Fatigue, Sleep Disturbances, and Their Influence on Quality of Life in Cervical Dystonia Patients

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Abstract: Background: Nonmotor symptoms (NMS) are highly prevalent in cervical dystonia (CD). In general, fatigue and sleep are important NMS that determine a decreased health-related quality of life (HR-QoL), but their influence in CD is unknown. The authors systematically investigated fatigue, excessive daytime sleepiness (EDS), and sleep quality in patients with CD and controls and assessed the influence of psychiatric comorbidity, pain, and dystonia motor severity. They also examined the predictors of HR-QoL. Methods: The study included 44 patients with CD and 43 matched controls. Fatigue, EDS, and sleep quality were assessed with quantitative questionnaires and corrected for depression and anxiety using analysis of covariance. The Toronto Western Spasmodic Torticollis Rating Scale and the Clinical Global Impression Scale-jerks/tremor subscale were used to score motor severity and to assess whether motor characteristics could explain an additional part of the variation in fatigue and sleep-related measures. HR-QoL was determined with the RAND-36 item Health Survey, and predictors of HR-QoL were assessed using multiple regression. Results: Fatigue scores were increased independently from psychiatric comorbidity (4.0 vs. 2.7; \( P < 0.01 \)), whereas EDS (7.3 vs. 7.4; \( P = 0.95 \)) and sleep quality (6.5 vs. 6.1; \( P = 0.73 \)) were highly associated with depression and anxiety. In patients with CD, motor severity did not explain the variations in fatigue (change in the correlation coefficient \( \Delta R^2 = 0.06; \ P = 0.15 \)), EDS (\( \Delta R^2 = 0.00; \ P = 0.96 \)), or sleep quality (\( \Delta R^2 = 0.04; \ P = 0.38 \)) scores. Fatigue, EDS, psychiatric comorbidity, and pain predicted a decreased QoL. Conclusion: Independent from psychiatric comorbidity and motor severity, fatigue appeared to be a primary NMS. Sleep-related measures were highly associated with psychiatric comorbidity, but not with motor severity. Only NMS predicted HR-QoL, which emphasizes the importance of attention to NMS in patients with CD.

Introduction

Cervical dystonia (CD) is a hyperkinetic movement disorder characterized by sustained or intermittent contractions of the cervical musculature, leading to abnormal head postures. Although CD is by its motor symptoms, growing evidence indicates that nonmotor symptoms (NMS) are an important part of the phenotype of CD\(^1\)–\(^3\) and that they have a profound effect on health-related quality of life (HR-QoL).\(^3\)–\(^5\)

Although psychiatric comorbidity has been studied more extensively, only a few studies have investigated the prevalence and severity of fatigue, excessive daytime sleepiness, and sleep quality in patients with CD. Fatigue, which refers to an increased level of perceived fatigue,\(^6\) has been described in 50%
of patients with CD. Data from studies reviewed by Hertenstein et al. are usually within the normal range in patients with CD, whereas sleep quality reportedly was reduced in several studies. To date, it is still unknown whether these symptoms may be a response to or related with psychiatric comorbidity or whether they are a secondary phenomenon in response to motor symptoms. Interestingly, symptoms of excessive daytime sleepiness and disturbed sleep quality did not improve after botulinum toxin (BoNT) therapy despite significant improvement of dystonia motor severity, suggesting that these symptoms may be a primary phenomenon in dystonia.

Although the former studies have shown that fatigue and sleep disturbances are highly prevalent in patients with CD, methodological limitations were noted. Neither an appropriate control group nor an objective CD motor score were lacking. Moreover, not all studies examined the influence of depression, anxiety, pain, and severity of motor symptoms on fatigue, excessive daytime sleepiness, and sleep quality scores. HR-QoL and the most important predictors of a reduced HR-QoL were often not systematically assessed.

In the current study, we examined the prevalence and severity of fatigue, excessive daytime sleepiness, and sleep quality in patients who had CD compared with a matched control group. In addition, we calculated the fatigue and sleep-related scores corrected for depression and anxiety. Then, in the patient group, we used a stepwise linear regression model to examine whether motor characteristics could explain an additional part of the variation in fatigue and sleep-related measures other than the known association with psychiatric comorbidity and pain. In addition, we assessed whether motor symptoms and/or NMS were the most important contributors to a decreased HR-QoL.

**Patients and Methods**

**Participants**

We included patients who had clinically diagnosed, idiopathic CD with a group of age-matched and sex-matched controls. An exclusion criterion for the patients was the onset of CD before age 18 years. Additional exclusion criteria for all participants included other relevant neurological comorbidity and the use of antidepressant medication. All participants had previously been included in a study about psychiatric comorbidity (see also Smit et al.). Informed consent was obtained from all participants, and the study was approved by the local ethics committee.

**Fatigue, Excessive Daytime Sleepiness, Sleep Quality, and HR-QoL**

Fatigue was evaluated using the Fatigue Severity Scale (FSS). The FSS quantifies the impact of fatigue and contains 7 items, which are scored on a scale from 1 to 9. The summed score (maximum, 63) is divided by 9, and a total score of more than 4 is regarded as an indicator of fatigue. Excessive daytime sleepiness was assessed using the self-administered Epworth Sleepiness Scale (ESS), in which a score of 10 or higher (range, 0–24) indicates excessive daytime sleepiness. Quality of sleep was evaluated using the Pittsburgh Sleep Quality Index (PSQI), in which a score of 5 or higher (range, 0–21) indicates impaired sleep quality. The severity of depression and anxiety were measured with the Beck Depression Inventory (BDI) and the Beck Anxiety Inventory (BAI), respectively. HR-QoL was assessed using RAND-36 item Health Survey (RAND-36). For all scales, a score of zero indicates no complaints, and increasing scores indicate increasing severity.

**Motor Assessment**

Motor assessment was performed by using a systematic video protocol. To obtain the least influenced motor score, 39 patients were videotaped 2 weeks before their next BoNT injections, and 5 patients were videotaped in the first week after BoNT injections. CD severity was scored using the Toronto Western Spasmodic Torticollis Rating Scale (TWSTRS). Because the TWSTRS does not include severity of jerks and tremor, jerks and tremor also were scored using the 7-point Clinical Global Impression Scale: CGI-S jerks-tremor.

**Statistical Analysis**

Statistical analyses were performed using the PASW Statistics 22 software package (IBM Corporation, Armonk, NY), and differences were considered significant at \( P < 0.05 \). Demographic and clinical data were compared between patients with CD and controls using the Pearson \( \chi^2 \) test/Fisher exact test or the Mann-Whitney U test. An analysis of covariance (ANCOVA) was performed to control for the potential confounding effect of depression and anxiety on the FSS, ESS, and PSQI. For this purpose, the BDI and BAI scores were combined into 1 factor using factor analysis.

In the group of patients with CD, the influence of motor severity on fatigue, excessive daytime sleepiness, and sleep quality was assessed with a stepwise multiple linear regression analysis. In the first step, we assessed the influence of depression, anxiety, and the severity of pain on the FSS, ESS, and PSQI. In the second step, we assessed whether motor characteristics, including dystonia, jerks, and tremor, could explain an additional part of the variation in FSS, ESS, and PSQI scores.

The influence of clinical variables on HR-QoL in patients with CD was first assessed in a univariate analysis. Because we had a relatively small number of patients, this was performed with the Spearman’s \( \rho \) test, or, for the discrete dichotomous variables, with the Pearson \( r \) test. In multiple regression analysis, we then determined the influence of variables that had \( P \) values <0.05 in the univariate analysis on the HR-QoL domains using...
backward elimination. Assumptions of the linear regression and multicollinearity were checked.

## Results

### Clinical Characteristics

This study included 44 patients with CD (mean age, 51 years; range, 20–80 years) and 43 controls (mean age, 54 years; range, 25–83 years) (Table 1). Nine patients with CD used benzodiazepines, 1 used trihexyphenidyl, 1 used gabapentin, and 1 used pregabalin. In the control group, 3 participants used benzodiazepines. Benzodiazepine type, dosage, and frequency were highly variable. Mean ESS scores (±standard deviation) in patients with CD were significantly higher in those who were using psychoactive medication (mean ± standard deviation, 12.6 ± 6.7 vs. 7.7 ± 6.6; P = 0.04), but no relation with sleep quality was observed (Table S1). None of the participants were officially diagnosed with restless legs syndrome (RLS). Snoring was significantly more prevalent in patients with CD versus controls (68.2% vs. 39.5%; P < 0.01). Breath-holding spells also were more prevalent in CD patients, although the difference was not significant (18.2% vs. 7.0%, respectively; P = 0.12).

Patients with CD had a mean ± standard deviation dystonia duration of 13.3 ± 11.2 years. The mean ± standard deviation total TWSTRS score was 34.1 ± 13.0, and the mean CGI-S jerks/tremor score was 2.5 ± 1.3. Patients scored significantly worse than controls on the FSS (4.4 ± 1.7 vs. 2.7 ± 1.4; P < 0.01), the ESS (8.8 ± 6.9 vs. 5.8 ± 4.9; P = 0.04), and the PSQI (7.4 ± 3.9 vs. 5.1 ± 4.4; P < 0.01). In addition, patients scored significantly worse on the depression rating scale (10.6 ± 7.3 vs. 4.5 ± 5.0; P < 0.01) and the anxiety rating scale (9.3 ± 6.8 vs. 4.0 ± 4.2; P < 0.01).

Based on the criteria described above (see Patients and Methods), significantly more patients fulfilled the criteria for fatigue (n = 28 [63.3%] vs. 7 [16.7%]; P < 0.01), excessive daytime sleepiness (n = 19 [43.2%] vs. 9 [20.9%]; P = 0.03) and impaired sleep quality (n = 34 [77.3%] vs. 18 [41.9%]; P < 0.01) compared with controls.

After controlling for depression and anxiety, patients still scored significantly worse on the FSS (mean score, 4.0 vs. 3.1; P = 0.01). In contrast, scores on the ESS (mean score, 7.3 vs. 7.4; P = 0.95) and the PSQI (mean score, 6.5 vs. 6.1; P = 0.73) were not significantly different between groups after controlling for depression and anxiety (Table 1).

### Predictors of Fatigue, Excessive Daytime Sleepiness, and Sleep Disturbances

To assess whether the FSS, ESS, and PSQI scores in the CD patient group were associated with the severity of the dystonic posturing, jerks, and/or tremor, we performed a stepwise linear regression analysis. In the first step, we assessed the influence of depression, anxiety, and the severity of pain on FSS, ESS, and PSQI scores. In the second step, we assessed the influence of the severity of dystonia, jerks, and tremor in addition to Step 1. Thus, in the first step, we included factors that are known from the literature to have an effect on fatigue and sleep-related measures; and, in the second step, we assessed whether motor characteristics could explain an additional part of the variation in fatigue and sleep-related measures.

The FSS was significantly influenced by depression, anxiety, and pain (correlation coefficient $\beta^2 = 0.37$ for Step 1; $P < 0.01$), with a significant influence from depressive symptoms ($\beta = 0.44$; $P = 0.01$) (Table 2, S2). Motor severity did not influence fatigue scores (change in the correlation

### Table 1: Clinical Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CD, n = 44</th>
<th>HC, n = 43</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>54 ± 18.6</td>
<td>54 ± 11.3</td>
<td>0.93</td>
</tr>
<tr>
<td>Sex: No. of men/women</td>
<td>12/32</td>
<td>11/32</td>
<td>0.86</td>
</tr>
<tr>
<td>TWSTRS score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>34.1 ± 13.0</td>
<td>31.3 ± 11.2</td>
<td></td>
</tr>
<tr>
<td>Severity</td>
<td>16.0 ± 4.6</td>
<td>11.3 ± 3.9</td>
<td></td>
</tr>
<tr>
<td>Disability</td>
<td>18.2 ± 5.5</td>
<td>14.3 ± 5.0</td>
<td></td>
</tr>
<tr>
<td>Pain</td>
<td>7.9 ± 6.2</td>
<td>6.8 ± 4.0</td>
<td></td>
</tr>
<tr>
<td>CGI-S jerks/tremor</td>
<td>2.5 ± 1.3</td>
<td>2.1 ± 1.1</td>
<td></td>
</tr>
<tr>
<td>Nonmotor characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BDI score</td>
<td>10.6 ± 7.3</td>
<td>4.5 ± 5.0</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>BAI score</td>
<td>9.3 ± 6.8</td>
<td>4.0 ± 4.2</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Uncorrected/corrected scores:Mean ± SD/mean&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSS</td>
<td>4.4 ± 1.7/4.8</td>
<td>2.7 ± 1.4/3.1</td>
<td>&lt;0.01/0.81</td>
</tr>
<tr>
<td>ESS</td>
<td>8.8 ± 6.9/7.3</td>
<td>5.8 ± 4.9/7.4</td>
<td>0.04/0.95</td>
</tr>
<tr>
<td>PSQI</td>
<td>7.4 ± 3.9/6.5</td>
<td>5.1 ± 4.6/6.1</td>
<td>&lt;0.01/0.73</td>
</tr>
</tbody>
</table>

CD, cervical dystonia; HC, health controls; SD, standard deviation; TWSTRS, Toronto Western Spasmodic Torticollis Rating Scale; CGI-S, Clinical Global Impression Scale; BDI, Beck Depression Inventory; BAI, Beck Anxiety Inventory; FSS, Fatigue Severity Scale; ESS, Epworth Sleepiness Scale; PSQI, Pittsburgh Sleep Quality Index.

*Corrected values are controlled for depression and anxiety as 1 factor by using analysis of covariance.
HR-QoL and Predictors of a Decreased HR-QoL

The patient group scored significantly worse on the first 8 domains of the HR-QoL rating scale compared with the healthy control group (Table 3). Univariate analysis showed that decreased HR-QoL in patients with CD was associated with fatigue, excessive daytime sleepiness, sleep disturbances, depression, anxiety, and pain, whereas motor symptoms were not associated with HR-QoL (Table 4).

Multiple linear regression analysis revealed that the FSS had a significant negative influence on the domains physical functioning ($\beta = -0.60$; $P < 0.01$), mental health ($\beta = -0.26$; $P = 0.06$ for Step 2; $P = 0.00$ for Step 2; $P = 0.96$).

TABLE 2 Influence of Motor Symptom Severity on the Fatigue Severity Scale, the Epworth Sleepiness Scale, and the Pittsburgh Sleep Quality Index

<table>
<thead>
<tr>
<th>Measure</th>
<th>Step 1 R²</th>
<th>P value</th>
<th>Step 2 ΔR²</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSS</td>
<td>0.37</td>
<td>&lt;0.01</td>
<td>0.06</td>
<td>0.15</td>
</tr>
<tr>
<td>ESS</td>
<td>0.31</td>
<td>&lt;0.01</td>
<td>0.00</td>
<td>0.46</td>
</tr>
<tr>
<td>PSQI</td>
<td>0.26</td>
<td>0.01</td>
<td>0.04</td>
<td>0.38</td>
</tr>
</tbody>
</table>

$\Delta R^2$, change in the correlation coefficient; FSS, Fatigue Severity Scale; ESS, Epworth Sleepiness Scale; PSQI, Pittsburgh Sleep Quality Index; R², correlation coefficient.

*Multiple linear regression analysis was used to predict the effect of depression, anxiety, and pain (Step 1) on the FSS, ESS, and PSQI and the additional effect of severity of motor symptoms (Step 2) in patients with cervical dystonia.

coefficient ($\Delta R^2$) = 0.06 for Step 2; $P = 0.15$), although the CGI-S jerks/tremor score showed a mild association with the FSS ($\beta = 0.27$; $P = 0.05$).

The ESS was also significantly influenced by Step 1 ($R^2 = 0.31$ for Step 1; $P < 0.01$), with depression being the only significant predictor ($\beta = 0.57$; $P < 0.01$). In Step 2, severity of dystonia, jerks, and tremor did not significantly influence the model ($\Delta R^2 = 0.00$ for Step 2; $P = 0.96$).

The PSQI was significantly influenced by the TWSTRS pain score ($\beta = 0.40$; $P = 0.01$; $R^2 = 0.26$ for Step 1; $P = 0.01$), whereas depressive symptoms had no significant influence. Motor symptoms did not influence the PSQI score ($\Delta R^2 = 0.04$ for Step 2; $P = 0.38$).

TABLE 3 Health-related Quality of Life in Patients with Cervical Dystonia and Healthy Controls

<table>
<thead>
<tr>
<th>HR-QoL Domain</th>
<th>CD, n = 44</th>
<th>HC, n = 43</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical functioning</td>
<td>75.0 (55.0-98.0)</td>
<td>95.0 (90.0-100.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Social functioning</td>
<td>75.0 (62.5-88.0)</td>
<td>100.0 (88.0-100.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Role limitation-physical</td>
<td>50.0 (9.0-100.0)</td>
<td>100.0 (75.0-100.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Role limitation-emotional</td>
<td>100.0 (42.4-100.0)</td>
<td>100.0 (100.0-100.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Mental health</td>
<td>72.0 (63.5-80.0)</td>
<td>88.0 (80.0-92.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Vitality</td>
<td>55.0 (40.0-68.0)</td>
<td>80.0 (65.0-85.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Pain</td>
<td>62.0 (45.0-79.9)</td>
<td>90.0 (67.0-100.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>General health perception</td>
<td>57.5 (41.3-78.0)</td>
<td>80.0 (70.0-98.0)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Expected health change</td>
<td>50.0 (31.3-58.0)</td>
<td>50.0 (50.0-58.0)</td>
<td>0.13</td>
</tr>
</tbody>
</table>

HR-QoL, health-related quality of life; CD, cervical dystonia; HC, healthy controls.

TABLE 4 Correlations between the Domains of Health-related Quality of Life and Clinical Variables in Patients with Cervical Dystonia

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PF</td>
</tr>
<tr>
<td>Demographic characteristics</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.14</td>
</tr>
<tr>
<td>Sex</td>
<td>-0.03</td>
</tr>
<tr>
<td>Nonmotor scores</td>
<td></td>
</tr>
<tr>
<td>FSS</td>
<td>-0.71b</td>
</tr>
<tr>
<td>ESS</td>
<td>-0.55b</td>
</tr>
<tr>
<td>PSQI</td>
<td>-0.29</td>
</tr>
<tr>
<td>BDI</td>
<td>-0.51b</td>
</tr>
<tr>
<td>BAI</td>
<td>-0.43b</td>
</tr>
<tr>
<td>Dystonia rating scales</td>
<td></td>
</tr>
<tr>
<td>Dystonia duration</td>
<td>-0.09</td>
</tr>
<tr>
<td>TWSTRS severity</td>
<td>-0.13</td>
</tr>
<tr>
<td>TWSTRS pain</td>
<td>-0.44b</td>
</tr>
<tr>
<td>CGI-S jerks/tremor</td>
<td>0.01</td>
</tr>
</tbody>
</table>

PF, physical functioning; SF, social functioning; RLP, role limitation-physical; RLE, role limitation-emotional; MH, mental health; GHP, general health perception; EHC, expected health change; FSS, Fatigue Severity Scale; ESS, Epworth Sleepiness Scale; PSQI, Pittsburgh Sleep Quality Index; BDI, Beck Depression Inventory; BAI, Beck Anxiety Inventory; TWSTRS, Toronto Western Spasmodic Torticollis Rating Scale; CGI-S, Clinical Global Impression Scale.

*P < 0.05; bP < 0.01.
TABLE 5  Predictors of Decreased Health-related Quality of Life in Patients with Cervical Dystonia*

<table>
<thead>
<tr>
<th>Domain</th>
<th>Predictor(s)</th>
<th>Adjusted R²</th>
<th>B( SE)</th>
<th>β</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical functioning</td>
<td>FSS</td>
<td>0.48</td>
<td>−0.82 (0.16)</td>
<td>−0.60</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Social functioning</td>
<td>TWSTRS pain</td>
<td>0.48</td>
<td>−0.82 (0.48)</td>
<td>−0.24</td>
<td>0.05</td>
</tr>
<tr>
<td>Role limitation-physical</td>
<td>TWSTRS pain</td>
<td>0.48</td>
<td>−1.88 (0.37)</td>
<td>−0.62</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Role limitation-emotional</td>
<td>BDI</td>
<td>0.48</td>
<td>−2.88 (0.61)</td>
<td>−0.52</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Mental health</td>
<td>BDI</td>
<td>0.67</td>
<td>−2.58 (0.72)</td>
<td>−0.39</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Vitality</td>
<td>BDI</td>
<td>0.49</td>
<td>−0.84 (0.24)</td>
<td>−0.39</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Pain</td>
<td>TWSTRS pain</td>
<td>0.45</td>
<td>−0.81 (0.24)</td>
<td>−0.39</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>General health perception</td>
<td></td>
<td></td>
<td>0.70 (0.23)</td>
<td>−0.38</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

R² = correlation coefficient; B, unstandardized regression coefficient; SE, standard error; β, standardized regression coefficient; FSS, Fatigue Severity Scale; TWSTRS, Toronto Western Spasmodic Torticollis Rating Scale; BDI, Beck Depression Inventory; ESS, Epsworth Sleepiness Scale; BAI, Beck Anxiety Inventory.

*Clinical characteristics that were significantly associated with decreased health-related quality of life were assessed with multiple linear regression analysis after backward elimination. For variables that had a significant influence, the adjusted R², B (with SE in parenthesis), and β were calculated.

P = 0.03) and pain (β = −0.37; P < 0.01) (Table 5). The ESS had a significant negative influence on the domains mental health (β = −0.39; P < 0.01) and vitality (β = −0.36; P = 0.01). The PSQI was not associated with any of the HR-QoL domains. In addition to fatigue and excessive daytime sleepiness, the severity of depression, anxiety, and pain was also negatively associated with the domains physical functioning, social functioning, role limitation-emotional, vitality, and pain. Motor symptoms were not included in the multiple regression analysis, because they were not associated with HR-QoL in the univariate analysis.

**Discussion**

These results demonstrate a significantly increased prevalence of fatigue, excessive daytime sleepiness, and impaired sleep quality in patients who have CD compared with controls. The level of perceived fatigue in patients with CD appeared to be increase independent of psychiatric comorbidity and motor symptom severity. Excessive daytime sleepiness and sleep quality were highly associated with depression and anxiety, but not with motor symptoms severity.

Compared with other studies, we observed a higher prevalence of fatigue in patients with CD. In our cohort, 63.3% fulfilled the criteria of fatigue, whereas 2 other studies reported a prevalence of 50%. One explanation could be that depression symptom scores were also higher in our cohort compared with those in the study by Wagle Shukla et al. (10.6 vs. 6.8). Because depression is positively associated with fatigue scores, this might explain the higher frequency of fatigue in our patient group. However, after correction for depression and anxiety, fatigue scores were still significantly increased in our CD population. Moreover, we also observed higher excessive daytime sleepness scores (8.8 vs. 7.4), a variable that is also positively associated with fatigue. Severity of motor symptoms did not significantly influence fatigue scores, although severity of jerks/tremor showed a mild association with the perceived level of fatigue. Similar to other neurological disorders like Parkinson’s disease (PD) and multiple sclerosis, in which fatigue is a primary symptom,5 fatigue may be part of the phenotype of dystonia instead of a secondary phenomenon. Dysfunction of the basal ganglia is likely to form a shared underlying mechanism of both the dystonia motor pathophysiology and fatigue.6 In particular, serotonergic functioning in the basal ganglia might especially contribute to both fatigue and dystonia. Decreased serotonin transporter binding was observed in patients with PD, and was even lower in those who had PD with fatigue.21 These findings reinforce the hypothesis that a primary mechanism, intrinsic to dystonia, may be responsible for the perception of fatigue in patients with CD.

The severity of excessive daytime sleepiness and impaired sleep quality was similar to the scores reported in other studies and was related even more to depressive and anxiety symptoms. Pain, which was present in 77.3% of our patients, also appeared to be significantly associated with impaired sleep quality, and excessive daytime sleepiness was related to medication use. The severity of dystonia and/or jerks/tremor was not associated with excessive daytime sleepiness or an impaired sleep quality. A different approach to assessing the influence of motor symptoms was used by Eichenseer et al., who examined patients before and after BoNT treatment. Although BoNT significantly improved the motor symptoms, there was no effect on the excessive daytime sleepiness or sleep quality scores.9 Both approaches suggest that the severity of motor symptoms does not significantly contribute to excessive daytime sleepiness or an impaired sleep quality. Along with the influence of depression and pain, other factors, such as RLS, possibly also may contribute. As described by Paus et al., the prevalence of RLS in...
CD was increased and was associated with an impaired sleep 
quality.22 None of our participants had a medical history of 
RLS, but it was not systematically investigated in our study. 
Medications like benzodiazepines or GABAergic agents also 
were related to higher excessive daytime sleepiness scores in 
our patient cohort, but not to impaired sleep quality. Due to 
the use of several types of medication, with different doses and 
variable frequencies and ranging from sporadic to daily use, it was 
not possible to perform a reliable correction for medication use. 
However, the study by Eichenseer et al. did not identify an 
influence of benzodiazepine use on sleep impairment in patients 
with CD,22 suggesting that medication does not play a major 
role in altered sleep in CD.

HR-QoL in patients with CD not only is influenced by psy-
chiatric comorbidity,5 but fatigue and excessive daytime sleepi-
ness also appeared to be significant contributors to a decreased 
HR-QoL. The influence of tiredness on HR-QoL was previ-
ously described by Soeder et al., although they did not use a 
CD-specific motor scale and thus could not exclude the influ-
ence of motor symptoms.3 In our study, the severity of dystonia 
and of jerks and tremor was not associated with decreased HR-
QoL. The influence of fatigue and excessive daytime sleepiness on 
HR-QoL highlights the need for systematic screening of 
these symptoms in daily practice and the necessity of treating 
possible contributing factors like depression and pain.

This study had several limitations. First, our results could 
have been biased by the use of medication. Nine patients and 2 
healthy controls used benzodiazepines, which could have 
held sedative effects and a reduced sleep quality.3 On the 
other hand, the exclusion of patients using antidepressant medi-
ation also could have caused a selection bias by excluding 
those with high depressive scores. In total, we did not include 8 
patients who were using various antidepressants; and within the 
different hospitals, several additional patients were not asked to 
participate because of known medication use. Because depres-
sion appeared to be highly correlated with fatigue and excessive 
daytime sleepiness, this could have influenced our results. 
Therefore, the increased fatigue, excessive daytime sleepiness, 
and sleep disturbance scores in our cohort may be underesti-
imated, emphasizing the need to screen for these symptoms in 
daily practice. Second, in our study, we focused only on the 
subjective sensations of fatigue, excessive daytime sleepiness, and 
sleep quality. In future studies, objective measures to study fati-
gability or sleep quality, like electromyography or polysomnog-
raphy, would be helpful in understanding the underlying 
pathophysiological mechanisms.

In conclusion, high rates of fatigue, excessive daytime 
sleepiness, and sleep disturbances were detected in our study 
among patients with DC. Independent from psychiatric comorbid-
ity, pain, and motor severity, fatigue appeared to be 
a primary NMS. Sleep-related measures were highly associ-
ated with depression, anxiety, and pain, but not with motor 
symptom severity. Importantly, only NMS significantly influ-
enced HR-QoL, whereas severity of motor symptoms had no 
influence on any of the HR-QoL domains. Our results sug-
gest that fatigue, excessive daytime sleepiness, and a decreased 
sleep quality are correlated with psychiatric comorbidity but 
must be seen independently from motor symptoms and 
require different treatment approaches. Future studies are war-
ranted to investigate pathophysiological mechanisms behind 
fatigue and impaired sleep quality in patients with dystonia 
and to assess whether targeted treatment of fatigue, excessive 
daytime sleepiness, and sleep disturbances could improve 
HR-QoL in patients with CD.

Disclosures

Ethical Compliance Statement: We confirm that we have 
read the Journal’s position on issues involved in ethical publica-
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**Supporting Information**

Additional Supporting Information may be found online in the supporting information tab for this article:

- **Table S1.** The effect of psychoactive medication on FSS, ESS, and PSQI scores
- **Table S2.** Influence of motor symptom severity on the FSS, ESS, and PSQI