The NeckPix©: development of an evaluation tool for assessing kinesiophobia in subjects with chronic neck pain

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Introduction

Chronic neck pain (NP) is not only related to physical factors such as postural alterations, articular stiffness or muscle weakness, but may also be influenced by beliefs and behaviours, which are important determinants of symptoms, disability and their perception [1]. It is now recognised that kinesiophobia (i.e. fear-based movement avoidance) plays a central role in the development and persistence of spinal chronic pain [2–6]. According to the fear-avoidance model, negative appraisals such as anxiety or catastrophising lead to fear-avoidance beliefs that may then lead to illness behaviour and poor physical perfor-mance; this induces subjects to sacrifice other tasks, such as everyday activities or the use of adaptive coping strategies [2, 7]. It is therefore important to use outcome measures to help clinicians identify patients whose level of disability

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may be determined by kinesiophobia to improve interventions targeted at its management [2, 8].

The Fear-Avoidance Beliefs questionnaire and the Tampa Scale of Kinesiophobia (TSK) are two widely used questionnaires for assessing fear of movement/re-injury in subjects with musculoskeletal complaints [9, 10]. Studies have demonstrated their good reliability and validity, and they have been found to be associated with measures of pain, disability, and mood disorders [9, 11, 12]. One limitation is they do not provide information about which specific activities of daily living (ADL's) a patient might fear or avoid. On the other hand, region-specific patient-related outcomes for assessing "disability", such as the Neck Disability Index (NDI) [13], provide ratings of specific activities, but these are present in differing formats in the numerous NP-related instruments for assessing self-rated disability. As such, they may not allow sufficient information to be obtained that is directly related to the patients' first-hand self-perceptions of activity avoidance. They are also limited by the number of ADL's used for rating in each of the instruments.

It has been suggested that the presentation of images of ADL's patients might find stressful or consider difficult to perform can allow a more in-depth investigation of the situations important to each individual patient which they are avoiding during their everyday activities [2]. This is the rationale underlying the development of the Photo-graph Series of Daily Activities Scale (PHODAS) for patients with chronic low back pain (LBP) [14]. This instrument, which consists of 100 photographs showing everyday activities ranging from household chores to physical exercise, investigates patients' judgements of the harmful consequences of everyday movements. It has been found to have good psychometric properties [15], and has been used in studies of cognitive-behavioural therapy (CBT) [16–18]. Subsequently, the Pictorial Fear of Activity Scale-Cervical (PFActS-C) was developed as a tool for assessing fear in whiplash injuries; it consists of 77 photographs and evaluates the extent to which specific kinds of biomechanical loads (i.e. direction of movement, arm position, weight bearing, and extremity movement) influence fear ratings. It has been found to have good psychometric properties [19].

However, given the importance of identifying specific daily activities a patient might fear in the context of CBT programmes for NP [20], and recognising the inappropriateness of the PHODAS in relation to neck disorders and of the limitations of the PFActS-C in assessing ADLs, we developed a novel instrument suitable for patients with NP called NeckPix©. The aim of this article is to describe its development and validation as a simple and rapid means of assessing daily activities in the context of pain-related fear of chronic non-specific NP.

Methods

This cross-sectional study was approved by our Institutional Review Board.

Subjects

Outpatients attending our Physical Medicine and Rehabilitation Unit were consecutively recruited between April and December 2012. The inclusion criteria were chronic non-specific (i.e. common) NP (lasting more than 12 weeks), an age of >18 years, and an ability to read and speak Italian fluently. The exclusion criteria were acute (lasting up to 4 weeks) and subacute non-specific NP (lasting up to 12 weeks), specific causes of NP (e.g. disc herniation, cervical stenosis, spinal deformity, fracture, spondylolisthesis), central or peripheral neurological signs, systemic illness, mental deficits, recent cerebrovascular accidents or myocardial infarctions, chronic lung or renal diseases, and previous CBT.

The subjects' demographic and clinical characteristics were recorded by a research assistant, and the eligible patients gave their written informed consent.

Construct definition and purpose

NeckPix© was designed to measure the beliefs of subjects with chronic non-specific NP concerning pain-related fears of a specific set of ADL's in such a way that the scale score would generalise to a measure of activity-related kinesiophobia.

Choice of measurement method

As the perception of pain-related fear requires direct information from patients, we developed a multi-image instrument with one global question about the construct applied to each item.

Development

The measure was developed by means of item generation and reduction/selection [21, 22]. The first defines the content of an index and ensures all the important variables are considered for inclusion; the second eliminates redundant or inappropriate items, and decreases their number to a total that is feasible to administer to patients while ensuring the scale measures the construct of interest.

Item generation The images were generated on the basis of: (1) a review of the literature concerning spinal disabilities; (2) input from patients and NP experts; and (3) a review of the concepts covered by existing outcome scales. A total of 50 images were generated at the end of this stage.

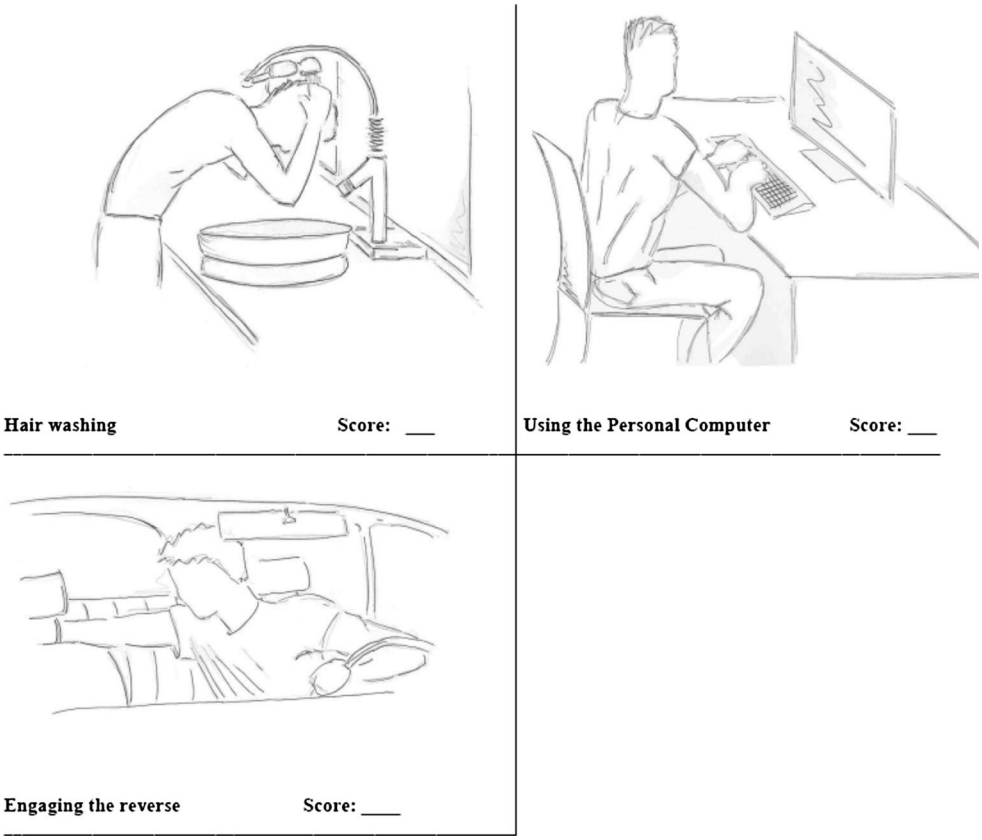

Fig. 1 Examples of pictures taken from the NECKPIX© Questionnaire. Please rate each picture according to this question: How much do you fear that doing this activity would hurt your neck? To rate the picture, use a number from 0 to 10 where 0 = no fear and 10 = greatest fear

Item reduction/selection The developers first eliminated 24 images that were considered redundant or not clinically related to the neck. The subsequent selection was made by three expert evaluators (a physiatrist, a chiropractor, and a physiotherapist) and two patients with chronic NP, who rated the importance of each image on a five-point scale ranging from "not at all important" to "extremely important". Their scores for each item were added together and the ten images with the highest mean scores were selected.

Completed instrument The ten images were formatted to fit on a single page beneath the heading*: "The following images have been created with the aim of understanding how you feel about common situations experienced during usual activities. Please rate each picture according to this question: How much do you fear doing this activity would hurt your neck? To rate the picture, use a number from 0 to 10 where 0 = no fear and 10 = greatest fear".

The images require no translation, and so the instructions were translated into English to facilitate the widest use of NeckPix©. An Italian/English-speaking investigator made the first translation, which was back translated by another English-speaking investigator.

Pilot testing The instrument was administered to 20 patients with chronic non-specific NP with the aim of verifying it was comprehensible, relevant and complete [23]. The results were assessed by the developers, who decided that no further adjustment was required.

The total score ranges from 0 to 100, with higher scores representing stronger fear-avoidance beliefs.

Figure 1 presents examples of pictures taken from the NeckPix© questionnaire. The full instrument is available from the corresponding author by e-mail request.

Sample size calculation

This was based on the "rule of 10" patients per item [24], giving a final sample of 100. Subsequent investigations described below were conducted on this sample.

Factor analysis

An exploratory factor analysis was first made, and Cattell's scree test was used to determine the number of extracted factors (eigenvalues >1). Varimax rotation was used, and the items with a factor loading of >0.40 were included in

the factor; the expected explained variance was >50 % [24].

Content validity

This was based on the patients' answers to specific questions as no statistical testing could be involved. The hypotheses were considered acceptable if the percentage rate of expected answers was >90 % [24].

The degree to which each image adequately reflected the construct to be measured (i.e. face validity) [25] was evaluated by means of two questions investigating clarity and specificity: "What do you think is happening here?" and "Do some of the images overlap in any way?"

The appropriateness of the images for the population for which they were developed (i.e. the target population in terms of disease characteristics) was evaluated by means of the question: "Do you think what is happening here may be related to your neck problems?"

The degree to which the content adequately reflected the construct to be measured (i.e. content validity) [25] was evaluated by means of two questions investigating relevance and completeness: "Do you think these images are relevant to evaluate your fear of movement due to NP during ADL?" and "Do you think these images comprehensively reflect your fear of movement due to NP?"

Acceptability and feasibility

Acceptability refers to whether or not patients are willing to complete the instrument [26]. The patients were asked about any problems they encountered during the assessment, and the examiners checked all the data, including any missing or multiple responses.

Feasibility is the ease of using the scale in terms of time to completion and scoring [26]; this was evaluated by means of two questions: "Is this battery of images quick to complete?" and "Is a 0–10 numerical rating scale easy to use?"

The time needed to answer the questionnaire was also recorded.

Generalisability

This refers to whether an instrument can be effectively applied to different populations and settings, and was assessed by collecting information concerning the subjects' age, gender, disease characteristics, and settings [26].

Distribution and floor/ceiling effects

Mean values and standard deviations were calculated to determine the distribution and floor/ceiling effects, which were considered to be present when >15 % of the patients had either the lowest or highest possible scores [24].

Internal consistency and test–retest reliability

The first reflects the degree of interrelatedness of the items [25], which can be considered good if the value of Cronbach's alpha is >0.70; the second measures reliability over time (i.e. the proportion of total variance in the measurements which is due to true differences between patients [25]) by administering the same questionnaire to the same subjects after a certain interval (in our case 7 days in order to avoid the natural fluctuations in symptoms associated with possible memory effects). The intra-class correlation coefficient (ICC 2.1) was used to test the agreement of the results, with good and excellent reliability being, respectively, indicated by values of 0.60–0.80 and >0.80.

Construct validity

This is the degree to which the scores of a measurement instrument are consistent with the hypotheses [25]. It was hypothesised a priori the correlation between NeckPix© and the TSK should be positive, moderate to high and closer than the correlation between NeckPix© and the Pain Catastrophising Scale (PCS), the NDI, and a Numerical Rating Scale (NRS) of pain intensity. The correlations were measured using Pearson correlations of $r < 0.30 =$ little correlation; $0.30 < r < 0.60 =$ moderate correlation; and $r > 0.60 =$ close correlation [27].

Outcome measures

TSK Fear-avoidance behaviours [10] were assessed using the Italian 13-item version of this self-report measure with the reversed items removed [28]. Each item was scored using a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree), and the total score was calculated by adding the scores of the individual items (range 13–52).

PCS This 13-item self-report questionnaire assesses catastrophising in subjects with musculoskeletal complaints. Each item was scored using a five-point scale, ranging from 0 (never) to 4 (always), and the total score was calculated by adding the scores of the individual items (range 0–52) [29]. We used the Italian version [30].

NDI This self-administered 10-item questionnaire allows a comprehensive evaluation of self-rated disability due to NP. Each question was scored on a six-point scale ranging from 0 (no disability) to 5 (full disability), and these were added together and the result multiplied by 2 to obtain a total percentage score [13]. We used the Italian version [31].

NRS This was an 11-point pain intensity rating scale, ranging from 0 (no pain at all) to 10 (the worst imaginable pain) [32].

Statistics

The analyses were made using the Italian version of SPSS 20.0 software.

Results

Subjects

Of the 152 patients invited to participate in the study, 118 satisfied the inclusion criteria (77.6 %): 78 females (66.1 %) and 40 males (33.9 %) with a mean age of 47.8 ± 15.9 years (range 20–78). The median duration of NP was 15.5 months (range 4–60), and their mean body mass index was 23.3 ± 3.7. Table 1 shows their general characteristics.

Table 1 General characteristics of the study population ($n = 118$)

Variable	*N*	%
Marital status		
Unmarried	46	38.9
Married	72	61.1
Employment		
Employee	44	37.3
Self-employed	33	28.0
Housewife	11	9.3
Pensioner	30	25.4
Education		
Elementary	11	9.3
Middle school	29	24.6
High school	43	36.4
University	35	29.7
Smoking		
Yes	15	12.7
No	103	87.3
Use of drugs		
Antidepressants	12	10.1
Analgesics/opioids	18	15.2
Muscle relaxants	16	13.6
NSAIDs	31	26.3
None	41	34.8
Comorbidities (principal)		
Hypertension	21	17.8
NIDDM	7	5.9
Heart disease	12	10.2
Enteric disease	10	8.5
Liver disease	11	9.3
None	57	48.3
Insomnia		
Presence	35	29.7
Absence	83	70.3
Anxiety (medical history)		
Presence	55	46.6
Absence	63	53.4
Depression (medical history)		
Presence	12	10.1
Absence	93	89.9

NSAIDs non-steroidal anti-inflammatory drugs, *NIDDM* non-insulin dependent diabetes mellitus

Development

The images were developed using a process of item generation and reduction/selection. No special difficulties were found by the developers and evaluators, and the pilot testing confirmed the comprehensibility, relevance and completeness of the instrument.

Scale properties

Factor analysis

The exploratory factor analysis revealed a one-factor structure on the basis of eigenvalues >1. The explained variance was 71.12 %, and the item-factor loadings using orthogonal rotation ranged from 0.786 to 0.921.

Content validity

The content of the images was considered adequate, appropriate for the target population, and relevant for the evaluation of activity-related kinesiophobia as the percentage of correct answers was always >90 % (Table 2).

Acceptability and feasibility

All the images were well accepted, and there were no missing responses or multiple answers. Ease of use was satisfactory as the percentage of expected answers was always >90 % (Table 2). The questionnaire was completed in 2.01 ± 0.78 min.

Generalisability

NeckPix© can be used to assess adult subjects with chronic non-specific NP of both genders in outpatient settings.

Table 2 Content validity of NeckPix©

Aspect investigated	Question	Percentage of expected answers	Percentage of unexpected answers
Face validity	What do you think is happening here?	100	0
Face validity	Do some of the images overlap in any way?	95.8	4.2
Target population	Do you think what is happening here may be related to your neck problems?	99.4	0.6
Relevance	Do you think these images are relevant for evaluating your fear of movement due to NP during ADL?	99.3	0.7
Completeness	Do you think these images comprehensively reflect your fear of movement due to NP?	99.2	0.8
Feasibility	Is this battery of images quick to complete?	100	0
Feasibility	Is a 0–10 numerical rating scale easy to use?	100	0

NP neck pain, *ADL* activities of daily living

Distribution and floor/ceiling effects

Table 3 shows the distribution of NeckPix© in comparison with the other outcome measures. There were no floor/ceiling effects.

Reliability

Cronbach's α was 0.954. Test–retest reliability was measured in all the subjects and was excellent (ICC 0.979; 95 % CI 0.969–0.985) (Table 4).

Construct validity

All the a priori hypotheses were confirmed. Table 5 summarises the correlations.

Table 4 Day 1–7 test–retest reliability of NeckPix©

Repeatability	ICC	95 % CI
Item 1: sleeping	0.917	0.883–0.942
Item 2: hair washing	0.918	0.883–0.942
Item 3: using a personal computer	0.936	0.910–0.955
Item 4: lifting a weight	0.910	0.873–0.936
Item 5: carrying a bag	0.935	0.907–0.954
Item 6: engaging reverse gear	0.938	0.912–0.957
Item 7: cleaning windows	0.923	0.891–0.946
Item 8: putting garbage can out	0.928	0.898–0.949
Item 9: sitting up	0.931	0.902–0.951
Item 10: recreation	0.955	0.936–0.969
Total score	0.979	0.969–0.985

Table 5 Construct validity

Outcome measures	NeckPix©
TSK	0.759**
PCS	0.583**
NDI	0.520**
NRS	0.455**

Pearson's correlations between outcome measures

** $p < 0.001$

Discussion

This study describes the development of the NeckPix©, an instrument for assessing activity-related kinesiophobia in subjects with chronic non-specific NP. The motivation for this was the limited number of image-based instruments for assessing fear-avoidance based activity limitations. The only other neck-related instrument, the PFActS-C [19], was regarded as having limitations with respect to the large number of items and their focus on mechanical loads on the neck, rather than on ADL's.

The results of the generation process indicate it was successfully developed following international recommendations [21, 22]. The developers played an important role during the item-generation phase, and the evaluators and patients played a key role during the item selection/reduction phase, which improved the content and format of the instrument. Pilot testing on a sample of chronic non-specific NP subjects confirmed the generated images

Table 3 Distribution of NeckPix© and other outcome measures scores

	Mean	SD	25th percentile	50th percentile	75th percentile	Floor effect (%)	Ceiling effect (%)
NeckPix (0–100)	50.24	20.13	36	54	65	0	0
NDI (0–100)	32.80	12.67	24	32	39	0	0
TSK (13–52)	27.71	8.93	21.25	27	33.75	0	0
PCS (0–52)	18.53	9.04	11	18.50	24	0	0
NRS (0–10)	4.71	1.89	3	4	6	0	0

NDI neck disability index, *TSK* tampa scale of kinesiophobia, *PCS* pain catastrophising scale, *NRS* numerical rating scale

created an innovative measure of activity-related kinesiophobia.

The use of factor analysis revealed the instrument's one-dimensional structure, which suggests the strong measuring invariance of the images [26].

The content validity, acceptability and feasibility of the instrument were satisfactory. It is self-administered and seemed to be easy to apply for adult subjects with chronic NP of both genders in everyday clinical practice.

The absence of any serious floor/ceiling effects demonstrated the instrument's ability to assess different degrees of kinesiophobia.

Its internal consistency suggests a high degree of interrelatedness among the items, and its excellent test–retest reliability indicates it is a stable instrument over time. The satisfactory internal consistency and test–retest reliability of the PHODAS and the PFActS-C [15, 19] confirms the reliability of such instruments.

Construct validity was initially analysed by comparing NeckPix© with the TSK, and the correlation suggests the theoretical construct of the two measures is fairly similar; this is not surprising as both scales evaluate kinesiophobia, and indicate that the more harmful the activities are considered, the higher the level of fear of movement. However, the new measure can be expected to make a distinct contribution to the analysis and treatment of kinesiophobia, because it has the advantage of presenting non-verbal material in the form of images and only solicits the score of the patient's rating of fear avoidance for each item; a second advantage is that health providers can engage the patient in a discussion of the reasons for their responses, which should lead to a more effective approach to changing beliefs. Poorer correlations were found between PFActS-C and TSK ($r = 0.372$), suggesting that images presenting ADLs related to neck disorders might provoke increased fear reactions than pictures showing cervical mechanical loads in a systematic way [19]; also, the smaller number of items in the NeckPix© has the advantage of avoiding habituation to fear reactions that probably develops after a larger number of items are presented.

The moderate association with PCS suggests there is a link between catastrophising and activity-related kinesiophobia. This is also not surprising because catastrophising is considered a precursor of kinesiophobia and catastrophizers can therefore also be expected to present increased levels of fear of movement [33]. The moderate associations with the NRS and NDI suggest the images may be conditioned by the level of NP and disability: persisting levels of pain and neck limitations can be expected to reinforce fear-avoidance behaviours and may contribute to chronic vicious circles [34]. In accordance with our findings, moderate associations were also found between PFActS-C and PCS (r = 0.403) and NDI (r = 0.562) [19].

This study has a number of limitations. First of all, its cross-sectional design means that any significant correlations should not be confused with causal effects. Secondly, the relationships between NeckPix© and physical tests were not considered because only self-administered questionnaires were used. Thirdly, the study was restricted to subjects with chronic non-specific NP and it is uncertain whether the findings can be extended to other chronic neck complaints, particularly whiplash injury. Fourthly, the NeckPix© specifically assesses only activity-related fear of movement and, based on the questionnaire findings, it should be seen as a starting point to decide whether investigating more deeply the construct of kinesiophobia by means of a wider cognitive-behavioural evaluation. Finally, the instrument was tested in Italian subjects and it is uncertain whether our conclusions can be extended to different countries and cultures; additional investigations are recommended to confirm its properties.

Conclusions

NeckPix© has a one-factor, 10-item structure, and is reliable and valid. It can be recommended for clinical and research purposes because it should improve the assessment of chronic NP.

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Conflict of interest None.

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