0.76 in caregivers, respectively.

Resilience

The 10-item Connor-Davidson Resilience Scale [27] was used to assess resilience. Responses were rated on a five-point Likert scale ranging from "Not true at all" = 0 to "True almost always" = 4. Higher scores were associated with greater resilience. Cronbach's α of the questionnaire was 0.93 in patients and 0.92 in caregivers, respectively.

Family functioning

The General Functioning subscale of the Family Assessment Device [28] was used to assess participants perceived overall functioning of a family system. The 12-item scale was rated on a four-point Likert scale ranging from “strongly disagree” = 1 to “strongly agree” = 4. Higher scores reflected greater family functioning. Cronbach’s α of the questionnaire was 0.85 in patients and 0.81 in caregivers.

QoL

The Medical Outcomes Study Short Form-8 Health Survey (SF-8) [29] was used to assess QoL. SF-8 comprises eight dimensions: general health perceptions, physical functioning, physical role, bodily pain, vitality, social functioning, mental health, and emotional role. Responses were rated on a five-point Likert scale. The raw scores were transformed into standard scores of 0–100, with higher scores associated with better QoL. Cronbach’s α of the SF-8 was 0.90 in patients and 0.89 in caregivers, respectively.

Covariates

The covariates analyzed in the study consisted of demographic and medical characteristics such as advanced lung cancer patients and their caregivers’ age, sex, marriage, education, employment status, lung cancer type, Eastern Cooperative Oncology Group (ECOG) performance, caregivers’ relationship with patients (see Table 1).

Data analysis

Latent profile analysis (LPA) is a person-centered approach that determines heterogeneity profiles of dyadic QoL, categorizing them as diverging subgroups that are internally homogeneous [30] based on the patterns of means on observed variables (i.e., the eight dimensions of QoL in this study). The optimal number of profiles was evaluated using model-fit indices, such as the Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size-adjusted BIC (aBIC), entropy, the Vuong-Lo-Mendell-Rubin likelihood ratio test (LMR), and the bootstrapped likelihood ratio test (BLRT).

After the optimal number of profiles was obtained, the one-way analysis of variance (ANOVA) and chi-square tests were conducted to identify differences in demographic and medical characteristics, neuroticism, resilience, and family functioning among different dyadic QoL profiles. Multinomial logistic regression analysis was conducted to evaluate the unique association of each predictor variable that was significant in the one-way ANOVA or chi-square tests with profile membership. To examine the combined effect, we initially divided the scores of neuroticism, resilience, and family functioning of patients and caregivers into high (above mean) and low (below mean) groups according to the mean split method. Then, we created a new composite variable (e.g., neuroticism) including 4 combinations of the patient neuroticism (high vs. low) and caregiver neuroticism (high vs. low) to further explore the combined effect of patients’ and caregivers’ neuroticism, resilience and family functioning on dyadic QoL profiles were employed using multinomial logistic regression analysis. Statistical analyses were performed using SPSS 26.0 and Mplus 7.4 with a significance level of 5% (2-tailed).

Results

The mean age of the advanced lung cancer patient-caregiver dyads were 58.50 (SD = 10.11) years for patients and 45.47 (SD = 11.85) for caregivers. Table 1 depicts the detailed demographic and medical characteristics.

Latent profile analyses

To identify the optimal profile solution, LPA models with one to six profiles were estimated (see Table 2). The four-profile solution fitted the data significantly better than the three-profile solution; more specifically, the four-profile solution demonstrated lower values of AIC, BIC, and aBIC, higher entropy than the three-profile solution, and LMR and BLRT became significant when reaching the four-profile solution. Although the five-profile solution demonstrated lower values of AIC, BIC, and aBIC than the four-profile solution, the nonsignificant p value for LMR further confirmed that the five-profile solution did not significantly improve over the four-profile solution. Additionally, the entropy values in the four-profile solution were the highest, indicating that the four-profile solution provided fair classification accuracy.

Four profiles of dyadic QoL are presented graphically in Fig. 1. In group 1 ($n=118$, 38.82%), labeled as *patient low-caregiver high profile*, patients reported low levels of QoL, but caregivers reported a higher level of QoL than patients. Group 2 ($n=68$, 22.37%), labeled

as *patient high-caregiver high profile*, was characterized by both patients and their caregivers reporting higher levels of QoL relative to the other profiles. In group 3 ($n=60$, 19.74%), labeled as *patient high-caregiver low profile*, patients reported a comparatively higher level of QoL than their caregivers, who reported low levels of QoL. Group 4 ($n=58$, 19.08%), labeled as *patient low-caregiver low profile*, was characterized by patients and their caregivers reporting lower levels of QoL compared with the other profiles.

Comparisons of demographic, medical characteristics, neuroticism, resilience, family functioning among the four profiles

The results showed that patients' economic situation, ECOG performance status, caregivers' age, marriage, economic situation, relationship to the patient, and the neuroticism, resilience, and family functioning of patients and their caregivers significantly differed across the four profiles (see Table 1).

Multinomial logistic regression was further conducted to explore whether the significant variables in the univariate analysis predicted profile membership (Table 3). Considering that no caregivers whose marital status was single/divorced/widowed were classified into a patient low-caregiver low profile, marriage was omitted from further analyses. The patient high-caregiver high profile was used as the reference group. Patients whose economic situation was income lesser than the expenditure ($OR = 5.943$; $p = 0.006$) were more likely to belong to the patient low-caregiver high profile compared to those with income more than the expenditure. Patients with higher scores on ECOG performance status and neuroticism were associated with increased odds of membership to the patient low-caregiver high profile and patient low-caregiver low profile. Elderly caregivers ($OR = 1.067$; $p = 0.015$) were more likely to be categorized as having a patient high-caregiver low profile. Moreover, caregivers with low resilience tended to have increased odds of belonging to the patient high-caregiver low and patient low-caregiver low profiles. Patients with high family functioning were more likely to be categorized as a patient high-caregiver low profile.

Combined Effect of patient neuroticism, resilience, family functioning and caregiver neuroticism, resilience, family functioning associated with distinct dyadic QoL profiles

As Table 4 shows, the subgroup of patient high neuroticism-caregiver low neuroticism was 3.21 times more likely to belong to the patient low-caregiver high profile compared to the dyads of patient low neuroticism-caregiver low neuroticism. The subgroup of patients and their caregivers who both had high neuroticism was 3.92 times more likely to be classified as the patient high-caregiver low profile. The subgroups of patient low neuroticism-caregiver high neuroticism, patient high neuroticism-caregiver low neuroticism, and patient high neuroticism-caregiver high neuroticism had 4.247, 9.167, and 10.869 times the likelihood of belonging to the patient low-caregiver low profile, respectively. That is, both the patients and their caregivers with a high level of neuroticism simultaneously had a higher likelihood of belonging to the patient low-caregiver low profile, compared with only one member with high neuroticism.

Furthermore, compared to patient high resilience-caregiver high resilience, the subgroup of patient low resilience-caregiver high resilience and patient low resilience-caregiver low resilience were 2.727, 7.271 times respectively more likely to belong to the patient low-caregiver high profile. In addition, the subgroup of patient high resilience-caregiver low resilience and the subgroup of patients and their caregivers with low resilience were 4.088, 8.620 times more likely to belong to the patient high-caregiver low profile, respectively. Finally, the subgroup of patient high resilience-caregiver low resilience was 4.311 times more likely to belong to the patient low-caregiver low profile, and the subgroup of patient low resilience-caregiver low resilience was 11.340 times more likely to belong to the patient low-caregiver low profile. Therefore, the dyads of both patients and their caregivers with low resilience increased their likelihood of belonging to the patient low-caregiver low profile than only one party with low resilience ($OR = 11.340$ vs. $OR = 4.311$ vs. $OR = 2.223$). One interesting finding is that only caregivers with lower resilience were found to be at a higher likelihood of being classified in the patient low-caregiver low profile than only patients with lower resilience ($OR = 4.311$, $P = 0.013$ vs. $OR = 2.223$, $P = 0.173$).

As for the combined effect of family functioning, the odds of both patients and their caregivers with low family functioning being classified in the patient high-caregiver low and patient low-caregiver low profiles were 5.453 and 2.944 times, respectively.

Discussion

This study utilized a person-centered approach (i.e., LPA) to capture the heterogeneity of dyadic QoL profiles and explored their associations with different characteristics among advanced lung cancer patients and their caregivers.

Our findings revealed four dyadic QoL profiles. First, most advanced lung cancer patient-caregiver dyads (n=118, 38.82%) were divided into patient low-caregiver high profile, in which patients scored low, but caregivers scored high on the QoL indicators. This result is expected, given that most prior researchers have found worse QoL among cancer patients than their caregivers [9, 10, 31]. Second, a patient high-caregiver high profile was observed. Third, an important and interesting finding is the existence of such a patient high-caregiver low profile characterized by patients scoring high on the QoL indicators, but caregivers scoring low on the QoL indicators. This finding is difficult to trace using the traditional variable-centered approach and suggests that clinical practitioners should pay more attention to this vulnerable profile, especially the caregivers, because of lower QoL. Fourth, a patient low-caregiver low profile was also identified. The heterogeneity of dyadic QoL profiles highlights the importance of adopting tailored dyadic interventions, rather than taking on a “one-size-fits-all” approach. For instance, the dyads in patient low-caregiver high profile may benefit from adopting a patient-focused, caregiver-assisted dyadic intervention. The dyads in patient low-caregiver low profile may benefit from adopting both patient and caregiver focused dyadic intervention. Future research could explore the effectiveness of personalized dyadic interventions in heterogeneous profiles.

The demographic and medical characteristics of the dyadic QoL profiles differed. Specifically, patients with higher financial burdens had an increased likelihood of belonging to the patient low-caregiver high profile. A study indicated that 72.68% of lung cancer patients reported catastrophic health-related spending, and 37% reported healthcare costs exceeding the annual household income [32]. Our results revealed that 70.06% of the patients had incomes less than their expenditures. The association between high financial burden and poor QoL in this study is consistent with prior research [33]. Patients with higher scores of ECOG performance status were more likely to belong to the patient low-caregiver high profile and patient low-caregiver low profile. Cancer patients with higher scores on ECOG performance status have more difficulty in completing daily living activities and therefore experience QoL deterioration [34]. Older caregivers were more likely to belong to the patient high-caregiver low profile. This may be owing to elderly caregivers’ decline in physical health (e.g., degenerative changes), which is also associated with lower QoL [35, 36].

Patients in the patient low-caregiver high profile and patient low-caregiver low profile were more neurotic. Unsurprisingly, a person with high neuroticism may regard the diagnosis of cancer as more threatening or severe, have more negative health perception, and will thus report lower QoL [17, 18, 37]. Caregivers with low resilience were more likely to be classified in the patient high-caregiver low and patient low-caregiver low profiles. Resilience is a critical psychological asset that embodies the personal qualities needed for individuals to thrive in the face of adversity [38, 39]. Caregivers with low resilience tended not to utilize the resources to adapt to the adversity they encountered, thereby decreasing their QoL. Moreover, patients who perceived better family functioning were more likely to be included in the patient high-caregiver low profile. Patients with better family functioning perceived a strong emotional bonding with their family and could acquire more support from family members, which led to better QoL, which was consistent with prior work [24].

This study found that the dyads of both patients and caregivers with high neuroticism were associated with the highest odds of belonging to the patient low-caregiver low profile, followed by the dyads of only patients with high neuroticism, and the dyads of only caregivers with high neuroticism. This finding indicated that both the patients and their caregivers with a high level of neuroticism simultaneously had lower dyadic QoL, compared with only one of the dyads being neurotic. Additionally, the dyads of only patients with high neuroticism were found to be at a higher likelihood for being classified in the patient low-caregiver low profile than the dyads of only caregivers with high neuroticism. Patients with advanced lung cancer and their caregivers are inclined to react as emotional units. Patients’ neuroticism has a negative effect on their own QoL, as does spillover on their caregivers’ QoL [40]. In this study, compared to caregivers’ neuroticism, patients’ neuroticism generated greater spillover effects on the QoL of patient-caregiver dyads.

An interesting finding was that only caregivers with lower resilience showed a higher likelihood of belonging to the patient low-caregiver low profile than only patients with low resilience. Caregivers’ heavy caregiving tasks (e.g., form treatment regimens, and manage medications) place high demands on their physical and emotional reserves, and resilience not only helps them facilitate the caregiving task but transmits from them to the patients through information exchange, and communication. [38, 41]. Moreover, both patients and caregivers with low resilience showed the highest risk of reducing dyadic QoL compared with only one of the dyads with low resilience. This finding suggests that identifying the dyads of both patients and caregivers with low resilience may be conducive to implementing preventive interventions to mitigate their higher risk of poor QoL.

Furthermore, patients and caregivers with low family functioning were more likely to belong to the patient high-caregiver low profile or patient low-caregiver low profile. A previous study suggested that patients’ perceived family functioning may be different from that of their caregivers, even though they belonged to the same family [41, 42]. Thus, assessing family functioning from the perspectives of

both patients and their caregivers could truly reflect the functioning of the family [43]. Both patients and caregivers in this study reported poorer family functioning, which was related to ineffective communication patterns and poor health-related behaviors (e.g., physical activity, screening physical examination), thus reducing their QoL.

This study has certain limitations. First, causal directionality needs to be cautiously interpreted with this cross-sectional design. Second, this study focused on modifiable psychological variables that could be addressed through an intervention. However, several factors (e.g., symptom distress, caregiver burden, and coping strategy) that can predict dyadic QoL were not included. Future research should incorporate these factors to develop a robust predictive model of dyadic QoL. Third, this study assessed participants' perceived family functioning rather than objective family functioning. However, this study assessed family functioning from multiple perspectives and greatly reduced the error. Future studies are recommended to specify extended or nuclear families when assessing family functioning.

Conclusion

This study captured the four heterogeneities of dyadic QoL profiles among advanced lung cancer patient-caregiver dyads and explore their influencing factors. Future dyadic interventions should consider the heterogeneity of dyadic QoL in this population and prioritize patient-caregiver dyads who are at risk of poor dyadic QoL. Furthermore, when high neuroticism, low resilience, or family functioning coexist between patients and their caregivers, both parties exhibit much lower dyadic QoL.

Declarations

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Data availability: The data of this study can be available from the corresponding author.

Code availability: N/A.

Ethical approval: This study was approved by the ethics review board of the School of Nursing at Shandong University and was conducted following tenets of the Declaration of Helsinki.

Consent to participate: Informed consent was obtained from all participants *included* in this study.

Consent for publication All of the authors approved the final paper for publication.

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Tables

Table 1
Demographic, medical characteristics, neuroticism, resilience, and family functioning of four latent profiles

	All sample	Patient low-caregiver low profile	Patient low-caregiver high profile	Patient high-caregiver low profile	Patient high-caregiver high profile	P-value
Patients						
Sex						0.608
Male	203(66.8%)	35(60.3%)	78(66.1%)	42(70.0%)	48(70.6%)	
Female	101(33.2%)	23(39.7%)	40(33.9%)	18(30.0%)	20(29.4%)	
Age (Mean±SD)	58.50±10.11	56.57±11.09	58.75±11.03	59.44±7.56	58.91±9.48	0.423
Education						0.941
Illiterate	33(10.9%)	8(13.8%)	13(11.0%)	5(8.3%)	7(10.3%)	
Primary school	54(17.8%)	8(13.8%)	26(22.0%)	9(15.0%)	11(16.2%)	
Junior high school	103(33.9%)	22(37.9%)	36(30.5%)	23(38.3%)	22(32.4%)	
High school/vocational high school	67(22.0%)	10(17.2%)	25(21.2%)	15(25.0%)	17(25.0%)	
University and college	47(15.5%)	10(17.2%)	18(15.3%)	8(13.3%)	11(16.2%)	
Marital Status ^a						0.587
Married	290(95.4%)	54(93.1%)	113(95.8%)	58(98.3%)	65(95.6%)	
Single/divorced/widowed	13(4.3%)	4(6.9%)	5(4.2%)	1(1.7%)	3(4.4%)	
Current work status						0.557
Employed	61(20.1%)	11(19.0%)	21(17.8%)	12(20.0%)	17(25.0%)	
Unemployed	153(50.3%)	35(60.3%)	59(50.0%)	28(46.7%)	31(45.6%)	
Retired	90(29.6%)	12(20.7%)	38(32.2%)	20(33.3%)	20(29.4%)	
Economic situation ^a						<0.001
Income lesser than the expenditure	213(70.1%)	43(74.1%)	94(79.7%)	42(71.2%)	34(50.0%)	
Income equal to the expenditure	60(19.7%)	14(24.1%)	17(14.4%)	7(11.9%)	22(32.4%)	
Income more than the expenditure	30(9.9%)	1(1.7%)	7(5.9%)	10(16.9%)	12(17.6%)	
Clinical Tumour-Node-Metastasis stage						0.191
III	99(32.6%)	15(25.9%)	34(28.8%)	25(41.7%)	25(36.8%)	
IV	205(67.4%)	43(74.1%)	84(71.2%)	35(58.3%)	43(63.2%)	
Lung cancer type ^a						0.114
Small cell carcinoma	79(26.0%)	13(22.4%)	35(29.9%)	13(21.7%)	18(26.5%)	
Squamous cell carcinoma	46(15.1%)	11(19.0%)	11(9.4%)	13(21.7%)	11(16.2%)	
<i>Note.</i> ECOG: Eastern Cooperative Oncology Group						
^a implies that the numbers/percentages may not account to the total, due to missing data.						

	All sample	Patient low-caregiver low profile	Patient low-caregiver high profile	Patient high-caregiver low profile	Patient high-caregiver high profile	P-value
Adenocarcinoma	174(57.2%)	33(56.9%)	71(60.7%)	31(51.7%)	39(57.4%)	
Large cell carcinoma	2(0.7%)	0(0.0%)	0(0.0%)	2(3.3%)	0(0.0%)	
Adeno-squamous carcinoma	2(0.7%)	1(1.7%)	0(0.0%)	1(1.7%)	0(0.0%)	
Chemotherapy ^a						0.112
Yes	230(75.7%)	39(67.2%)	86(73.5%)	50(83.3%)	55(82.1%)	
No	72(23.7%)	19(32.8%)	31(26.5%)	10(16.7%)	12(17.9%)	
Radiotherapy ^a						0.198
Yes	23(7.6%)	8(13.8%)	9(7.7%)	3(5.0%)	3(4.5%)	
No	279(91.8%)	50(86.2%)	108(92.3%)	57(95.0%)	64(95.5%)	
Targeted-therapy ^a						0.381
Yes	81(26.6%)	12(20.7%)	35(29.9%)	19(31.7%)	15(22.4%)	
No	221(72.7%)	46(79.3%)	82(70.1%)	41(68.3%)	52(77.6%)	
Immunotherapy ^a						0.565
Yes	17(5.6%)	5(8.6%)	6(5.1%)	4(6.7%)	2(3.0%)	
No	285(93.8%)	53(91.4%)	111(94.9%)	56(93.3%)	65(97.0%)	
Supportive care ^a						0.443
Yes	45(14.8%)	12(20.7%)	17(14.5%)	6(10.0%)	10(14.9%)	
No	257(84.5%)	46(79.3%)	100(85.5%)	54(90.0%)	57(85.1%)	
Time since diagnosis						0.700
≤3 month	137(45.1%)	22(37.9%)	55(46.6%)	25(41.7%)	35(51.5%)	
3-6 month	45(14.8%)	13(22.4%)	13(11.0%)	11(18.3%)	8(11.8%)	
6-12 month	49(16.1%)	9(15.5%)	20(16.9%)	9(15.0%)	11(16.2%)	
≥1 year	73(24.0%)	14(24.1%)	30(25.4%)	15(25.0%)	14(20.6%)	
Physical Comorbidity ^a						0.746
Yes	152(50.0%)	29(50.0%)	57(49.1%)	28(46.7%)	38(55.9%)	
No	150(49.3%)	29(50.0%)	59(50.9%)	32(53.3%)	30(44.1%)	
Smoking ^a						0.461
Yes	152(50.0%)	28(48.3%)	54(47.4%)	34(59.6%)	36(52.9%)	
No	145(47.7%)	30(51.7%)	60(52.6%)	23(40.4%)	32(47.1%)	
ECOG performance status	1.82±1.00	2.14±1.10	2.03±0.99	1.57±0.93	1.38±0.81	<0.001

Note. ECOG: Eastern Cooperative Oncology Group

^a implies that the numbers/percentages may not account to the total, due to missing data.

	All sample	Patient low-caregiver low profile	Patient low-caregiver high profile	Patient high-caregiver low profile	Patient high-caregiver high profile	P-value
Neuroticism	21.30±6.17	23.25±5.86	22.23±5.99	21.05±5.71	18.25±6.10	<0.001
Resilience	26.90±7.72	25.40±7.74	25.16±7.76	28.26±6.39	30.00±7.65	<0.001
Family functioning	35.61±6.02	34.91±6.89	35.60±5.78	34.31±5.88	37.35±5.46	0.025
Caregivers						
Sex						0.375
Male	164(53.9%)	34(58.6%)	63(53.4%)	27(45.0%)	40(58.8%)	
Female	140(46.1%)	24(41.4%)	55(46.6%)	33(55.0%)	28(41.2%)	
Age (Mean±SD)	45.47±11.85	46.86±10.25	45.16±11.83	48.67±12.28	41.96±12.06	0.010
Education						0.543
Illiterate	10(3.3%)	3(5.2%)	4(3.4%)	2(3.3%)	1(1.5%)	
Primary school	27(8.9%)	5(8.6%)	13(11.0%)	6(10.0%)	3(4.4%)	
Junior high school	81(26.6%)	18(31.0%)	26(22.0%)	20(33.3%)	17(25.0%)	
High school/ vocational high school	93(30.6%)	20(34.5%)	38(32.2%)	15(25.0%)	20(29.4%)	
University and college	93(30.6%)	12(20.7%)	37(31.4%)	17(28.3%)	27(39.7%)	
Marital status ^a						0.022
Married	284(93.4%)	58(100.0%)	110(94.0%)	57(95.0%)	59(86.8%)	
Single/divorced/widowed	19(6.3%)	0(0.0%)	7(6.0%)	3(5.0%)	9(13.2%)	
Current work status						0.131
Employed	156(51.3%)	27(46.6%)	65(55.1%)	22(36.7%)	42(61.8%)	
Unemployed	105(34.5%)	21(36.2%)	39(33.1%)	26(43.3%)	19(27.9%)	
Retired	43(14.1%)	10(17.2%)	14(11.9%)	12(20.0%)	7(10.3%)	
Economic situation ^a						0.009
Income lesser than the expenditure	170(55.9%)	40(69.0%)	66(56.4%)	39(65.0%)	25(37.3%)	
Income equal to the expenditure	85(28.0%)	14(24.1%)	32(27.4%)	14(23.3%)	25(37.3%)	
Income more than the expenditure	47(15.5%)	4(6.9%)	19(16.2%)	7(11.7%)	17(25.4%)	
Relationship to patient						0.007
Spouse	136(44.7%)	35(60.3%)	47(39.8%)	34(56.7%)	20(29.4%)	
Child	151(49.7%)	21(36.2%)	62(52.5%)	24(40.0%)	44(64.7%)	
Friend and family	17(5.6%)	2(3.4%)	9(7.6%)	2(3.3%)	4(5.9%)	
Resides with patient						0.097

Note. ECOG: Eastern Cooperative Oncology Group

^a implies that the numbers/percentages may not account to the total, due to missing data.

	All sample	Patient low-caregiver low profile	Patient low-caregiver high profile	Patient high-caregiver low profile	Patient high-caregiver high profile	<i>P</i> -value
Yes	205(67.4%)	44(75.9%)	71(60.2%)	45(75.0%)	45(66.2%)	
No	99(32.6%)	14(24.1%)	47(39.8%)	15(25.0%)	23(33.8%)	
Caregiving hours per day ^a						0.398
≤8h	81(26.6%)	15(25.9%)	36(30.8%)	10(16.9%)	20(29.9%)	
9-16h	82(27.0%)	17(29.3%)	26(22.2%)	18(30.5%)	21(31.3%)	
17-24h	138(45.4%)	26(44.8%)	55(47.0%)	31(52.5%)	26(38.8%)	
Duration of caregiving (month) ^a	8.10±12.09	9.38±15.50	7.92±12.07	7.50±7.92	7.82±11.98	0.837
Neuroticism	22.19±5.85	24.28±5.45	21.92±5.94	22.97±5.85	20.18±5.39	0.001
Resilience	27.64±7.18	24.79±8.46	27.84±6.30	26.15±7.41	31.04±5.80	<0.001
Family functioning	35.68±5.30	35.02±5.20	36.04±5.63	34.34±4.73	36.80±5.02	0.039
<i>Note.</i> ECOG: Eastern Cooperative Oncology Group						
^a implies that the numbers/percentages may not account to the total, due to missing data.						

Table 2 Fit statistics: Patient-caregiver dyadic QoL latent profile analysis models

Model	K	AIC	BIC	aBIC	Entropy	LMR(<i>P</i>)	BLRT(<i>P</i>)	Probability of classes
1-class	32	45456.808	45575.753	45474.265				1.00
2-class	49	44579.384	44761.518	44606.115	0.870	0.007	<0.001	0.54/0.46
3-class	66	44088.927	44334.251	44124.932	0.891	0.233	<0.001	0.40/0.30/0.30
4-class	83	43784.001	44092.514	43829.280	0.915	0.019	<0.001	0.39/0.22/0.20/0.19
5-class	100	43615.996	43987.699	43670.549	0.908	0.598	<0.001	0.34/0.18/0.17/0.16/0.15
6-class	117	43493.369	43928.262	43557.197	0.911	0.251	<0.001	0.32/0.18/0.17/0.15/0.13/0.04
7-class	134	43427.699	43925.781	43500.800	0.899	0.770	<0.001	0.20/0.17/0.17/0.16/0.13/0.13/0.04

Note. AIC: Akaike's information criterion; BIC: Bayesian information criterion; sBIC: sample-size-adjusted BIC; LMR: The Vuong-Lo-Mendell-Rubin likelihood ratio test, BLRT bootstrapped likelihood ratio test.

Table 3 Potential predictors of latent profile membership

characteristics	Patient low-caregiver low profile			Patient low-caregiver high profile			Patient high-caregiver low profile		
	OR	95%CI	<i>P</i>	OR	95%CI	<i>P</i>	OR	95%CI	<i>P</i>
Patients									
Economic situation									
Income lesser than the expenditure	5.749	0.589-56.127	0.132	5.943	1.663-21.240	0.006	0.653	0.193-2.213	0.494
Income equal to the expenditure	5.251	0.494-55.791	0.169	1.764	0.453-6.871	0.413	0.263	0.064-1.083	0.064
Income more than the expenditure	Ref			Ref			Ref		
ECOG performance status	3.058	1.857-5.037	<0.001	2.350	1.528-3.615	<0.001	1.572	0.976-2.531	0.063
Neuroticism	1.125	1.037-1.221	0.005	1.072	1.006-1.142	0.032	1.074	0.996-1.158	0.064
Resilience	1.006	0.941-1.075	0.866	0.970	0.921-1.022	0.252	1.037	0.973-1.105	0.264
Family functioning	0.935	0.853-1.026	0.157	0.965	0.895-1.041	0.363	0.916	0.841-0.996	0.041
Caregivers									
Age	1.008	0.955-1.064	0.763	1.026	0.982-1.073	0.253	1.067	1.013-1.124	0.015
Economic situation									
Income lesser than the expenditure	2.150	0.494-9.352	0.307	0.919	0.325-2.598	0.873	2.231	0.639-7.795	0.209
Income equal to the expenditure	1.609	0.357-7.237	0.536	0.995	0.359-2.763	0.993	2.078	0.569-7.592	0.268
Income more than the expenditure	Ref			Ref			Ref		
Relationship to patient									
Spouse	1.727	0.191-15.644	0.627	0.557	0.106-2.939	0.491	1.266	0.165-9.731	0.821
Child	0.430	0.050-3.736	0.444	0.492	0.100-2.435	0.385	1.398	0.192-10.175	0.741
Friend and family	Ref								
Neuroticism	1.073	0.986-1.169	0.103	1.037	0.967-1.113	0.311	1.068	0.986-1.156	0.108
Resilience	0.897	0.836-0.962	0.002	0.956	0.901-1.013	0.128	0.922	0.864-0.983	0.014
Family functioning	1.038	0.934-1.153	0.488	1.039	0.953-1.132	0.385	1.012	0.919-1.115	0.806

Note. ECOG: Eastern Cooperative Oncology Group

CI: confidence interval

The patient high-caregiver high profile was used as the reference group.

Table 4 The combined effect of patient-caregiver dyads' neuroticism, resilience, and family functioning on latent profile membership

Combined effect		Patient low-caregiver high profile			Patient high- caregiver low profile			Patient low-caregiver low profile		
Patient neuroticism	Caregiver neuroticism	OR	95%CI	<i>P</i>	OR	95%CI	<i>P</i>	OR	95%CI	<i>P</i>
Low	Low	Reference			Reference			Reference		
High	Low	3.210	1.256-8.200	0.015	2.032	0.680-6.070	0.204	9.167	2.480-33.886	0.001
Low	High	1.365	0.527-3.535	0.522	2.066	0.726-5.876	0.174	4.247	1.125-16.027	0.033
High	High	2.520	0.974-6.520	0.057	3.920	1.353-11.359	0.012	10.869	3.041-38.849	<0.001
Patient resilience	Caregiver resilience	OR	95%CI	<i>P</i>	OR	95%CI	<i>P</i>	OR	95%CI	<i>P</i>
High	High	Reference			Reference			Reference		
Low	High	2.727	1.101-6.758	0.030	1.721	0.566-5.230	0.338	2.223	0.705-7.051	0.173
High	Low	1.367	0.487-3.838	0.553	4.088	1.428-11.702	0.009	4.331	1.367-13.726	0.013
Low	Low	7.271	2.412-21.925	<0.001	8.620	2.555-29.078	0.001	11.340	3.221-39.921	<0.001
Patient family functioning	Caregiver family functioning	OR	95%CI	<i>P</i>	OR	95%CI	<i>P</i>	OR	95%CI	<i>P</i>
High	High	Reference			Reference			Reference		
Low	High	1.236	0.511-2.987	0.638	1.011	0.338-3.027	0.984	0.498	0.148-1.677	0.260
High	Low	0.502	0.176-1.434	0.198	1.044	0.316-3.453	0.994	1.286	0.407-4.062	0.668
Low	Low	1.916	0.756-4.853	0.170	5.453	1.914-15.537	0.001	2.944	1.039-8.344	0.042

Note. CI: confidence interval

The patient high-caregiver high profile was used as the reference group.

Model adjusted for significant demographic variables (patient's economic situation, ECOG performance status; caregiver's age, economic situation, relationship to patient).

Figures

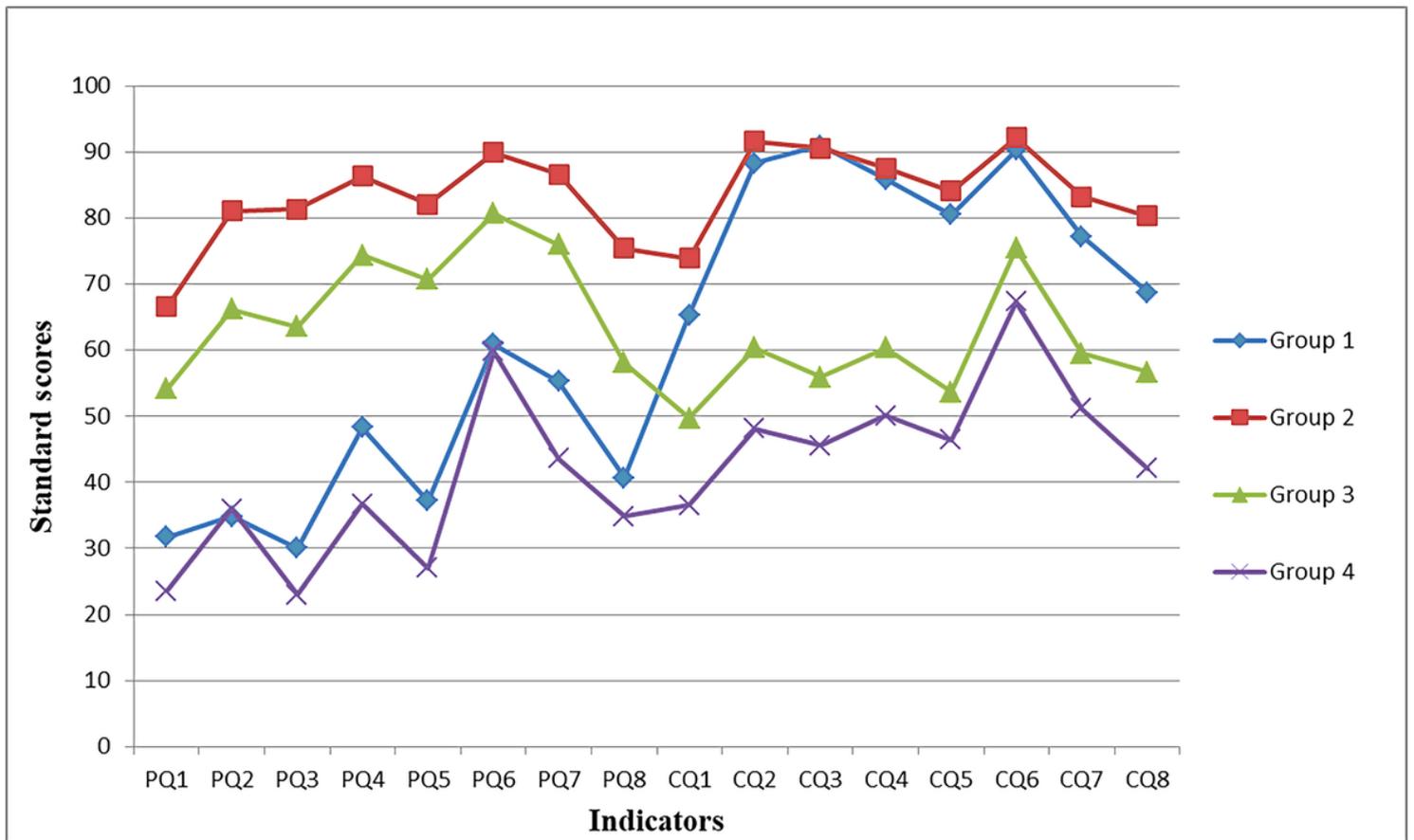


Figure 1

Dyadic quality of life profiles in advanced lung cancer patient-caregiver dyads

PQ1 represents general health perceptions (patients), PQ2 represents physical functioning (patients), PQ3 represents physical role (patients), PQ4 represents social functioning (patients), PQ5 represents emotional role (patients), PQ6 represents bodily pain (patients), PQ7 represents mental health (patients), PQ8 represents vitality (patients); CQ1 represents general health perceptions (caregivers), CQ2 represents physical functioning (caregivers), CQ3 represents physical role (caregivers), CQ4 represents social functioning (caregivers), CQ5 represents emotional role (caregivers), CQ6 represents bodily pain (caregivers), CQ7 represents mental health (caregivers), CQ8 represents vitality (caregivers).

Group 1: Patient low-caregiver high profile; Group 2: Patient high-caregiver high profile; Group 3: Patient high-caregiver low profile; Group 4: Patient low-caregiver low profile