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Original article

Development and psychometric validation of the headache screening questionnaire – Dutch Version

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ABSTRACT

Background: Headache is a common disorder which may lead to substantial socio-economic loss. Treatment options include self-management strategies, medication and physiotherapy. Physiotherapists need to be able to screen for the presence of migraine and tension-type headache (TTH), so they can adjust their treatment strategies to the type of headache. A quick screening questionnaire to recognize migraine and TTH in the physiotherapy practice is needed.
Objective: The aim of this study was to create a headache screening questionnaire based on the ICHD-3 beta criteria for migraine and TTH, and to establish its content and criterion validity.
Design: A cross-sectional design was used during the validation phase of the study.
Methods: A screening questionnaire was developed for migraine and TTH. Content validity was checked by the research group and a headache research expert. For validation of this questionnaire, patients from the headache clinic of the Canisius Wilhelmina Hospital in Nijmegen were recruited. The outcome of the questionnaire was compared to the ICHD-3 beta diagnosis of the headache specialist. For criterion validity, sensitivity, specificity, likelihood ratios, and positive- and negative predictive values were calculated.
Results: A 10-item questionnaire has been developed: the Headache Screening Questionnaire. For validation of the Dutch version (HSQ-DV), 105 patients were included in the study. The sensitivity and specificity were 0.89 and 0.54 respectively for probable migraine, and for probable TTH 0.92 and 0.48 respectively.
Conclusion: The HSQ-DV is a sensitive screening tool to detect patients with probable migraine and probable TTH.

1. Introduction

Currently, 46% of adults worldwide are affected by headaches (Stovner et al., 2007). Of all headaches, tension-type headache (TTH) is most common (31–42%) followed by migraine (11–22%) and both have a substantial impact on quality of life (Abu Bakar et al., 2016; Steiner et al., 2014; Stovner et al., 2007; Terwindt et al., 2003). Headaches are also important health-related drivers of economic losses (Linde et al., 2012). The total annual cost of headache amongst adults is estimated at €173 billion in Europe (Linde et al., 2012). Improving headache healthcare may decrease the socio-economic burden (Linde et al., 2012; Steiner et al., 2014; Terwindt et al., 2003).

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Patients suffering from headache commonly use self-management strategies, including medication and physiotherapy (Biondi, 2005; Furto et al., 2006; Karakurum Göksel et al., 2014; Kristoffersen et al., 2013; Lipton et al., 2002; Pascual et al., 2001). A physiotherapist (PT) can contribute valuable information through clinical reasoning within their diagnostic- and therapeutic process in headache healthcare (Biondi, 2005; Furto et al., 2006). A PT is equipped to treat secondary headaches attributed to musculoskeletal complaints (Childs et al., 2005; Gaul et al., 2011) such as cervicogenic headache (Biondi, 2005; Rubio-Ochoa et al., 2016), headaches attributed to a whiplash injury (Wiangkham et al., 2015) and secondary headache attributed to a temporomandibular disorder (TMD) (Gaul et al., 2011). Signs and symptoms that can be influenced by physiotherapy are, for example, a limited cervical range of motion in patients with cervicogenic headache (Zito et al., 2006; IHS, 2013) and patients with headache attributed to a whiplash injury (Fernández-pérez et al., 2012), or muscle pain in patients with a secondary headache attributed to TMD (Wieckiewicz et al., 2015).

Besides treating secondary headaches, PTs are also able to support treatment of the primary headaches migraine and TTH (de Tommaso & Fernández-de-Las-Penas, 2016; Fernandez-de-las-Penas & Cuadrado, 2015; Luedtke et al., 2015). Physiotherapy focused on relaxation exercises and triggers to prevent headache episodes for migraine and TTH, is beneficial as complementary therapy (Biondi, 2005; Chaibi et al., 2011; de Tommaso & Fernández-de-Las-Penas, 2016; Gaul et al., 2011). Training motor control impairment in the deep neck flexor muscles can influence TTH (Fernandez-de-las-Penas & Cuadrado, 2015), while treating myofascial trigger points and relaxation therapy may influence both migraine and TTH (Bendtsen et al., 2015; Bendtsen & Fernández-De-La-Peñas, 2011; Fernandez-de-las-Penas & Cuadrado, 2015; Fernández-De-Las-Peñas et al., 2006; Luedtke et al., 2016). The effectiveness of PT will depend on proper clinical reasoning during the physiotherapeutic diagnostic process, as not all interventions are as effective for different types of headache (Fernandez-de-las-Penas & Cuadrado, 2015).

Within the physiotherapeutic diagnostic process, it is important to differentiate between primary and secondary headaches. Secondary headaches attributed to musculoskeletal complaints can already properly be diagnosed by a PT using findings from the history-taking and clinical examination (K. Luedtke et al., 2016; Rubio-Ochoa et al., 2016). Currently, primary headaches like migraine and TTH are only recognizable during history-taking (IHS, 2013). At this moment there are no clinical examination tests that can diagnose migraine or TTH (IHS, 2013; Luedtke et al., 2016). It is therefore important that a PT should be able to recognize the symptoms of migraine and TTH while taking the history of the patient to deliver an optimal treatment appropriate for the complaints of the patient. As primary headaches are complex conditions, they need to be definitively diagnosed by a specialized neurologist. So when needed the PT can advise a patient to see a headache specialist when a suspicion of a primary headache is present (Gaul et al., 2011). To optimize history-taking by the PT a validated screening tool is needed to check for both migraine and TTH.

The International Headache Society (IHS) has created the International Classification of Headache Disorders (ICHD), a worldwide recognized standardized and validated classification system to diagnose headache disorders (IHS, 1988; IHS, 2004; IHS, 2013). There are questionnaires based on the first two editions of the ICHD. The 'Lifting the Burden' campaign developed a headache questionnaire for population-based research (March et al., 2004). Because of the research scope this questionnaire is not feasible as a quick screening questionnaire (Ayzenberg et al., 2010; Galesic and Bosnjak, 2009; March et al., 2004). Two screening questionnaires are developed for migraine only (Lipton et al., 2003; Valentinis et al., 2009). To increase the effectiveness of the screening of both migraine and TTH, and to decrease administrative burden, one short questionnaire covering both headaches is favourable.

Therefore, the aim of this study is to create a headache screening questionnaire based on the ICHD-3 beta criteria for migraine and TTH, and to establish its content and criterion validity.

2. Methods

The six steps of measurement development of de Vet et al. (2011) were used to create the headache screening questionnaire (HSQ). These six steps are: 1) definition of the construct to be measured; 2) choice of measurement method; 3) selecting items; 4) scoring issues; 5) pilot-testing; and 6) field-testing. Within this study, the first four steps are described under 'phase I: Development'. The last two steps are described under 'phase II: Validation of the HSQ-DV'.

2.1. Phase I: Development

2.1.1. Step 1: Definition of the construct

The researchers HAvdM, CMV, NWGN-vdS and CMS established that the constructs to be measured related to the aim of this study are the two primary headaches migraine and TTH, as described in the ICHD-3 (IHS, 2013).

2.1.2. Step 2: Choice of measurement instrument

The researchers HAvdM, CMV and CMS discussed the possibilities for measurement instruments. As migraine and TTH are disorders recognized during the history-taking of the patient, the measurement instrument had to be an addition in this process. Therefore, a questionnaire was the favourable type of measurement instrument.

2.1.3. Step 3: Selecting items

For the third step, HAvdM, CMV and CMS transformed the ICHD-3 criteria for migraine without aura and TTH of the domains frequency, duration, characteristics and symptoms (A to D of the ICHD-3 beta) into questions in the first draft of the Dutch Version of the Headache Screening Questionnaire (HSQ-DV; see Table 1). No differentiation was made between episodic and chronic migraine, nor between infrequent, frequent and chronic TTH. The last domain "headache is not better accounted for by another ICHD-3 diagnosis" was left out; this domain is not relevant for this screening instrument.

Thereafter, the HSQ-DV was translated into the English version (HSQ-EV) by an independent researcher (JT). JT is a native English speaker and fluent in Dutch. Simultaneously, the original ICHD-3 beta criteria were translated into layman English by another independent researcher and native English speaker (DT). JT and DT were both blinded for all other HSQ development steps.

The layman English ICHD-3 beta criteria were compared to the HSQ-EV and differences were discussed (HAvdM, CMV and CMS), resulting in adjustments in phrasing and word-use of the HSQ-EV. This HSQ-EV was back-translated into Dutch (HAvdM), which resulted in adjustments of the HSQ-DV.

2.1.4. Step 4: Scoring issues

For part A to D of the ICHD-3 beta criteria, 2 points can be scored (Table 1). Question 1 is related to the domain "frequency" for TTH, corresponding with part A from the ICHD-3 criteria. For migraine, question 2 corresponds with part A (Table 1). Parts B-D are translated into the same questions for both migraine and TTH, but

Table 1
– ICHD-3 beta criteria for migraine and Tension-Type Headache and the corresponding question numbers of the Headache Screening Questionnaire (HSQ).

Migraine		Tension-Type Headache	
ICHD-3 beta criteria	Corresponding question number HSQ	ICHD-3 beta criteria	Corresponding question number HSQ
A. At least five attacks fulfilling criteria B-D	2	A. At least 10 episodes of headache occurring on 1–14 days per month on average for >3 months (≥12 and < 180 days per year) and fulfilling criteria B-D	1 (3)
B. Headache attacks lasting 4–72 h (untreated or unsuccessfully treated)	4	B. Lasting from 30 min to 7 days	4
C. Headache has at least two of the following four characteristics:		C. At least two of the following four characteristics:	
1. unilateral location	6	1. bilateral location	6
2. pulsating quality	5	2. pressing or tightening (non-pulsating) quality	5
3. moderate or severe pain intensity	7	3. mild or moderate intensity	7
4. aggravation by or causing avoidance of routine physical activity (e.g., walking or climbing stairs)	8, 9	4. not aggravated by routine physical activity such as walking or climbing stairs	8
D. During headache at least one of the following:		D. Both of the following:	
1. nausea and/or vomiting	10	1. no nausea or vomiting	10
2. photophobia and phonophobia	10	2. no more than one of photophobia or phonophobia	10

HSQ-DV: Headache Screening Questionnaire Dutch Version.

different answers correspond with each headache. The HSQ provides 2 final scores: 0–8 points for migraine and 0–8 points for TTH (Fig. 1a and 1b). In case all ICHD-3 beta criteria are met for migraine and/or TTH, a person receives the maximum score of 8 points for migraine and/or TTH. As people may have concurrent migraine and TTH (Sedlic et al., 2016), it is possible for patients to receive 8 points for each headache. When at least 6 points are appointed, migraine or TTH is considered 'probably present'; hereafter named 'probable' migraine or 'probable' TTH.

2.2. Phase II: Validation of the HSQ-DV

2.2.1. Step 5: Pilot testing

Within this study, the HSQ-DV was presented to three bachelor students physiotherapy and eight master students orofacial physiotherapy. They tested the HSQ-DV on written case reports and each other. Their feedback regarding the scoring system was used to finalize the HSQ-DV before field-testing with patients and resulted in the development of the algorithms.

2.2.2. Steps 6: Field testing

A cross-sectional study was conducted at the Canisius-Wilhelmina Hospital (CWZ) headache clinic of Nijmegen. Applying convenience sampling, patients entering the clinic in the period between December, 2013 and August, 2015 were asked to participate in this study. To be included, patients had to: 1) be at least 18 years of age; 2) visit the neurologist for an intake; and 3) be able to understand and read Dutch. No exclusion criteria were applied. A medical ethical waiver was obtained from the medical ethics committee at the Radboud university medical center of Nijmegen [file number 2013/453]. Written informed consent for participation in the study was obtained from all patients. Gender, age and headache pain intensity based on the numeric pain rating scale (NPRS) (Kahl and Cleland, 2005) were obtained from all patients.

Patients received the HSQ-DV before their visit to the neurologist, which then was collected by a nurse at the clinic. The neurologist took the patient's medical history, performed complementary clinical tests when needed for a diagnosis and wrote the ICHD-3 beta diagnosis on a separate form. This separate form was also collected by this nurse who also appointed participant numbers to anonymize the forms. The HSQ-DV and neurologist's diagnosis were anonymously collected for analysis by HAvdM.

2.2.3. Data analysis

Face validity, as a sub form of content validity, was checked by examining the degree to which the content of the HSQ was an adequate reflection of the construct to be measured (Mokkink et al., 2010). To establish this, the HSQ-DV and HSQ-EV were compared to the ICHD-3 beta criteria by an expert in headache research (DG). Adjustments were made to both the HSQ-DV and HSQ-EV. To establish clinical utility the HSQ-DV was shown to a group of 10 PTs for their feedback regarding the clinical utility on face value.

Criterion validity is the degree to which the scores of an instrument are consistent with hypotheses based on the assumption that the instrument validly measures the construct to be measured (Mokkink et al., 2010). The ICHD-3 beta diagnosis of the neurologist was used as gold standard. This diagnosis was compared with the outcome of the HSQ-DV (migraine yes/no and TTH yes/no). Agreement (percentage [%] and kappa [K]) between the neurologist and HSQ-DV were calculated. Kappa values below 0.20 were considered slight agreement, between 0.21 and 0.40 fair, between 0.41 and 0.60 moderate, 0.61–0.80 as substantial and between 0.81 and 1 almost perfect agreement (Landis and Koch, 1977).

Related to criterion validity, sensitivity and specificity were calculated for migraine, probable migraine, TTH and probable TTH. Furthermore the positive likelihood ration (LR+), the negative likelihood ratio (LR-), and the positive predictive value (PPV) and negative predictive value (NPV) were calculated (Lalkhen and McCluskey, 2008). The PPV and NPV were calculated using the prevalence numbers from the validation study, but also applied to the general population. For migraine, the prevalence range of 11–22% is used (Steiner et al., 2014; Stovner et al., 2007). When considering probable migraine, it is estimated that the prevalence numbers double so the range 22–44% was used. For TTH, the prevalence range of 31–42% was used (Steiner et al., 2014; Stovner et al., 2007). There were no estimates available for probable TTH. Likelihood ratios can range from 0 to infinity, where the value 1 lacks diagnostic value, values greater than 1 increase the probability of disease (LR+) and values below 1 decrease the probability of disease (LR-) (McGee, 2002).

Analysis of the data was performed using the *Statistical Package for the Social Sciences* (IBM SPSS) version 22.0 (SPSS Corp, Chicago, Ill, USA).

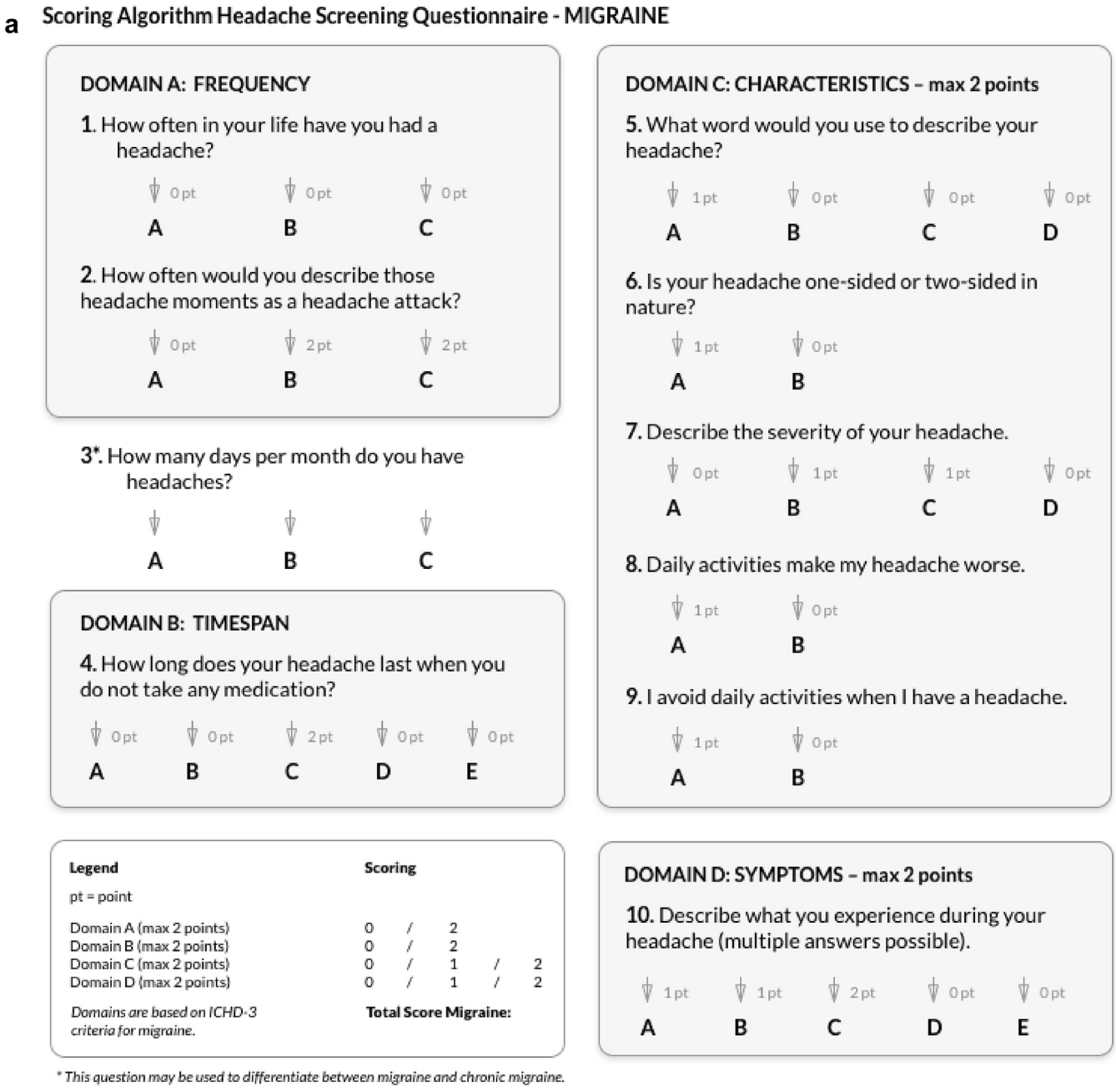

Fig. 1a. Headache Screening Questionnaire Algorithm for Migraine.

3. Results

3.1. Study population

In total, 125 patients participated in this study, of whom 20 were excluded based on missing data. Of the included 105 patients, 82 were female (Table 2). The mean headache pain intensity was 7.7 (±1.3). The neurologist diagnosed 55 migraines, 36 TTHs and 29 other headaches (Table 2). Five patients with the diagnosis medication-overuse headache were also diagnosed with migraine. Three other patients with medication-overuse headache were also diagnosed with TTH.

3.2. Content validity

The questionnaire consisted of 10 items corresponding to the ICHD-3 beta A, B, C, and D criteria for migraine and TTH. To optimize face validity, the feedback from the headache expert (DG) resulted in adjusting question 3 to improve the accuracy of headache frequency by changing how many 'times' to how many 'days' they have experienced a headache. The content validity was established, as all the questions from the HSQ-DV and HSQ-EV are a direct derivative off the ICHD-3 beta criteria. The ICHD-3 beta criteria and the corresponding question numbers of the HSQ-DV are shown in Table 1.The final 10-item version of the HSQ-EV can be found in Appendix 1.

b

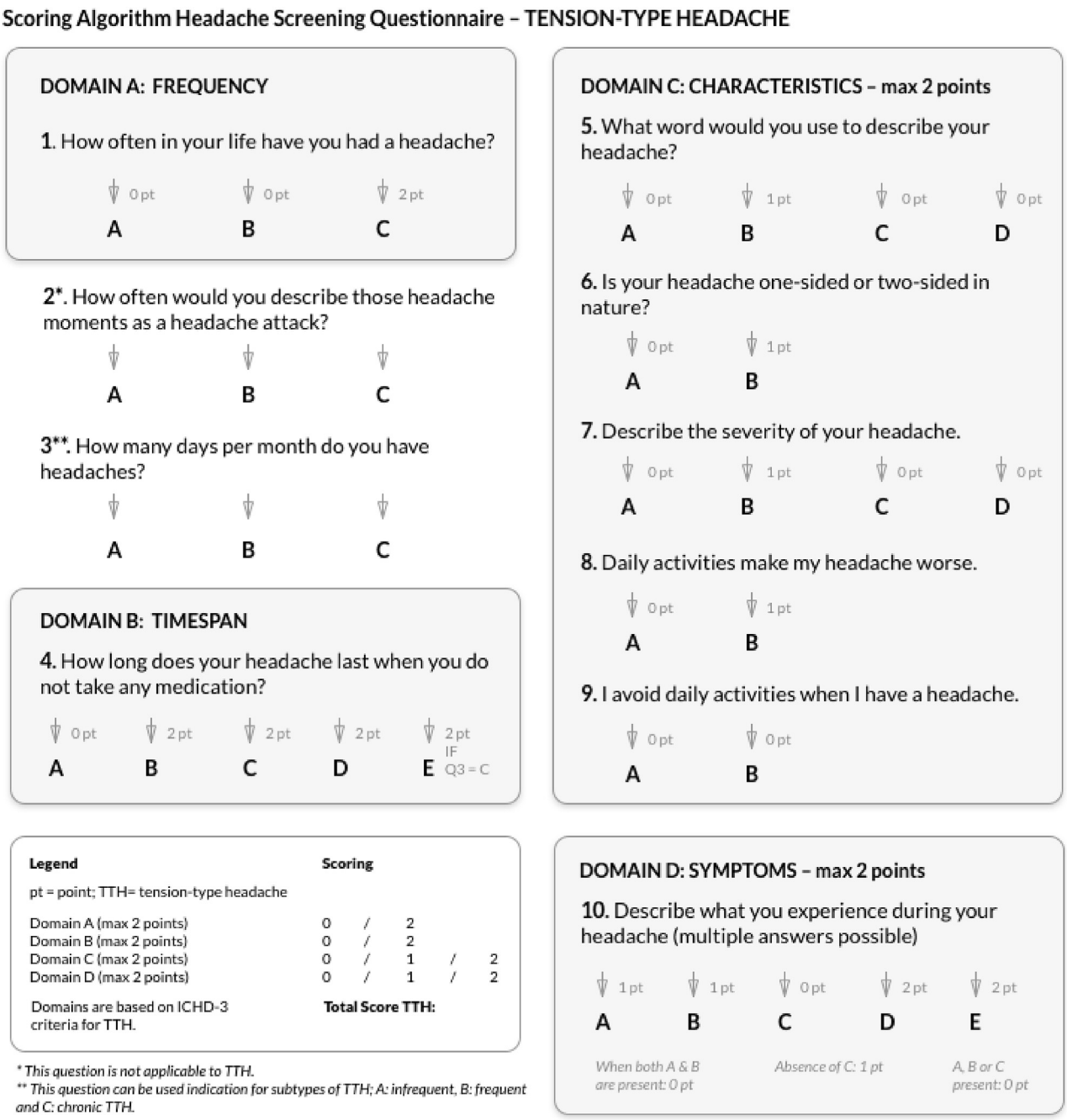

Fig. 1b. Headache Screening Questionnaire Algorithm for Tension-type Headache.

3.3. Criterion validity

For migraine, there was a moderate overall agreement between the ICHD-3 beta diagnoses and the HSQ-DV of 79.0% ($\kappa = 0.585$; $p = 0.000$) (Landis and Koch, 1977). The concomitant sensitivity is 0.69 and the specificity is 0.90. For a diagnosis of probable migraine ($\geq$6 points), the overall agreement dropped to 72.4% (moderate kappa value; $\kappa = 0.438$; $p = 0.000$) (Landis and Koch, 1977) with a sensitivity of 0.89 and specificity of 0.54 (Table 3).

For TTH, the overall agreement between the diagnosis of the neurologist based on the ICHD-3 beta criteria and the HSQ-DV was 68.6%. The kappa value between the two diagnoses was fair ($\kappa = 0.237$; $p = 0.011$) (Landis and Koch, 1977). The sensitivity was 0.36, and the specificity was 0.86. For the recognition of a probable TTH ($\geq$6 points), the overall agreement was 62.9% with a fair kappa value ($\kappa = 0.324$; $p = 0.000$) (Landis and Koch, 1977). The sensitivity was 0.92, and the specificity was 0.48 (Table 4).

The PPV and NPV for both the study population in the headache clinic and the general population are depicted in Table 5.

3.4. Clinical utility

A group of 10 PTs received the HSQ-DV to establish the face value clinical utility. The length of the questionnaire and algorithms were seen as positive attributes, provided that the questionnaire is available.

Table 2
Basic demographics.

Gender:	
Male; *n(%)*	23 (21.9)
Female; *n(%)*	82 (78.1)
Age; *mean (SD)*	40.3 (*14.5*)
Marital status	
Single; *n(%)*	27 (*25.7*)
Married; *n(%)*	46 (*43.8*)
Living together; *n(%)*	22 (*21.0*)
Divorced; *n(%)*	6 (*5.7*)
Widow(er); *n(%)*	2 (*1.9*)
Missing; *n(%)*	2 (*1.9*)
Education	
Primary school; *n(%)*	2 (*1.9*)
High school; *n(%)*	38 (*36.2*)
Community college; *n(%)*	32 (*30.5*)
University applied sciences; *n(%)*	20 (*19.0*)
University; *n(%)*	10 (*9.5*)
Missing; *n(%)*	3 (*2.9*)
Medication usage	
None; *n(%)*	21 (*20.0*)
Light painkillers <15 days p/m; *n(%)*	17 (*16.2*)
Light painkillers ≥15 days p/m; *n(%)*	19 (*18.1*)
Heavy painkillers <10 days p/m; *n(%)*	15 (*14.3*)
Heavy painkillers ≥10 days p/m; *n(%)*	17 (*16.2*)
Light and heavy painkillers; *n(%)*	10 (*9.5*)
Missing	6 (*5.7*)
Body Mass Index; *mean (SD)*	24.9 (*4.6*)
Headache NPRS; *mean (SD)*	7.7 (*1.3*)
Headache Diagnoses [ICHD-3 beta code][a]	
Migraine [1]; *n(%)*	55 (52.4)
Tension-Type Headache [2]; *n(%)*	36 (34.3)
Cluster Headache [3.1]; *n(%)*	5 (4.8)
Hemicrania continua [3.4]; *n(%)*	1 (1.0)
Hypnic Headache [4.9]; *n(%)*	2 (1.9)
New Daily Persistent Headache [4.10]; *n(%)*	1 (1.0)
Post-traumatic Headache [5.1]; *n(%)*	1 (1.0)
Headache attributed to whiplash [5.3]; *n(%)*	1 (1.0)
Headache attributed to giant cell arteritis [6.4.1]; *n(%)*	2 (1.9)
Headache attributed to spontaneous intracranial hypotension [7.2.3]; *n(%)*	1 (1.0)
Medication-overuse Headache; *n(%)*	9 (8.6)
Headaches attributed to disorder of the neck [11.2]; *n(%)*	2 (1.9)
Headaches attributed to temporomandibular disorder [11.7]; *n(%)*	3 (2.9)
Occipital neuralgia [13.4]; *n(%)*	1 (1.0)

SD: standard deviation; NPRS: numeric pain rating scale.
[a] Patients may have been diagnosed with multiple headache types.

Table 3
Sensitivity, specificity, positive and negative likelihood ratios of questionnaire diagnostic performance of the HSQ-DV for migraine and probable migraine compared to the diagnosis of the neurologist.

Neurologist	HSQ-DV			Sens (95%CI)	Spec (95%CI)	LR+	LR-
	Migraine	No Migraine	*Total*				
Migraine	38	17	55	0.69 (0.55–0.80)	0.90 (0.77–0.96)	6.91	0.34
No Migraine	5	45	50				
Total	43	62	105				
Neurologist	'Probable' HSQ-DV			Sens (95%CI)	Spec (95%CI)	LR+	LR-
	Migraine	No Migraine	*Total*				
Migraine	49	6	55	0.89 (0.77–0.95)	0.54 (0.39–0.68)	1.94	0.20
No Migraine	23	27	50				
Total	72	33	105				

HSQ-DV score = 8 points; "probable" HSQ-DV score ≥ 6 points; Sens: sensitivity; Spec: specificity; CI: Confidence Interval; LR+: positive likelihood ratio; LR-: negative likelihood ratio.

4. Discussion

In this study the 10-item Headache Screening Questionnaire for migraine and TTH was constructed in both English (HSQ-EV) and Dutch (HSQ-DV) based on the ICHD-3 beta criteria. As the HSQ-DV was in part a literal translation of the ICHD-3 beta criteria, the questions reflect the construct that was measured (migraine and TTH) well for content validity. The criterion validity was established for two cut-off points per headache: ≥6 points (probable migraine or probable TTH) or 8 points (migraine or TTH). The criterion validity was moderate for probable migraine and migraine, and fair for probable TTH and TTH.

Table 4
Sensitivity, specificity, positive and negative likelihood ratios of questionnaire diagnostic performance for TTH and probable TTH compared to the diagnosis of the neurologist.

Neurologist	HSQ-DV			Sens (95%CI)	Spec (95%CI)	LR+	LR-
	TTH	No TTH	*Total*				
TTH	13	23	36	0.36 (0.21–0.54)	0.86 (0.74–0.92)	2.49	0.75
No TTH	10	59	69				
Total	23	82	105				
Neurologist	'Probable' HSQ-DV			Sens (95%CI)	Spec (95%CI)	LR+	LR-
	TTH	No TTH	*Total*				
TTH	33	3	36	0.92 (0.76–0.98)	0.48 (0.36–0.60)	1.76	0.17
No TTH	36	33	69				
Total	69	36	105				

HSQ-DV score = 8 points; "probable" HSQ-DV score ≥ 6 points; TTH: tension-type headache; Sens: sensitivity; Spec: specificity; CI: Confidence Interval; LR+: positive likelihood ratio; LR-: negative likelihood ratio.

Table 5
Sensitivity, specificity, positive predictive values (PPV) and negative predictive values (NPV) for combinations of HSQ-DV outcomes in relation to headache diagnosis made by neurologist.

	Sensitivity	Specificity	General Population[a]		Headache Clinic[b]	
			PPV	NPV	PPV	NPV
Migraine	0.69	0.90	0.46–0.66	0.96–0.91	0.88	0.73
Probable Migraine[c]	0.89	0.54	0.35–0.60	0.95–0.86	0.68	0.82
TTH	0.36	0.86	0.53–0.65	0.75–0.65	0.57	0.72
Probable TTH[d]	0.92	0.48	n/a	n/a	0.48	0.92

n/a: not applicable.
[a] With prevalence range for general practice 11%–22% for migraine and 31%–42% for TTH.
[b] With a prevalence for migraine of 52.4% and a prevalence for TTH of 34.3%.
[c] With an estimation of double the prevalence of strict migraine: 22%–44% for general practice.
[d] Prevalence is unknown for general practice.

The sensitivity to recognize migraine with the HSQ-DV using a full score of 8 points was 0.69 and the specificity was 0.90. When applying a cut-off point of ≥6 points, the sensitivity increased to 0.89 and the specificity decreased to 0.54. Since a screening tool primarily aims to recognize the patients with the disorder of interest, a high sensitivity is preferred over high specificity (van Stralen et al., 2009). Therefore, the cut-off point of ≥6 is recommended to use when screening for migraine in the clinical practice. With this cut-off point, the HSQ-DV performed well in excluding people who do not have migraine because the NPV of the HSQ for migraine is 0.82, and the LR-is 0.20. With a cut off value of ≥6 point on the HSQ-DV, most people with migraine were accurately detected, even though the lower PPV (0.68) indicates that also quite some patients with headache are incorrectly suspected of having migraine.

To recognize TTH with the HSQ-DV, the sensitivity using a full score of 8 points was 0.36 and the specificity was 0.86. When applying a cut-off point of ≥6 points, the sensitivity increased to 0.92 and the specificity decreased to 0.48. The use of ≥6 points is favourable when screening for TTH in the clinical practice, as the sensitivity is higher than for the full 8 points (van Stralen et al., 2009). The HSQ-DV also performed well in excluding people who do not have TTH, because the NPV is 0.92 and the LR-is 0.17. All of these findings indicate that most people with TTH were accurately detected with a cut off value of ≥6 point on the HSQ-DV. However, there may also have been some patients with headache who were incorrectly suspected of having a TTH, indicated by a low PPV (0.48).

This study was performed in a headache clinic in the Netherlands, where the female gender was predominant and the mean age was 40.3 years. These findings are similar to other studies (Stovner and Andree, 2010). In this study, 64.8% was married or living with their partner, compared to 69.0% in the general Dutch population (Steiner et al., 2014). Within this study, 59.0% went through higher education and 38.1% did not meet this educational level. However, most studies report the opposite (Köseoglu et al., 2003). It is important to note that the prevalence of a specific headache in the headache clinic is different from the prevalence of a specific headache in the general population or PT practice. In a higher prevalence population, a test is more likely to be positive and is therefore not always a good representation of the general population. In this study, we compared the headache clinic with the general population to show the change in PPV/NPV when the prevalence changes. When we extrapolated our findings to the general population for the PPV and NPV (Table 5), the PPV for migraine decreased. In this study, 52.4% was diagnosed with a migraine by the neurologist, whereas the prevalence of migraine in the general population is between 11 and 22% (Steiner et al., 2014; Stovner et al., 2007). For TTH, the findings in the headache clinic (34.3%) are comparable to the general population (31–42%) (Steiner et al., 2014; Stovner et al., 2007). However, within the PT practice, the HSQ-DV will only be used in patients with headaches and it is reasonable to assume that the prevalence of migraine and TTH will be higher in the PT practice than in the general population. We therefore recommend considering the population in which the HSQ-DV is used, before interpreting the results.

Due to the absence of specific and distinguishing features, TTH is a difficult headache to diagnose and often diagnosed by exclusion (Bigal and Lipton, 2005; Jensen, 2003). Within this study, similar to validating headache questionnaire studies (Rizolli et al., 2016; Valentinis et al., 2009), the headache specialist's diagnosis was seen as the gold standard. This can be debated for two reasons: 1. the wide clinical spectrum of TTH (i.e. diversity of symptoms, frequency and intensity) frequently challenges the physician's diagnostic judgement (Bigal and Lipton, 2005; Chowdhury, 2015) and 2. the ICHD-3 beta system provides the gold standard based on both

empirical evidence and clinical experience (Beithon et al., 2013). A patient might have TTH according to the HSQ-DV, based on the ICHD-3 beta criteria, but clinically shows different features to which the headache specialist diagnoses another headache, applying criterion D from the ICHD-3 beta, which states 'that the headache may not be better accounted for by another ICHD-3 diagnosis'. The HSQ-DV, however, did not use this criterion in order to include more headaches. Therefore, it is important for PTs to use the outcome of the HSQ-DV as an indication for the presence of migraine or TTH, and continue their diagnostic process to confirm or reject their differential diagnoses. This is especially important for TTH, as the HSQ-DV shows a high number of false positives. The results from a recently published Delphi round show the recommended physical examination tests for different types of headache within the PT practice (K. Luedtke et al., 2016). The outcome of the HSQ-DV combined with these tests, can result in patient specific treatment plans.

Within this study no discrimination was made between episodic and chronic migraine, nor between infrequent, frequent or chronic TTH. If a healthcare provider is interested in the specific subtype of migraine or TTH with regard to its frequency, question 3 ('how many days per month do you have a headache') can be used. Based on the HSQ and physical examination outcomes, a PT can discuss with the patient, by shared decision making (Chewning et al., 2012), if the headache diagnosis of a headache specialist is needed.

For migraine the findings of this study are similar to other screening questionnaires (Fritsche et al., 2007; Láinez et al., 2005; Lipton et al., 2003). An English 3-item screening questionnaire showed a sensitivity of 81% and a specificity of 75% (Lipton et al., 2003). This screening questionnaire only included disability, nausea and sensitivity to light items from the ICHD-II criteria. A Spanish 5-item screening questionnaire for migraine showed a sensitivity of 93% and a specificity of 81% when 4 of the 5 items were positive (Láinez et al., 2005). This questionnaire, however, did not completely use items from the ICHD-II criteria, but more general questions such as: "Do you have frequent or intense headaches?". Deviating from the exact ICHD-II wording negatively impacted on the content validity of this questionnaire in our opinion.

After the development of the HSQ, a German 22-item questionnaire was discovered, which is very similar to the HSQ-DV. The German questionnaire consists of 7 items for migraine, 7 items for TTH and 6 items for trigeminal autonomic cephalgias. The migraine component showed a sensitivity of 73% and a specificity of 96%. The TTH part showed a sensitivity of 85.0% and a specificity of 98.2% (Fritsche et al., 2007). Even though the German questionnaire shows better overall validity, it was created for research purposes and may therefore not be applicable in the clinical setting, whereas the HSQ-DV was developed for clinical use and the clinical utility tested on face value. For use in clinical practice, a high sensitivity is preferred (van Stralen et al., 2009) and the HSQ-DV has a higher sensitivity when using cut-off point of $\geq$6 points than the German questionnaire.

The HSQ-DV is a short 10-item screening tool that can be used by PTs, but also by other health care providers. A study performed in 15 countries looked into the overlap between the diagnosis 'migraine' given by a family practitioner (FP) and given by an expert panel based on the ICHD-II criteria (Tepper et al., 2004). This study showed that of the patients diagnosed with migraine by the FP, 97% fulfilled the criteria according to the ICHD-II. However, of the patients diagnosed with a non-migraine primary headache by the FP, 48% fulfilled the criteria for migraine. This shows that screening by a FP may lead to an underestimation of migraine (Tepper et al., 2004). Using the validated HSQ-DV may increase the number of accurately recognized migraineurs, as the HSQ-DV only missed 10.9% of the migraineurs, when applying the $\geq$6 points cut-off, compared to the 48% the FP missed.

4.1. Limitations and strengths of this study

A limitation of this study is that the HSQ-DV was validated in a headache clinic where no PT was present, whereas the intention of the HSQ-DV is to be used in a clinical setting such as a PT practice. However, the clinical utility and usability in a patient population has been established through field-testing, which created the opportunity to compare the results of the HSQ-DV with the diagnosis of the neurologist. The usability of the HSQ-DV as a screening tool in the PT practice, however, still needs to be established in future research. Another limitation of the study is the use of convenience sampling, which may have led to selection bias of the participants.

One of the strengths of this study is the use of the six steps of development of a measurement instrument to create the HSQ-DV (de Vet et al., 2011). Another strength is that the questionnaire is based on the validated criteria for migraine and TTH as described in the ICHD-3 (IHS, 2013).

4.2. Implications for future research

Future research is needed to test the clinical utility of the HSQ-DV in the PT practice. For this we propose a mixed-methods study including a decision model for comparing three strategies (a test-and-treat strategy, a treat-all strategy, and a wait-in-all strategy) and the experiences of the PT using the HSQ-DV (Bossuyt et al., 2012). Therefore, we will perform further research to validate the HSQ-DV and HSQ-EV in PT practice.

4.3. Implications for practice

We expect that with the HSQ-DV or HSQ-EV and associated algorithm, PTs are facilitated to screen for the presence of migraine and/or TTH and adjust their clinical examination and treatment plan to the findings.

In conclusion, the HSQ-DV can be used as a screening tool for the recognition of probable migraine (sensitivity 0.89) and probable TTH (sensitivity 0.92) by PTs and other health care providers. Physical examination tests for migraine, TTH or other musculoskeletal headaches need to be performed to optimize a personal treatment plan.

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Appendix 1. Headache Screening Questionnaire – English Version

1 **How often in your life have you had a headache?**
   A. 1–4 times
   B. 5–9 times
   C. $\geq$ 10 times
2 **Looking back at the last question, how often would you describe those headache moments as a headache-attack?**
   A. 0–4 times

B. 5–9 times
C. ≥ 10 times

3 **How many days per month do you have headaches?**
A. < 1 per month
B. ≥1 - <15 per month
C. ≥15 per month

4 **How long does your headache last when you do not take any medication?**
A. 0–30 min
B. 30 min–4 h
C. 4 h–3 days
D. 3–7 days
E. >7 days

5 **What word would you use to describe your headache?**
A. Pulsating feeling
B. Tight or pressing feeling
C. Burning or stabbing feeling
D. Other, such as

6 **Is your headache one-sided or two-sided in nature?**
A. One-sided
B. Two-sided

7 **Describe the severity of your headache**
A. Mild
B. Moderate
C. Severe
D. Very severe

Indicate by the following statements if these are applicable to you when you have a headache.

8 ***Daily activities (such as climbing stairs or walking) make my headache worse.***
A. Yes
B. No

9 ***I avoid daily activities when I have a headache.***
A. Yes
B. No

10 **Describe what you experience during your headache (multiple answers possible).**
A. Sensitivity to light
B. Sensitivity to sound
C. Nausea and/or vomiting
D. None of the above
E. Other, such as

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