ORIGINAL ARTICLE

Pain and Fatigue in Persons With Postpolio Syndrome: Independent Effects on Functioning

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ABSTRACT. Jensen MP, Alschuler KN, Smith AE, Verrall AM, Goetz MC, Molton IR. Pain and fatigue in persons with postpolio syndrome: independent effects on functioning. Arch Phys Med Rehabil 2011;92:1796-801.

Objectives: To better understand the importance of pain and fatigue in relation to functioning, and to investigate the role that age plays in these relationships in individuals with postpolio syndrome (PPS).

Design: Cross-sectional survey.

Setting: Community-based survey.

Participants: Convenience sample of 446 individuals with PPS.

Interventions: Not applicable.

Main Outcome Measures: Physical functioning (Patient Reported Outcomes Measurement Information System Physical Functioning item bank items), psychological functioning (Patient Health Questionnaire-9), pain intensity (0–10 numerical rating scale [NRS]), and fatigue (0–10 NRS).

Results: Pain and fatigue make independent contributions to the prediction of physical and psychological functioning. Depression was more severe in the middle-aged (≤64y) group than in the young-old (65–74y) or middle-old to oldest (≥75y) groups, although the associations between pain and fatigue and both physical and psychological functioning are similar across all age cohorts.

Conclusions: Complaints of pain or fatigue in patients with PPS who are older or elderly should not be attributed "merely" to the process of aging. The findings also support the need for clinical trials to develop and evaluate interventions that may help patients with PPS function better by treating pain and fatigue, as well as the negative effects that these symptoms can have on functioning.

Key Words: Depression; Fatigue; Pain; Postpoliomyelitis syndrome; Rehabilitation.

PAIN AND FATIGUE ARE common in individuals with postpolio syndrome (PPS).[1-4] One early survey study[5] found that the most common new health problems reported by a large sample (N=539) of individuals with PPS were fatigue, weakness, muscle pain, and joint pain. Similarly, a retrospective chart review[6] of 79 consecutive patients with a history of poliomyelitis identified weakness (87%), muscle pain (86%), fatigue (86%), decreased activity level (78%), joint pain (77%), and back pain (70%) as the most common symptoms acknowledged by this group of patients. Another survey study[7] with 86 individuals with PPS found that fatigue usually occurred daily and increased as the day progressed.

Measures of pain and fatigue have also been shown to be associated with various measures of dysfunction in PPS populations. For example, Hildegunn et al[1] found that self-reported muscle strength, disability, and pain intensity were all associated significantly with measures of fatigue and activity level in a sample of 32 patients with PPS. Östlund et al[8] found pain intensity to be significantly associated with lower levels of physical and psychological functioning in a sample of 143 individuals with PPS. In another survey study,[9] measures of fatigue demonstrated significant associations with both physical and psychological dysfunction.

Although not often examined empirically, the nature of PPS suggests that chronologic age should be associated with more physical dysfunction, as most PPS symptoms tend to start developing in middle age and then often continue to worsen.[10] However, only 1 study[8] has examined the association between age and physical functioning in persons with PPS, and reported only a weak and nonsignificant association between these variables (r=.08). On the other hand, there is some evidence that both pain and fatigue tend to be less severe in older individuals (eg, ≥71y) compared with (relatively) younger individuals with PPS.[8,11]

It is also possible that chronologic age may moderate the associations between symptoms such as pain and fatigue and measures of patient functioning. For example, as individuals age, they may have fewer physiologic reserves, potentially making the negative effects of pain and fatigue on functioning domains (eg, physical functioning, psychological functioning, and overall quality of life) stronger with increased age.[12] On the other hand, there are a number of plausible reasons why the impact of pain and fatigue may become weaker with age. For example, increasing age might be associated with greater experience in managing troublesome symptoms and, therefore, with the development of more effective coping strategies.[13] Similarly, the social context of older adults differs from that of other age groups and may include lower expectations for performance, a perception that pain and fatigue are more normal

List of Abbreviations

NRS	numerical rating scale
PHQ-9	Patient Health Questionnaire-9
PPS	postpolio syndrome
PROMIS	Patient Reported Outcomes Measurement Information System

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or expected, and positive social comparisons with other disabled older adults. Finally, it is also possible that as people with PPS age, pain and fatigue simply become less important than other factors in predicting patient functioning.

Findings from other populations of individuals with chronic pain are generally consistent with models predicting a general decrease in the effects of pain on psychological functioning[14,15] and pain interference with activities of daily living[13] as people age. However, moderation effects of age are not always found in other populations,[16] and in at least 1 study,[12] increased age was found to be associated with stronger associations between pain and psychological functioning. Thus, the presence and direction of age moderation effects may be population dependent. To our knowledge, however, these possible age moderation effects have not yet been examined in individuals with PPS.

The purposes of the current study were (1) to better understand the importance of pain and fatigue in relation to functioning and (2) to investigate the role that age plays in these relationships in persons with PPS by examining and testing for independent effects of pain and fatigue on measures of physical and psychological functioning, and by testing the potential moderating effects of chronologic age on these relationships. Based on findings from previous research, we hypothesized that pain and fatigue would demonstrate significant correlations with both physical and psychological functioning in our sample. However, we did not have a specific a priori hypothesis regarding the potential moderating effects of age on the associations between symptoms and patient functioning, because of the lack of previous research examining such effects in individuals with PPS.

METHODS

Measures

Criterion variables: physical and psychological functioning. Physical activity was measured using 12 items from the 124-item Patient Reported Outcomes Measurement Information System (PROMIS) Physical Functioning item bank.[17-19] The PROMIS Physical Functioning item bank assesses an individual's ability to perform a range of physical activities. Average performance in ability to engage in various tasks over the past week is measured on 5-point scales that range from "without any difficulty" to "unable to do." The items used in the study survey were selected from the PROMIS item bank pool by the study investigators to represent a broad range of activities both inside and outside the home. Chosen items asked respondents to indicate the difficulty with which they are able to (1) put on and take off a coat or jacket; (2) walk more than a mile; (3) carry a bag of groceries for a short distance; (4) prepare simple meals for themselves or for others; (5) do housework such as vacuuming or sweeping floors; (6) move around on a slippery surface outdoors; (7) do vigorous activities such as playing sports; (8) stand up from a low, soft couch; (9) wash and dry their body; (10) make a bed, including spreading and tucking in bed sheets; (11) get up off the floor from lying on their back without help; and (12) go for a walk for at least 15 minutes. As with all PROMIS measures, scores are transformed into t scores, and higher scores represent higher levels of the domain assessed—in this case better physical functioning. Preliminary evaluation supports the PROMIS Physical Functioning item bank's psychometric properties.[20]

The Patient Health Questionnaire-9 (PHQ-9) was used to assess psychological functioning. This 9-item measure asks respondents to rate the frequency that they experienced 9 symptoms of depression in the past 2 weeks by using a 4-point scale, where 0 is "not at all," and 3 is "nearly every day." The PHQ-9 total score can range from 0 to 27, and a higher score represents higher levels of depressive symptoms. The PHQ-9 has been widely used to assess depression severity and has a great deal of support for its validity in populations with physical disabilities, such as spinal cord injury, traumatic brain injury, and multiple sclerosis.[21,22]

Predictor variables: pain intensity and fatigue. Pain intensity and fatigue were measured with the use of numerical rating scales (NRSs) by asking participants to rate the severity of these symptoms over the past week on scales from 0 to 10 (0, "none"; 10, "very severe"). NRSs are frequently used to assess symptom severity, including the severity of both pain and fatigue, and research supports their validity for this purpose.[23-25]

Procedures

To be eligible to participate, potential subjects had to have a self-reported diagnosis of PPS or a self-reported history of polio and polio sequelae, be able to read and write English, and be at least 18 years of age. Potential participants were recruited from (1) a pool of adults with PPS who had previously participated in studies with the University of Washington,[26,27] as well as (2) individuals responding to advertisements through the Post-Polio Health International organization, other PPS support groups, publications, and clinics. Of the 533 people who responded to these invitation letters and advertisements, 479 were found to be eligible to participate in the current study and were sent a survey. Of the surveys mailed, 446 surveys were completed and returned (39 from past University of Washington studies; 407 from advertisements), representing a 93% response rate. After completion of the survey, a check for $25 was sent to each participant. Informed consent was obtained from all participants, and this study was approved by the Institutional Review Board at the University of Washington.

Data Analysis

Before analysis, we examined the distributions of the variables to ensure that they met the assumptions for the planned regression analyses. No evidence for significant skew, kurtosis, outliers, or heteroscedasticity for any predictor or criterion variable was found. Next, we computed means and SDs of the study variables for descriptive purposes. We then computed Pearson correlation coefficients between the predictor and criterion variables to determine their zero-order associations. Finally, we performed 2 regression analyses to determine whether pain and fatigue made independent contributions (ie, when controlling for the other) to the prediction of physical and psychological functioning. The PROMIS Physical Functioning scale and PHQ-9 scale were the criterion variables in these analyses. All predictor variables were centered before being inputted into the model, to reduce any potential problems associated with multicolinearity. Chronologic age was entered in step 1, age^2 was entered in step 2 to test for a possible quadratic association between age and the criterion variables (eg, if there was greater or less dysfunction in the young-old participants relative to the middle-aged or middle-old/oldest participant cohorts), the NRS ratings (0–10) of average pain intensity and fatigue were entered in step 3, and Age $\times$ Pain Intensity and Age $\times$ Fatigue Intensity interaction terms were entered in the fourth step (to test for linear age moderation effects). Finally, the Age^2 $\times$ Pain Intensity and Age^2 $\times$ Fatigue Intensity interaction terms were entered in the fifth step to test for possible quadratic age effects (eg, to determine whether

Table 1: Descriptive Statistics for Physical Functioning, Depression, Fatigue, Pain, and Age

Variable	Mean ± SD	Range	Skew	Kurtosis
PROMIS Physical Functioning (T score)	34.62±7.25	13.96–54.29	0.13	−.04
PHQ-9 Depression	5.85±4.44	0–22	1.06	.99
Average pain over past week	4.30±2.69	0–10	0.07	−.93
Average fatigue over past week	6.10±2.45	0–10	−0.61	−.23
Age (y)	67.22±8.28	41–94	0.39	−.10

there was a larger or smaller association between age and the criterion measures for the young-old cohort relative to the middle-aged and middle-old/oldest cohorts). The β weights and significance levels of each predictor were examined to evaluate their effects.

RESULTS

Participants

The average age ± SD of the 446 study participants was 67.22±8.28 years (range, 41–94y), and the average age at the onset of acute polio was 8.45±7.92 years (range, 0–57y). The sample included 336 women (75.3%) and 110 men (24.7%). Most participants reported their race/ethnicity as white (n=426, 95.5%), with the remainder Native American/American Indian/Alaska Native (n=8, 1.8%), Hispanic/Chicano (N=7, 1.6%), black or African American (n=6, 1.3%), and Asian (n=4, 0.9%). About one-third of the participants (n=151, 33.9%) reported that they had completed graduate or professional school, with the remainder college graduates (n=127, 28.5%), completing some college (n=106, 23.8%), completing high school or a general equivalency diploma (n=40, 9.0%), completing vocational or technical school (n=17, 3.8%), or completing grade 10 or 11 (n=5, 1.1%). There were 184 participants in the middle-aged cohort (range, 41–64y, but only 1 participant was younger than 47y, and only 14 were younger than 55y). One hundred sixty-eight participants were in the young-old cohort (65–74y), and 85 participants were in the middle-old to oldest-old (>75y) cohort.

Means, SDs, and Associations Among the Study Variables

Descriptive analyses for the predictor and outcome variables are reported in table 1. Zero-order correlations between the variables are reported in table 2 and revealed that all the variables were statistically significantly associated with one another, with the exception of age and fatigue.

Table 2: Zero-Order Correlation Matrix of Physical Functioning, Depression, Fatigue, Pain, and Age

Variable	1.	2.	3.	4.
1. PROMIS Physical Functioning				
2. PHQ-9 Depression	−.15*			
3. Average pain intensity over past week	−.21†	.36†		
4. Average fatigue intensity over past week	−.25†	.40†	.45†	
5. Age	−.20†	−.19†	−.04	−.19†

*$P<.01$; †$P<.001$.

Regression Analyses

The overall model for the regression analysis predicting physical functioning was significant ($F_{8,431}=8.37$, $P<.0001$) (table 3). In step 1, age was a significant predictor ($\beta=-.21$, $P<.0001$) and accounted for 4.3% of the variance in the PROMIS Physical Functioning score. The direction of the association indicated that participants who were relatively younger (recall that the "younger" participants in this sample were middle-aged) reported higher levels of physical functioning than those who were relatively older. In step 2, age^2 was not a significant predictor and did not significantly contribute to the variance in physical functioning. In step 3, pain and fatigue accounted for an additional 8.5% of the variance in the PROMIS Physical Functioning score ($F\Delta=21.32$, $P<.0001$). Pain ($\beta=-.16$, $P<.05$) and fatigue ($\beta=-.16$, $P<.0001$) each made significant independent contributions to PROMIS Physical Functioning, with the direction of the associations indicating that those reporting higher levels of pain and fatigue also report lower levels of physical functioning. The interaction terms entered in steps 4 and 5 did not contribute significantly to the model.

The results of the regression analysis predicting depression are presented in table 4. The overall model was significant ($F_{8,424}=15.53$, $P<.0001$). In the first step, chronologic age was a significant predictor ($\beta=-.19$, $P<.0001$) and accounted for 3.4% of the variance in the PHQ-9 Depression score. The direction of the association was consistent with the zero-order associations and indicated that older participants reported less depression. In step 2, age^2 was also a significant predictor ($\beta=.11$, $P<.05$) and accounted for 1.1% of the variance in the PHQ-9 Depression score. This quadratic association was further explored by examining the depression scores for each of 3 age cohort groups: (1) middle-aged (PHQ-9 score, 6.94); (2) young-old (PHQ-9 score, 4.79); and (3) middle-old and oldest-old (PHQ-9 score, 5.65). These findings indicate that the middle-aged participants reported the highest levels of depression, the young-old participants reported the lowest levels of depression, and the middle-old and oldest-old participants reported levels of depression in between the middle-aged and young-old participants.

In step 3, pain and fatigue accounted for an additional 17.4% of the variance in the PHQ-9 Depression score ($F\Delta=47.58$, $P<.0001$). Pain ($\beta=.19$, $P<.0001$) and fatigue ($\beta=.30$, $P<.0001$) each made independent significant contributions to the criterion. The direction of the associations suggests that more pain and more fatigue are associated with greater depressive symptomatology. The interaction terms entered in steps 4 and 5 did not contribute significantly to the model.

DISCUSSION

The findings from this study confirm the significant associations between the severity of pain and fatigue and lower levels of physical functioning and higher levels of depression in

Table 3: Regression Model Predicting PROMIS Physical Functioning Score

Variable	β	t	P	$R^2\Delta$	F($R^2\Delta$)	P
Block 1				.043	19.81	<.001
Age (centered)	−.21	−4.45	<.0001			
Block 2				.005	2.11	.15
Age^2 (centered)	−.07	−1.45	.15			
Block 3				.085	21.32	<.001
Pain (centered)	−.16	−3.15	.02			
Fatigue (centered)	−.19	−3.69	<.0001			
Block 4				.001	0.16	.85
Age (centered) × Pain (centered)	−.03	−.46	.65			
Age (centered) × Fatigue (centered)	.03	.53	.60			
Block 5				.001	0.24	.79
Age^2 (centered) × Pain (centered)	.04	.54	.59			
Age^2 (centered) × Fatigue (centered)	.00	−.04	.97			

NOTE. Overall model: $F_{8,431}$= 8.37, P<.001.

individuals with PPS. Moreover, the findings indicate that both pain and fatigue make independent contributions to the prediction of patient functioning, even when controlling for the other. The symptoms also appeared to show a stronger association with depression than they did with physical functioning. Finally, although we found that age did not moderate the association between pain and functioning, there was a significant quadratic relationship between age and depression. The findings have important implications for understanding the role that pain and fatigue have on functioning in persons with PPS.

Although pain and fatigue have been identified as common problems in individuals with PPS,[1-4] less research has examined the role that these symptoms might play in the physical or psychological functioning of patients. The current findings showing that both pain and fatigue are significantly associated with patient dysfunction are not only consistent with the few studies that have examined this issue,[1,8,9] but indicate that each symptom contributes unique variance to the prediction of both depression and physical functioning. These findings support the need for research to understand the potential benefits of interventions that decrease pain and fatigue in persons aging with PPS.

A recent Cochrane review[28] summarized research findings regarding the efficacy of treatments for PPS, relative to placebo, usual care, or no treatment. The review identified only 9 studies that examined pharmacologic interventions and 3 that tested the efficacy of nonpharmacologic rehabilitation. However, the authors concluded that none of the identified studies were completely free from the risk of bias, and that therefore it is not yet possible to draw definitive conclusions regarding the effectiveness of interventions for PPS. However, the reviewers did identify several promising interventions in need of further study, including intravenous immunoglobulin, lamotrigine, muscle-strengthening exercises, and the use of static magnetic fields.

Although it is reasonable to identify and test the efficacy of medications and other biomedical treatments (eg, physical activity) for PPS-related pain and fatigue, contemporary models of pain and fatigue argue that both biologic and psychosocial factors play a role in the development and maintenance of symptoms, as well as in the impact of symptoms on functioning.[29-33] This is particularly important to keep in mind when considering treatment options for these conditions in older adults, as decreased drug clearance can make for more troubling (and potentially dangerous) side-effect profiles in persons older than 60 years. The natural conclusion from biopsychosocial models of pain and fatigue is that clinicians need not limit themselves to only biomedical interventions when offering treatments for these symptoms. Researchers should also consider testing nonpharmacologic interventions in clinical trials. A number of nonpharmacologic interventions have demonstrated promising results for improving pain or fatigue in a wide variety of patient populations, and include such treatments as cognitive-behavioral therapy,[34] yoga,[35] and self-hyp-

Table 4: Regression Model Predicting PHQ-9 Depression Score

Variable	β	t	P	$R^2\Delta$	F($R^2\Delta$)	P
Block 1				.034	15.29	<.001
Age (centered)	−.19	−3.91	<.0001			
Block 2				.011	4.79	.03
Age^2 (centered)	.11	2.19	.03			
Block 3				.174	47.58	<.001
Pain (centered)	.19	3.96	<.0001			
Fatigue (centered)	.30	6.23	<.0001			
Block 4				.008	2.18	.12
Age (centered) × Pain (centered)	−.08	−1.41	.16			
Age (centered) × Fatigue (centered)	−.03	−.54	.59			
Block 5				.000	.03	.97
Age^2 (centered) × Pain (centered)	−.01	−.15	.88			
Age^2 (centered) × Fatigue (centered)	.00	−.03	.98			

Note: Overall model: $F_{8,424}$=15.53, P<.001.

nosis training.[36,37] Research is needed to determine the extent to which individuals with PPS might also benefit from these treatments. The findings from the current study suggest the possibility that such treatments should target both fatigue and pain, when both are present, to have the best outcomes.

Inconsistent with some research findings using other pain populations,[12-15] but consistent with others,[16] we found that age did not moderate the association between pain intensity and either physical functioning or depression in our sample. This lack of significant moderation effect may be due, at least in part, to our study not including the full age spectrum typical of research on pain in other conditions. Because of the nature of PPS, we had very few young adults in our sample; in fact, only 1 of the study participants was younger than 47 years. In any case, the findings indicate that the importance of pain and fatigue to functioning is similar in all age divisions of middle-aged and older persons with PPS—there is no one particular older age cohort that requires a greater focus on symptom management than any other, at least as far as the potential benefits of improving these symptoms might have on patient functioning.

Consistent with a great deal of research supporting age effects on psychological functioning across both disabled[38] and nondisabled populations,[39-40] overall, older participants reported lower levels of depression than did younger patients. Although rarely examined in other studies, we also found a curvilinear (quadratic) age effect on depressive symptoms. Specifically, we found that the middle-aged (<65y) participants reported the highest levels of depression, that young-old (≥65 but <75y) participants reported the lowest levels of depression, and that middle-old and oldest-old (≥75y) participants reported higher levels of depression than young-old participants did, but less than the middle-aged participants. This pattern of findings is consistent with a larger literature suggesting that depression is often at its worst during middle age,[41] at a time when performance expectations are at their highest and physical functioning is beginning to deteriorate. Depression then often decreases in the years after retirement, when older adults have greater control over environmental demands and have fewer daily hassles,[42] although this requires adequate finances and health.[43] The subsequent increase in depression from the older adult to the elderly years is thought to be associated with the development of multiple health problems,[38,44] and is consistent with research showing such increases in individuals with various chronic diseases.[45] If our finding of greater depression scores in the middle-old and oldest-old groups, relative to the young-old, is replicated in future studies, it would suggest the need to develop and evaluate interventions that would help elderly individuals with PPS better cope with the factors that may be contributing to depression as they age.

Study Limitations

The current study has a number of limitations that should be kept in mind when interpreting the results. First, although the sample was large, it consisted of individuals willing to complete a survey; individuals with PPS who were not interested in or willing to complete the survey might differ in some unknown way from the current sample. Thus, the extent to which the findings generalize to all individuals with PPS is not known. Replication of the current findings in other samples is therefore needed to help establish their reliability. Second, although the relationships found between symptom severity and both physical and psychological functioning were statistically significant, they were in the moderate range; clearly, factors in addition to pain and fatigue contribute to both physical and psychological functioning in persons with PPS. Future research should examine variables in addition to symptoms such as pain and fatigue as correlates of patient functioning to help identify the factors that are most important, and to help build a more comprehensive predictive model. Third, although the participants were recruited from sources that are likely to consist mostly, if not entirely, of individuals with PPS (eg, advertisements through the Post-Polio Health International organization, other PPS support groups, publications, and PPS clinics), we did not directly confirm the PPS diagnosis of the study participants. Thus, it is possible that some unknown number of participants may not actually have PPS. Research is therefore needed to replicate the current findings in other samples of individuals with PPS—ideally samples whose diagnosis of PPS can be medically confirmed. Finally, the current study used a correlational cross-sectional design; the significant associations found cannot be used to conclude that pain and fatigue *cause* physical or psychological dysfunction. However, the findings do indicate that research testing the potential beneficial effects of pain and fatigue treatment on patient functioning is warranted. As discussed above, such research can and probably should include studies examining both medications and nonpharmacologic interventions.

CONCLUSIONS

Despite the study's limitations, the findings provide important new information regarding the importance of pain and fatigue as correlates of patient functioning in individuals with PPS. The results demonstrate that pain and fatigue both make independent contributions to the prediction of functioning, supporting the need for clinical trials to develop and evaluate interventions that may help patients with PPS function better by decreasing the severity and negative impact of pain and fatigue. Although depression may be more common or severe in middle-aged adults with PPS than in older adults and the elderly, the relationship between pain and fatigue and both physical and psychological functioning appears to be similar across all age cohorts. This finding suggests that complaints of pain, fatigue, or both, in patients with PPS who are older or elderly should not be attributed "merely" to the process of aging.

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