DOI: 10.1002/ejp.1879

EJP European Journal of Pain

ORIGINAL ARTICLE

The clinical course of neck pain: Are trajectory patterns stable over a 1-year period?

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Funding information
The Norwegian Research Foundation for Chiropractors (EliB) and the European Chiropractic Union Research Fund funded the study. They had no influence on the scholarly conduct of the research interpretation of the results or discrimination of study outcomes. The Danish Foundation for Advancement of Chiropractic Research and Postgraduate Education financially supports AK's position at the University of Southern Denmark.

Abstract

Background: Recent studies with data-driven approaches have established common pain trajectories. It is uncertain whether these trajectory patterns are consistent over time, and if a shorter measurement period will provide accurate trajectories.

Methods: We included 1,124 patients with non-specific neck pain in chiropractic practice. We classified patients into pre-defined trajectory patterns in each of four quarters of the follow-up year (persistent, episodic, and recovery) based on measures of pain intensity and frequency from weekly SMS. We explored the shifts between patterns and compared patients with stable and shifting patterns on baseline characteristics and clinical findings.

Results: 785 (70%) patients were in the same pattern in 1st and 4th quarters. Patients with episodic pattern in the 1st quarter shifted to other patterns more frequently than patients in the other patterns. A stable persistent pattern was associated with reduced function and higher scores on psychosocial factors. There was a decreased frequency of patients classified as persistent pattern (75% to 63%) and an increase of patients in recovery pattern (4% to 15%) throughout the four quarters. The frequency of patients classified as episodic remained relatively stable (21% to 24%).

Conclusions: We found an overall stability of the persistent pattern, and that episodic patterns have more potential for shifts. Shifts mostly occurred between patterns closest in pain variation. The deviation in pattern distribution compared with previous studies suggests that the duration of measurement periods has an impact on the results of the classification.

Significance: Having persistent pain and having very minor pain is relatively stable over one year, while episodic pain has more potential for shifts. The duration of measurement periods appears to have an impact on the results of the classification. The given criteria resulted in a reduced frequency of episodic pattern due to shorter measurement periods. Our findings contribute to improved understanding and predicting NP using a combination of patient characteristics and trajectory patterns.

1 | INTRODUCTION

Neck pain (NP) is the second most common musculoskeletal complaint, causing a considerable impact on quality of life and large economic consequences for patients and society (Hoy et al., 2014; Hurwitz et al., 2018). The majority of patients have no clinically identifiable pathoanatomic cause (non-specific neck pain) and are treated in primary care settings (Kinge et al., 2015; Kovacs et al., 2019). Several studies show that most patients display an initial attenuation in symptoms and disability subsequent to the onset of an acute episode of spinal pain (Burns et al., 2020; Carroll et al., 2008; Vasseljen et al., 2013; Vos et al., 2008). Although this initial improvement is also found in patients already in a long-lasting course of pain, it seems to be larger and more rapid in patients presenting at the onset of an acute episode (Bot et al., 2005; Knecht et al., 2020; Langenfeld et al., 2015; Leaver et al., 2013; Peterson et al., 2012; Rubinstein et al., 2008). Previous research is mainly based on outcomes measured as mean values at single time points. These methods miss the variations found in individual trajectories of pain and provide only general trends of recovery. However, trajectories based on frequent pain measures to capture temporal variation also show that a large majority of patients with spinal pain display patterns of initial improvement (Ailliet et al., 2018; Axén et al., 2012; Chen et al., 2018; Dunn et al., 2006, 2013; Kongsted et al., 2015; Pico-Espinosa et al., 2019). Also, patients with long-lasting pain have a dynamic course of pain (Ailliet et al., 2018; Irgens et al., 2020; Kongsted et al., 2016; Pico-Espinosa et al., 2019). A better understanding of various clinical courses may be helpful in communicating the likely pain prognosis with the patient and in decisions regarding treatment.

Previous studies on low back pain (LBP) patients have suggested criteria for classifying trajectories of LBP based on pain variation patterns (ongoing, fluctuating, episodic and recovery) and pain severity (severe, moderate, mild and minor) (Kongsted et al., 2016). Sixteen subgroups based on these criteria matched well with trajectories of LBP, and identified subgroups that also differed in severity on other parameters (Irgens et al., 2020; Kongsted et al., 2017). We have previously found that the same definitions fit readily to NP patients in a chiropractic setting, but also that they needed refinement (Irgens et al., 2020).

Based on the previous findings that most patients report an improvement in symptoms and disability in a follow-up period, one may hypothesize that they will shift from more severe trajectory patterns (e.g. persistent pain) to milder patterns (e.g. episodic pain or recovered). However, it is also demonstrated that spinal pain tends to affect people in similar ways over many years (Dunn et al., 2013; Lemeunier et al., 2012). Still, it is unknown to what extent trajectory patterns based on frequent pain measures are stable over time. Hence, the aims of the present study were to (1) describe the NP trajectories in four consecutive quarters and examine to what extent patients shift from one trajectory pattern to another, and (2) describe and compare patient characteristics within stable and shifting trajectories during 1-year follow-up. We investigated this in patients with non-specific NP in a chiropractic setting.

2 | METHODS

2.1 | Study design, population and setting

In this study, we used data from a one-year observational, multi-center practice-based cohort consisting of patients with non-specific NP in a chiropractic care setting in Norway. Seventy-one chiropractors located across Norway invited eligible patients with NP to participate in the study between September 2015 and June 2016. Decisions regarding treatment and follow-up were at the chiropractors' discretion. Descriptions of cohort recruitment and study procedures, including the comparison of our cohort with a cohort of LBP patients from Kongsted et al., are published previously (Irgens et al., 2020; Myhrvold et al., 2019, 2020). The Regional Committee for Medical and Health Research Ethics (2015/89) approved the study protocol.

We included patients aged 18 years or more, that presented with NP as their primary or secondary complaint and visited the chiropractor for the first time or were already in a treatment course. Patients had to have basic Norwegian reading and writing skills, as well as own and be able to operate a mobile phone. We excluded patients with suspected inflammatory diseases, fractures, systemic pathology, or nerve root involvement requiring referral to surgery. Participants received oral and written information about the study from the chiropractor and signed a written consent if they agreed to participate.

2.2 | Data collection

Once a week over a 1-year period, the participants received an automated short message service (SMS) with the following questions: "How many days the last week has your neck been bothersome? Please answer with a number between 0 and 7" (hereafter 'paindays'). If the answer to the first SMS was 0, question 2 was not sent. If the answer was between 1 and 7, the patient received a second SMS "How intense has your NP typically been the last week? 0= no bother, 10= worst possible bother" (hereafter 'pain intensity'). All participants received a third SMS "How many days the last week has your neck limited your daily activities? Please answer with a number between 0

and 7" (hereafter 'limitation days'). The SMS collection through SMS-Track has been used in several data collections (Ailliet et al., 2018; Axen et al., 2012; Kongsted et al., 2015), with acceptable reliability (Johansen & Wedderkopp, 2010).

2.2.1 | Baseline data

Characteristics of symptoms included duration of NP history (<5 years, ≥5 years), duration of current episode (<1 month, 1–3 months, >3 months), and functional status measured by the Neck Disability Index (NDI). NDI consists of 10 items regarding pain and function scoring from 0 to 5. The sum score ranges from 0 to 50 points, with higher scores indicating more disability (Johansen et al., 2014; Vernon & Mior, 1991). For this study, we used the pain intensity from SMS question 2. Number of musculoskeletal pain sites (0–10) was measured by the Nordic pain questionnaire (NPQ) (0–10) (Kuorinka et al., 1987). Patients who responded "Yes" to pain in shoulder, elbow and/or hand in the NPQ were defined as having radiating pain. Emotional stress was measured by the Hopkins Symptom Checklist (HSCL-10), scores ranging from 1 to 4 (Derogatis et al., 1974; Strand et al., 2003). Higher scores indicate higher emotional distress. Psychosocial risk factors were measured by the Örebro-screening questionnaire. The sum score ranges from 0 to 100 points, where higher scores indicate higher risk of persistent pain and disability (Grotle et al., 2006; Linton & Boersma, 2003). We measured recovery expectations from Item 7 of the Örebro Musculoskeletal Pain Questionnaire (Linton et al., 2011), "In your view, how large is the risk that your current pain may become persistent?" (0–10, 0 = no risk, 10 = very large risk).

We defined consultation type as follows; "first-time consultation" as patients recruited at the first visit for a new episode of NP, "follow-up consultation" as patients recruited arbitrarily during the treatment course, and "maintenance consultation" as patients recruited at a regular visit according to a pre-planned schedule (check-up irrespective of symptoms) to maintain improvement and/or prevent flare-ups (Axen et al., 2020; Bringsli et al., 2012; Myburgh et al., 2013).

All of these were from questionnaires completed by participants at baseline.

2.3 | Data analyses

We present descriptive variables as frequencies and percentages or means with standard deviations (SD). We imputated missing values on the weekly pain intensity measures in three stages as follows: (1) replaced missing responses in week 1 and 52 by the values in week 2 and 51 respectively, (2) replaced one-week or two-week gaps between weeks with the same pain intensity with that same value. A total of 333 (23%) of patients had one or more weeks where the data were imputed. However, the majority needed only one imputation. The most commonly imputed value was zero (51%). We omitted from analyses participants who after steps 1 And 2 had less than 6 SMS responses in each 13-week quarter.

2.3.1 | Categorization into variation patterns, trajectory pattern shifts, and subgroups

To be able to explore the research question regarding the stability of trajectories over one year, we needed to reduce the previously identified sixteen subgroups into fewer subgroups. We did that according to the suggestions from two previous studies (Irgens et al., 2020; Kongsted et al., 2017). These found that very few patients fit into the Ongoing and single episode variation patterns. Also, Ongoing and Persistent fluctuating patterns were found to be very similar with persistent pain rarely being absolutely steady in pain intensity. We, therefore, decided to combine the Ongoing and persistent fluctuating variation patterns into one pattern called persistent pattern. In our previous study (Irgens et al., 2020), we found that patients in the minor subgroups of Ongoing episodic and single episode shared similar demographic, functional and psychosocial characteristics, and patients were only negligibly affected by their pain. Also, pain intensity was below what is considered clinically significant (<2 on NRS) (Kovacs et al., 2008; Pool et al., 2007). We therefore included all patients with maximum pain intensity <2 in a new pattern called recovery. Patients in the Minor Persistent fluctuating subgroup were significantly more affected by their pain than the other three minor subgroups and were not included in the recovery pattern. Initial analyses showed that the single episode pattern included too few patients for comparison with the other patterns. We also considered that having one short episode of pain per quarter to be different from having no pain. We, therefore, combined the single episode pattern with the episodic pattern. This led to three variation patterns for analysing the stability persistent, episodic and recovery, defined as follows: In the persistent pattern, patients could have no pain-free period lasting four weeks or longer. Patients in the episodic pattern must have at least one pain-free period of minimum four weeks in a row between weeks with pain. The duration of the pain-free period was based on consensus-formed definitions (Stanton et al., 2011; de Vet et al., 2002), and has been tested in an LBP cohort (Eklund et al., 2016).

In order to assess the stability of the patterns over one year, we divided the year into four quarters (hereafter '1st quarter', '2nd quarter', etc.). We classified patients to one of the three patterns (persistent, Episodic or Recovery) within each of the quarters based on their SMS responses.

It was the main aim to study the shift in patterns between quarters during one year. To explore the development over time further, we also studied the shift of intensity levels within and/or between each pattern. For that purpose, we split the persistent pattern into four subgroups based on mean pain intensity as follows: severe (pain intensity ≥6), moderate (4≤pain intensity<6), mild (2≤pain intensity<4), and minor (pain intensity <2), in line with previously suggested cut-off values for pain (Boonstra et al., 2014, 2016; Fejer et al., 2005; Serlin et al., 1995). We split the episodic and single Episode patterns into three subgroups each, based on the maximum pain intensity reported throughout the quarter: Severe (pain intensity ≥6), Moderate (4≤pain intensity<6) and Mild (2≤pain intensity<4). Altogether this resulted in 11 subgroups, hereafter called 'subgroups' (see Table S1).

2.4 | Statistical analyses

To describe the course of NP in the four quarters, we report proportion of patients in each subgroup per quarter. For this part, we kept the single episode as a separate pattern.

We used Sankey diagrams to illustrate the proportions of patients shifting pattern from one quarter to the next, based on the patients' pattern in the 1st quarter. The columns represent the proportion of patients in the respective patterns in each quarter (Figure 1). The flow between columns represents the proportion of the patients shifting from one into another pattern.

The Sankey diagrams showed similar shifts between the quarters two through four. We therefore decided to define patients who were classified with the same pattern in the 1st and 4th quarter to have a stable trajectory pattern. We defined patients classified with different patterns in the 1st and 4th quarter to have a shifting trajectory pattern. This left us with three possibilities for patients in each of the patterns in the 1st quarter (staying in the same pattern or shifting to either of the other two).

All data were assessed for normality prior to analyses, and were found to have distributions close to normal. To compare the differences between patients in stable and shifting trajectory patterns, we used one-way analysis of variance (ANOVA) between the three possible shifts on the following baseline data: NDI, HSCL-10, Örebro, and pain intensity. We used Chi-square and Fisher exact tests (when appropriate) to examine differences in pain duration and total history of NP and to investigate the association between how patients shift trajectories within each consultation type. For all analyses of shifts, we performed pairwise comparisons with Bonferroni corrections. As a sensitivity analysis of the definition of a stable trajectory pattern, we performed the same analyses looking at the shifts occurring from the 3rd to 4th quarter instead of from the 1st to the 4th. All analyses were carried out using STATA 16.1 (StataCorp, Texas, USA).

3 | RESULTS

A total of 1,469 patients received SMS weekly of whom 1,124 (77%) responded to a sufficient number of SMSs to be classified as a pattern in all four quarters and formed the study sample. Seventeen percent of the sample were recruited at first consultation. There were few and mostly small differences between the included and excluded patients (Table 1).

3.1 | Distribution of patients into patterns in the four quarters

Seventy-five percent of the patients had a persistent pattern in first quarter. In the three consecutive quarters the frequency was reduced to about 65%. This reduction occurred mainly in the Moderate and Mild subgroups. The frequency of patients with episodic or single episode patterns remained stable at around 20% and less than 5%, respectively. The recovery group increased initially from 4% in the first quarter to 11–15% thereafter. The episodic pattern in the first quarter and the recovery pattern in all four quarters had the largest proportion of patients with imputed data, indicating that patients were most commonly pain-free when not responding to SMS for one or two weeks (Table 2).

3.2 | Shifts of trajectory patterns between quarters

In total, 785 (70%) patients were in the same trajectory pattern in the 1st and the 4th quarter, of whom 648 (82%) were in a stable persistent trajectory pattern, and 104 (13%) and 33 (4%) were in the episodic and recovery trajectory patterns, respectively.

Figure 1 shows the proportion of patients shifting between patterns from one quarter to the next, based on their pattern classification in the 1st quarter. Very few patients shifted directly between the Persistent and Recovery patterns after the 1st quarter. Patients classified as Persistent and Recovery in the 1st quarter showed similar trends for shifts. The majority of these

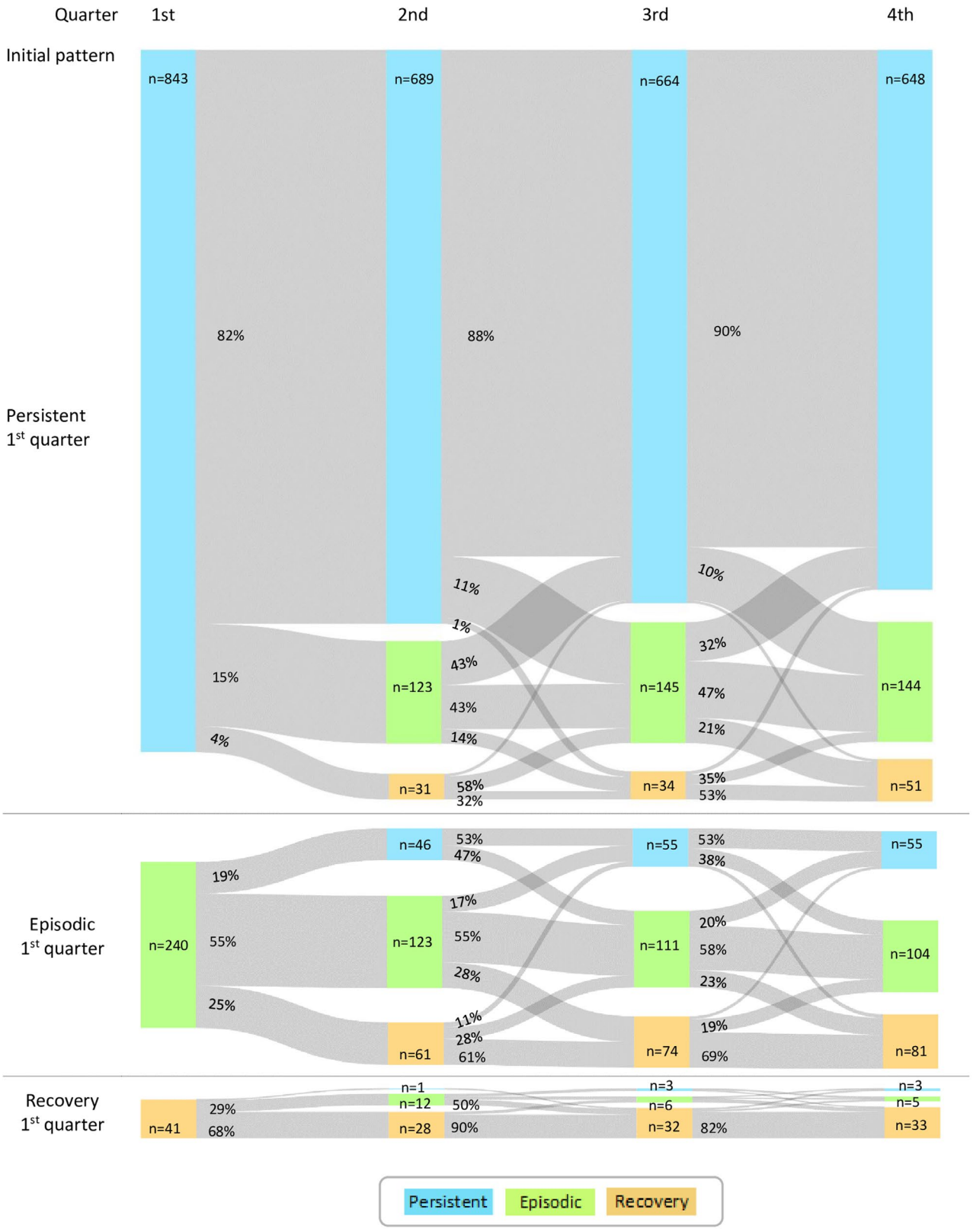

FIGURE 1 Sankey diagram showing the proportion[1] shifting from 1st Quarter through to 4th Quarter, in persistent, episodic (episodic and single Episode patterns) and recovery patterns. Explanatory legend: [1]The height of the columns reflect the number of patients in each quarter. The percentage reflects the proportion of patients responding to sufficient SMS for distribution from one quarter to the next. Shifts with $n \leq 10$ are not presented with percentage for flow. For instance, 15% of patients who were in the persistent pattern during the 1st quarter shifted to episodic during the 2nd quarter, and among these, 43%, 43%, and 14%, respectively, returned to persistent, stayed in episodic, and further shifted to recovery in the 3rd quarter

TABLE 1 Characteristics and clinical findings of patients at baseline

Characteristics	Study cohort $n = 1,124$ %	Study cohort $n = 1,124$ Mean (SD)	Excluded cohort $n = 235$[a] %	Excluded cohort $n = 235$[a] Mean (SD)
Age Mean (SD) [range 18–85]		45 (14)		41 (12)
Females	74		75	
Radiating pain	76		78	
Headache	87		87	
Concomitant low back pain	77		80	
Consultation type at recruitment				
First episode	23		24	
Follow-up	15		14	
Maintenance treatment plan	62		62	
Duration of NP				
<1 month	23		21	
1–3 months	14		19	
>3 months	63		60	
>5 year history of NP	32		32	
Traumatic cause	18		15	
Recovery expectations[b](0–10)		5.8 (3.1)		5.8 (3.1)
Baseline intensity of NP (NRS 0–10)		4.0 (2.2)		3.9 (2.2)
Disability - NDI (0–50)		12 (6.8)		12 (6.5)
Psychosocial screening - ÖMPQ (0–100)		38 (17)		31 (23)
Psychological distress - HSCL−10 (1–4)		1.7 (0.5)		1.6 (0.5)
General health (VAS 0–100)		71 (19)		69 (21)

HSCL-10, Hopkins Symptom Checklist-10; NDI, Neck Disability Index; NP, Neck pain; NRS, Numeric rating scale; ÖMPQ, Örebro Musculoskeletal Pain Questionnaire; SD, Standard Deviation.

[a]Patients responding to baseline questionnaire.

[b]Recovery expectations from Item 7 of the Örebro Musculoskeletal Pain Questionnaire.

patients (82–90% for persistent and 68–90% for recovery) remained in their initial pattern from one quarter to the next. Of the patients in a shifting persistent trajectory pattern, most shifted between Episodic and Persistent patterns.

Patients in an episodic pattern in the 1st quarter were more likely to shift but had no specific trend of shifts. About half of the patients remained in the episodic pattern from one quarter to the next, and about equal parts of the other half shifted to persistent or single episode.

On a subgroup level, there was a trend showing that patients remaining in one pattern from one quarter to the next still shifted between severity subgroups within their respective pattern (see Table S2). Of the patients starting in and then shifting away from a persistent pattern from one quarter to the next, the shift primarily occurred from the Minor Persistent subgroup to the Severe or Moderate episodic subgroups. No patients shifted from Severe or Moderate persistent subgroups into the recovery pattern from one quarter to the next. Patients in the Severe and Moderate episodic subgroups tended to shift to the lower intensity persistent subgroups or the recovery pattern.

3.3 | Characteristics of patients in stable and shifting patterns

Patients in the persistent pattern in the 1st quarter staying in the same pattern had worse baseline scores and a longer history of NP than those shifting away from that pattern (Table 3). For patients starting in an episodic pattern, there was a tendency for worse scores in those moving to a persistent pattern, but most differences were small. For those in a recovery pattern in the 1st quarter, a shift in pattern was only observed in very few patients and baseline profiles should be interpreted with great caution. It appears that those staying in the recovery pattern are relatively mildly affected and more often reported short episode duration.

TABLE 2 Distribution of patients into patterns and subgroups by the four quarters ($n = 1,124$)

Period	First Quarter (Week 1–13)	Second Quarter (Week 14–26)	Third Quarter (Week 27–39)	Fourth Quarter (Week 40–52)
Pattern	***n* (%)**	***n* (%)**	***n* (%)**	***n* (%)**
Persistent				
Severe	65 (6)	53 (5)	64 (6)	73 (6)
Moderate	245 (22)	192 (17)	188 (17)	185 (16)
Mild	413 (37)	360 (32)	341 (30)	318 (28)
Minor	120 (11)	131 (12)	129 (11)	130 (12)
Total	843 (75)	736 (66)	722 (64)	706 (63)
Episodic				
Severe	81 (7)	63 (6)	53 (5)	49 (4)
Moderate	82 (7)	74 (7)	72 (6)	81 (7)
Mild	66 (6)	85 (8)	77 (7)	63 (6)
Total	229 (20)	222 (20)	202 (18)	193 (17)
Single Episode				
Severe	2 (<1)	7 (<1)	6 (<1)	14 (1)
Moderate	4 (<1)	13 (1)	18 (2)	15 (1)
Mild	5 (<1)	26 (2)	36 (3)	31 (3)
Total	11 (1)	46 (4)	60 (5)	60 (5)
Recovery	41 (4)	120 (11)	140 (12)	165 (15)

TABLE 3 Baseline characteristics of patients with stable or shifting trajectories between the first and fourth quarter

Variable		Pain intensity	HSCL−10	NDI	Örebro	Duration >4weeks	NP history >5 years
Shifts	***n* (%)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	**Mean(SD)**	***n*(%)**	***n*(%)**
From persistent							
Stable persistent	652 (77)	4.6 (2.0)*	1.7 (0.5)*	13.6 (6.6)*	42.5 (16.4)*	533 (86)***	419 (73)**
to episodic	145 (17)	3.8 (2.0)	1.6 (0.5)	10.2 (5.7)	35.8 (16.1)	108 (79)	76 (67)
to recovery	53 (6)	3.4 (2.1)	1.5 (0.4)	10.0 (9.0)	31.5 (18.3)	34 (74)	14 (42)
From episodic							
to persistent	55 (23)	3.3 (2.3)	1.6 (0.4)	9.1 (5.4)	33.7(16.3)**	34 (65)	28 (64)
Stable episodic	104 (43)	2.8 (2.1)	1.5 (0.4)	7.9 (4.5)	29.6 (15.3)	55 (57)	55 (61)
to recovery	81 (34)	3.2 (2.1)	1.4 (0.4)	8.0 (4.9)	26.7 (15.1)	38 (52)	30 (53)
From recovery							
to persistent	3 (7)	0.3 (0.6)	1.2 (0.2)	1.3 (2.3)	20.0 (10.1)	2 (67)	1 (50)
to episodic	5 (12)	0.2 (0.4)	1.4 (0.4)	6.8 (5.3)	26.4 (16.5)	2 (40)	3 (100)
Stable recovery	34 (81)	0.1 (0.3)	1.3 (0.3)	3.7 (3.1)	19.5 (12.9)	12 (41)	6 (38)

Note: Differences: ANOVA or Pearson Chi2/Fisher's exact, Bonferroni corrected, *$p < 0.005$ between stable Persistent and Persistent to Episodic and Persistent to Recovery; **$p < 0.005$ between stable Persistent and Persistent to Recovery and between Episodic to Persistent and Episodic to Recovery; ***$p < 0.05$ between stable Persistent and Persistent to Recovery.

HSCL-10 short form, The Hopkins Symptom Checklist; NDI, Neck Disability Index; NP, Neck pain; SD, Standard deviation.

For the sensitivity analysis of the definition of a stable trajectory pattern, we found almost identical results in patient characteristics when we assessed the shift from third to fourth quarter, compared to first to fourth quarter (see Table S3).

4 | DISCUSSION

This study explored the stability of trajectories for patients with non-specific NP over one year. We classified patients from chiropractic practice into pre-defined trajectory

patterns of NP in each of four consecutive quarters of the follow-up year. The majority of patients stayed in the same trajectory pattern from one quarter to the next. The lowest frequency of shifts was found for patients classified as persistent. Patients showing a stable persistent trajectory had reduced function and higher scores on psychosocial factors compared with those reporting pain-free periods (classified as Episodic or Recovery) in one or more quarters.

4.1 | Patient distribution and shifts between subgroups and patterns

With 70% of patients in a stable pattern across four quarters, our findings indicate that the patterns remain relatively stable. A similar stability is found in other studies on LBP in GP practice (Dunn et al., 2013) and the general population (Lemeunier et al., 2013). In these studies, the majority of subjects were classified in the same pain pattern 7 and 8 years after the first measurement period.

Patients with a shifting pattern were most often classified as episodic in the first quarter. They shifted mainly to the nearby pattern, and rarely had a large change in pain- or pain-free duration (e.g. Shift from Persistent to Recovery). Overall there was a small trend of improvement across the 4 quarters, with decreased frequency of patients showing persistent pattern. This is in agreement with results from other studies with weekly measurements (Ailliet et al., 2018; Pico-Espinosa et al., 2019).

Apart from a small decrease in the frequency of persistent pattern and an increase in recovery pattern from first to second quarter, we found only minor differences in the distribution of patients into pre-defined patterns in each of the four quarters. However, the shorter measurement period of one quarter used led to a marked decrease in the number of patients classified as episodic (21–24% in the 4 quarters) when compared to our previous study of with a measurement period of 43 weeks (45%) (Irgens et al., 2020). While the shorter measurement period does not make a large impact on the stability of the patterns, it does appear to have an impact on the distribution of the patients. The definitions of an episode require a pain-free period of 4 weeks or longer (Kongsted et al., 2016, 2017; de Vet et al., 2002). It is more probable for such a period to occur during a full year compared to the quarter used in this study. Also, it is likely that some patients, by chance, have a painful episode that extends past the one quarter, thus classifying the patient as persistent. Previous trajectory studies on NP found that pain episodes could last from 3 to 20 weeks (Ailliet et al., 2018; Pico-Espinosa et al., 2019). Thus, the likely explanation for why more patients are classified as persistent during one quarter than during 43 weeks is a combination of a shorter measurement period and the criteria for the subgroup definitions.

4.2 | Characteristics of patients with stable and shifting trajectory patterns

Patients in a stable persistent trajectory pattern had more psychological stress and pronounced symptom histories compared to patients in the shifting trajectory patterns regardless of their initial pattern. This was similar to results from two other NP studies with frequent measures (Ailliet et al., 2018; Pico-Espinosa et al., 2019). Our findings can support the phenotypes recently described by Meisingset et al (2020), where the majority of the patients with continuous pain were in phenotypes characterized by poorer scores on all measured health-related factors. This opens up the possibility that an optimal prediction of the long-term course of pain needs a combination of early trajectory patterns and clinical phenotypes.

4.3 | Strengths and limitations

The main strengths in the present study were weekly SMS responses through one year, in a large cohort of NP patients. The high response rate on the SMS, ranging from 81% to 95%, throughout the study period ensured a solid basis for the analyses and the conclusions. Close to 75% of the recruited patients responded with sufficient SMS data to be classified into a pattern in each of the four quarters. In addition, there were only minor differences between the included participants and those excluded. Yet, we cannot completely rule out that missing data have influenced the distribution and the shifting of patterns. Moreover, we followed the recommendations for trajectory research proposed in a recent review (Kongsted et al., 2016) and used recognizable definitions as well as common, descriptive terminology (Stanton et al., 2011). Hence, the study can be replicated in different cohorts, settings and countries.

The small number of patients in the single episode pattern in all quarters can be a limitation and might indicate that patients with acute episodes were not recruited. Although instructed to document the number of patients not invited, or unwilling, to participate, very few chiropractors actually did so. However, reported baseline characteristics and outcomes of the participants are similar to other cohort studies from both primary care and the general population (Bruls et al., 2018; Hill et al., 2007; Vos et al., 2008), as well as other trajectory studies on NP (Ailliet et al., 2018; Pico-Espinosa et al., 2019). Also, it could be the result of it being quite unlikely to have only

one, very specific type of episode and thus, not surprisingly, it is seldom found. Furthermore, although patients received treatment at the chiropractors' discretion during the study period, this study does not include the assessment of the possible influence of this treatment on their course of pain.

This study was performed on patients in chiropractic practice. We have previously shown that our cohort distribution resembles that of LBP patients in GP practice (Irgens et al., 2020), and in Norway chiropractic patients represent 16% of patients who seek conservative treatment for musculoskeletal pain conditions (Kinge et al., 2015). Even with differences in distributions across patterns, the shifts over time are likely to be the same across settings, and we therefore consider it likely that our results are generalizable to other populations.

4.4 | Implications for clinical practice and future studies

Our study provides new information about the individual variations within trajectory patterns and the clinical course of pain. In particular, what is meant by chronic pain is challenged. It is well established that defining pain as chronic purely based on persistent pain lasting three months or longer is too simple. Persistent pain fluctuates (Irgens et al., 2020; Kongsted et al., 2017), and we have shown that an episode of pain can last for more than three months, yet still be followed by pain-free weeks and that these patients have a possibility of recovering. Moreover, patients with pain-free periods are less bothered by their pain and appear to have a potential for improvement compared to patients with little to no pain-free periods. However, patients classified as episodic also have a risk for shifting into persistent pain. Thus, including questions during the clinical consultation regarding the variations of the course of pain, may help identify which patients to target for (new) follow-up strategies, and which patients need only short-term advice. It is still to be investigated if persistent NP can be altered by effective treatment strategies, or how these patients are best supported in their ongoing self-management of NP. Investigating shifts in patterns may also be helpful for identifying prognostic factors that have not been revealed in 'traditional' prognostic research.

Our results can also be combined with phenotypes from prognostic studies (Meisingset et al., 2020; Myhrvold et al., 2019), and possibly be used in developing clinical tools for more targeted patient care. What remains to be learnt from these trajectory patterns in their current form with regard to clinical importance needs to be studied further. In particular, the relationship between treatment (intensity, content and timing) and clinical course is of great interest. However, frequent measures over a long period are time consuming, expensive, and impractical for use both in clinical practice and research. A next step should therefore examine if the trajectories can be found in drawings of corresponding visual patterns. The knowledge of such self-reported versus data-driven trajectories is emerging (Dunn et al., 2017; Hestbaek et al., 2019; Myhrvold et al., 2019, 2020), and visual trajectories have the potential to substitute long-term follow-ups in research. Our study can form a basis for applying the same approach to NP.

5 | CONCLUSION

This is the first study to assess the stability of non-specific NP trajectory patterns over consecutive periods. Having persistent pain and having very minor pain is relatively stable over one year, while episodic pain has more potential for shifts. The duration of measurement periods appears to have an impact on the results of the classification. The given criteria resulted in a reduced frequency of episodic pattern due to shorter measurement periods. Our findings contribute to improved understanding and predicting NP using a combination of patient characteristics and trajectory patterns.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS

All authors were involved in developing the design of the study. PI and BLM prepared and cleaned the data. PI did the statistical analysis in consultation with KW. PI, HSR and NKV wrote the first draft. All authors contributed by discussing the results, reviewing previous versions of the manuscript and approving the final version. PI and BLM had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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How to cite this article: Irgens, P., Myhrvold, B. L., Kongsted, A., Waagan, K., Engebretsen, K. B., Vøllestad, N. K., & Robinson, H. S. (2021). The clinical course of neck pain: Are trajectory patterns stable over a 1-year period? *European Journal of Pain*, 00, 1–12. https://doi.org/10.1002/ejp.1879