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Cross-sectional evaluation of the psychometric properties of the Headache Specific Locus of Control Scale in people with migraine

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Abstract

Objective: This study aims to investigate the psychometric properties (component structure, reliability, and construct validity) of the Headache-Specific Locus of Control scale in several clinical migraine populations.

Background: Headache specific locus of control beliefs may impact a person's behavioral decisions that affect the likelihood of migraine attack onset, emotional responses to migraine attacks, coping strategies used, and treatment adherence. The 33-item Headache Specific Locus of Control scale is the most widely used measure of locus of control specific to headache yet psychometric evaluations remain limited.

Methods: Six hundred and ninety-five adults with a diagnosis of migraine from five different research studies completed cross-sectional self-report measures including the Headache Specific Locus of Control scale and measures of quality of life and disability (Migraine Specific Quality of Life Questionnaire and Migraine Disability Assessment).

Results: Five Headache Specific Locus of Control components emerged from Horn's Parallel Analysis, Minimum Average Partial test, and Principal Components Analysis (eigenvalues: *Presence of Internal* = 5.7, *Lack of Internal* = 4.0, *Luck* = 2.9, *Doctor* = 2.0, and *Treatment* = 1.5). The 33 Headache Specific Locus of Control items demonstrated adequate internal consistency for total ($\alpha = .79$) and subscale scores, (α 's = .69 to .88). This study found preliminary evidence of convergent validity. For example, *Lack of Internal* ($r = -.12, p = .004$). *Doctor* ($r = -.20, p < .001$) and *Treatment* ($r = -.12, p = .004$) beliefs were associated with higher overall migraine specific quality of life impairments.

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Conclusions: The Headache Specific Locus of Control scale is a reliable and valid measure of headache specific locus of control. Findings suggest that headache specific locus of control is more multidimensional than previous conceptualizations and contribute to our understanding of control beliefs as a potential mechanism for migraine treatment.

Keywords

Migraine; Locus of Control; Quality of Life; Disability; Beliefs

INTRODUCTION

Migraine is a prevalent and disabling primary headache disorder characterized by attacks of moderate to severe head pain, nausea and/or vomiting, and extreme sensitivity to light and sound.¹ Between 11.7% to 22.7% of adults in the U.S. suffer from migraine.² People with migraine often experience impaired social and occupational functioning, decreased quality of life, and high levels of disability;^{3–7} for these reasons, migraine is ranked as the seventh highest cause of disability worldwide.⁸

People with migraine may differ in their beliefs about what factors they expect will influence their migraine attacks. Behavioral treatments are designed to impact adaptive and maladaptive beliefs about migraine. Social Learning Theory⁹ provides a framework for understanding the factors that impact a person's behavior and purports that locus of control, the extent to which people expect an outcome is due to their own actions or to external factors, is a key determinant of a person's response to their migraine attacks. Headache specific locus of control (HSLC) beliefs are posited to impact a person's behavioral decisions that affect the likelihood of migraine attack onset (e.g., managing triggers), emotional responses to migraine attacks, coping strategies used, and treatment adherence.^{10–11} Understanding HSLC beliefs is therefore especially salient since migraine is a chronic disease with episodic attacks¹² that are often unpredictable requiring a person with migraine to engage in many self-management behaviors in order to effectively manage their migraine attacks.

The HSLC scale¹⁰ is the most widely used measure of locus of control specific to headache. The 33-item scale was developed using content analysis and through use of principal components analysis rotated with an orthogonal solution, three HSLC components emerged; healthcare professional HSLC, internal HSLC, and chance HSLC.¹⁰ Subscale items were chosen based on Measure of Sampling Adequacy values and component loadings.¹⁰ Internal HSLC refers to an individual's belief that the onset and development of their headaches are due to their own behaviors (e.g. worrying and/or driving self too hard). Conversely, external HSLC (healthcare professional HSLC and chance HSLC) refers to an individual's belief that the onset and development of their headaches are due to external factors such as their healthcare providers (e.g. doctor's treatment) or simply due to chance (e.g. fate or luck).¹⁰

Martin and colleagues report adequate internal consistency across all three components (alpha's ranging from .84 to .88) and provide initial evidence of construct validity.¹⁰ A handful of studies provide further evidence of internal consistency (alpha's ranging from .71 to .88) and construct validity as demonstrated by typically moderate associations between

HSLC and headache-related beliefs (self-efficacy and pain catastrophizing), and typically small associations between HSLC and psychiatric symptoms (anxiety and depression), migraine specific quality of life, and disability.^{13–16}

Research guidelines and funding agencies recommend assessing putative therapeutic mechanisms, such as HSLC, in behavioral treatment trials.^{17–18} Empirical information about these beliefs and their relationship with migraine outcomes is essential to evaluate active components of existing treatments and to develop modifications or new treatments to more optimally treat migraine. Locus of Control is now a common target in behavioral treatments for migraine.¹⁹ HSLC may be a particularly pertinent mechanism of behavioral migraine treatments due to the impact of these beliefs on peoples' affective and behavioral responses to their migraine attacks.¹¹ Unfortunately, psychometric evaluations of the HSLC scale remain limited and inconsistencies prevail within the literature regarding associations between HSLC, quality of life, disability, and headache frequency. For example, it is widely believed that encouraging internal HSLC beliefs is desirable due to its association with less headache-related disability.^{11, 20} However, research does not always support this association. For example, positive associations between all three HSLC loci and greater headache disability were observed in a sample of college students and treatment seeking patients ($r_s = .16 - .25$, all $p_s < .05$).^{10, 21} Similarly, in our recent observational study with patients with migraine from a tertiary headache center, we observed positive associations between all HSLC beliefs and specific migraine-specific quality of life impairments, in terms of role function-restriction (e.g. migraine attacks interrupted leisure activities), role function-prevention (e.g. cancelled work because of migraine), and emotional function (e.g. feeling a burden on others due to migraine) ($r_s = .17 - .29$, all $p_s < .05$).²² Internal HSLC has been shown to be associated with quality of life impairments, anxiety, and depression, which suggests that internal HSLC may not always be beneficial and may actually be maladaptive in certain situations. Re-examination of the component structure of the HSLC scale may deepen our understanding of the HSLC construct and help explain the inconsistent findings.

Moreover, in the three decades since the HSLC was first developed, the efficacy of “third wave” behavioral therapies to treat pain disorders and migraine (e.g., Mindfulness-Based Cognitive Therapy²³ and Acceptance and Commitment Therapy²⁴) have provided more nuance in our scientific and clinical understanding about the role of control beliefs. Within the context of headache, understanding patient's control beliefs may impact the way that provider's educate their patients, the types of behavioral treatments patients may benefit from, and ways that patients are encouraged to engage in self-management techniques (e.g., tracking and managing triggers).

Given the historical changes in professional and lay beliefs regarding individual control of migraine attack onset, the importance of control beliefs to understanding the mechanisms of both established and emerging behavioral migraine treatments, and the small and inconsistent relationships observed between current HSLC subscales and patient-reported outcomes, there is a need to gain clarity regarding measurement of control beliefs in people with migraine. The present cross-sectional study aims to conduct an exploratory examination of the component structure, reliability (internal consistency), and construct validity of the HSLC scale in several clinical migraine populations.

METHOD

Participants and Procedures

The present current cross-sectional study is a secondary analysis, which combines data collected from six hundred and ninety-five adults, from five different research studies (cross-sectional survey studies or baseline data from randomized controlled trials). All the samples were independent and did not include repeat participants. Participants were recruited from urban and rural areas, tertiary headache centers, primary care settings, and patients who expressed an interest in being contacted for research studies. Written informed consent was obtained from all individual participants included in the study. The Einstein IRB approved this series of secondary analyses.

Missing data of combined sample.—Seven hundred and twenty-six participants were available in all five datasets; 695 completed the entirety of the HSLC and were therefore included in the scale development analyses. Five hundred and seventy-three participants completed quality of life questionnaires and were included in validity analyses. Six hundred and ninety-five participants completed disability questionnaires; 691 completed at least 70% of responses and were therefore included in validity analyses.

Sample 1.—One hundred and fifty-one adults with a physician diagnosis of migraine, based on the International Classification of Headache Disorders (ICHD-II) ²⁵ criteria participated in a 8-week behavioral treatment trial designed to decrease headache days per month in St Louis, MO, from July 2009 through November 2010. Inclusion criteria were: (1) adults aged 18 years to 65 years old (2) primary episodic or chronic migraine (between 4 to 20 migraine days per month) (3) stable use of acute and/or prophylactic migraine medications for at least 1 month. Exclusion criteria were: (1) under the age of 18 years or over the age of 65 years of age (2) no primary diagnosis of migraine (3) no stable use of acute and/or prophylactic migraine medications (4) inability to complete daily diary. Upon enrollment, nursing staff completed medical examinations and collected participant's background medical history. Participants then took part in an interview with the PI to assess headache history and study eligibility. Participants then completed electronic self-report questionnaires about their headache related cognitions. All participants then completed a 4-week baseline-monitoring period before being randomized for the treatment trial. The St. Louis University School of Medicine Institutional Review Board approved this study.

Sample 2.—Two hundred and eighteen adults with a physician diagnosis of episodic or chronic migraine, based on the International Classification of Headache Disorders (ICHD-II) ²⁵ criteria participated in a naturalistic observation study in St. Louis, MO, from January 2010 through February 2011²⁶. The study aimed to examine the usage patterns of migraine specific medications. Inclusion criteria were: (1) adults aged at least 18 years (2) primary episodic or chronic migraine diagnosis (between 4 to 30 migraine days per month), and (3) at least 4 headache days per month. Exclusion criteria were: (1) under the age of 18 years (2) no primary diagnosis of migraine (3) less than 4 headache days per month, and (4) inability to complete daily diary. Upon enrollment, nursing staff completed medical examinations and collected participant's background medical history. Participants then took part in an

interview with the PI to assess headache history and study eligibility. Participants completed electronic self-report questionnaires about their headache related cognitions. All participants then completed a 4-week baseline-monitoring period and filled out a series of electronic weekly and monthly questionnaires for a three-month assessment phase. The St. Louis University School of Medicine Institutional Review Board approved this study.

Sample 3.—Ninety adults with a physician diagnosis of migraine based on ICHD3-beta¹ criteria participated in an observational study from a tertiary care headache center in the Bronx, NY from June through August 2014. The study aimed to examine the relationship between migraine beliefs, psychiatric symptoms, and migraine-related disability²⁷. Inclusion criteria were: (1) physician diagnosis of migraine (2) adult aged 18 years or older, and (3) ability to read and understand English (4) ability to provide consent. Exclusion criteria were: (1) no physician diagnosis of migraine (2) under the age of 18 years (3) inability to read or understand English, and (4) inability to provide consent. Participants completed a one-time self-report paper and pencil questionnaires administered in the waiting room of the headache center before their scheduled neurology appointment. The Albert Einstein College of Medicine Institutional Review Board approved this study.

Sample 4.—Two hundred and thirty-two adults with a physician diagnosis of migraine, based on ICHD²⁸ criteria participated in a 16-month RCT in two outpatient clinics in Columbus and Athens, OH (the treatment of severe migraine trial) from July 2001 to November 2005.²⁹ The study aimed to examine whether the addition of behavioral migraine management, preventive medication, or their combination with optimized acute therapy improved migraine symptoms and migraine-related quality of life among people with migraine. Inclusion criteria were: (1) adults aged 18 years to 65 years old (2) at least three migraines with reported disability in a 30-day diary monitoring period and (3) less than 20 headache days over a 30-day period. Exclusion criteria were: (1) ICHD diagnosis of definite and probable medication overuse headache (2) an additional primary pain disorder (3) 20 or more headache days over a 30-day period (4) contraindication to study medications (β blocker: Propranolol or Nadolol) or current use of preventive medications, (5) receiving current psychological treatment (6) inability to read and understand study materials and (7) female participants who are pregnant or plan to become pregnant or breastfeed. All participants completed a 4-week baseline-monitoring period prior to randomization for the treatment trial. Upon enrollment, participants completed a structured interview in order to gather information about their headache and psychosocial history and then received a medical examination. Participants completed electronic self-report questionnaires about their headache related cognitions. The Ohio University Human Subjects Committee approved this study.

Sample 5.—Thirty-five adults with migraine based on ICHD 3-beta criteria¹ were recruited to participate in an RCT of individual Mindfulness-Based Cognitive Therapy for Migraine from December 2015 to December 2016 (NCT# 02443519). Participants were recruited through flyers distributed in a tertiary headache center in the Bronx, NY, around hospitals in the New York metropolitan area, and through social media platforms. Inclusion criteria were: (1) ICHD 3-beta diagnosis of migraine (confirmed via AMPP diagnostic screener, a

valid self-report questionnaire that assesses headache features based on ICHD-2 migraine criteria) (2) adult aged 18 years to 65 years of age (3) at least 6 migraine days per month (with at least a 4-hour pain free period), (4) ability to read and understand English and (5) ability to provide informed consent. Exclusion criteria were as follows: (1) no diagnosis of migraine (2) under the age of 18 years or over the age of 65 years (3) less than 6 headache days per month (with no 4-hour pain free period) (4) inability to read or understand English (5) inability to provide consent (6) use of new preventative migraine medication within 4 weeks of baseline assessment and (7) any severe psychiatric illnesses. All participants completed an electronic screening survey on the study's website to ensure they met inclusion/exclusion criteria, in addition to attending an in-person intake screening session conducted by advanced clinical psychology doctoral students. Participants completed electronic self-report questionnaires about their headache related cognitions. The Albert Einstein College of Medicine Institutional Review Board approved this study.

Measures

Demographics.

Participants completed questions about demographic characteristics including: age, gender (male or female), race (Caucasian or not-Caucasian), employment status (working or not working), highest education level completed (undergraduate degree or higher or less than undergraduate degree), marital status (married or not married), and number of headache days over a 30-day period. To allow for comparisons across samples, demographic characteristics were transformed into binary variables.

*Headache Specific Locus of Control (HSLC)*¹⁰ is a 33-item self-report measure of an individual's belief of who or what determines the onset and development of headaches. Items are rated on a 5-point Likert scale (1 = *strongly disagree* to 5 = *strongly agree*). Three subscale scores emerged in the original validation study (healthcare professional HSLC, internal HSLC, chance HSLC). There are 11 items per subscale score. Total scores range from 33 to 165. Total subscale scores range from 33 to 55. Items include, "My actions influence whether I have headaches" (internal HSLC), "When I have a headache, there is nothing I can do to affect its course" (chance HSLC), and "Health professionals keep me from getting headache" (healthcare professional HSLC). Items on the internal HSLC subscale were reverse coded so that higher scores on this subscale indicated higher external beliefs, as recommended in the original development paper. In the original validation study, the HSLC demonstrated good internal consistency (healthcare professional HSLC $\alpha = 0.88$, Internal HSLC $\alpha = 0.88$, Chance HSLC $\alpha = 0.84$), and adequate 3-week test-retest reliability ($r_s = .72 - .78$). Evidence of construct validity was provided through associations between HSLC beliefs, depression, headache related disability, medication use, and maladaptive pain coping.

Quality of Life.

*Migraine Specific Quality of Life Questionnaire (MSQL)*³⁰ is a 16-item self-report measure of an individual's migraine-related quality of life impairments over the past 4 weeks. Items are rated on a 6-point Likert scale (1 = *none of the time* to 6 = *all of the time*). There are

three subscales: Role Function-Restrictive, Role Function-Preventive, and Emotional Function. Items include, “In the past 4 weeks, how often have migraines interrupted your leisure time activities, such as reading or exercising?” (role function-restrictive), “In the past 4 weeks, how often have you had to cancel work or daily activities because you had a migraine?” (role function-preventative), and “In the past 4 weeks how often have you felt like you were a burden on others because of your migraines?” (emotional function). Higher scores on the MSQ indicate higher quality of life. The MSQ has demonstrated adequate to good internal consistency for all three subscales (α s = .70 – .85).³⁰

Disability.

*Migraine Disability Assessment (MIDAS)*³¹ is a 5-item self-report measure assessing the disabling impact of migraine over the past three months. Individuals specify the number of days they missed work, had a reduction in work productivity, missed household work, had a reduction in household productivity, and missed social or work events due to their migraine. A total score is calculated by summing the five items with higher scores indicating higher disability due to the impact of migraine. Total scores are rated on a 4-point scale (1 = *minimal or infrequent disability* to 4 = *severe disability*). People who score 21 or greater are considered to have “severe disability.” The MIDAS has demonstrated adequate internal consistency (α = .76).³¹

Headache severity.

Average headache pain severity over the past 3 month period was assessed across samples 1, 2, 3, and 5 using MIDAS question B: “On a scale of 0 – 10, on average how painful were these headaches? (0 = *no pain at all*, and 10 = *pain as bad as it can be*). Findings from previous research indicate a strong correlation (r = .77) between answers to MIDAS question B and daily diary data.³² All individuals from sample 4 had to experience moderate to severe headaches to be included in the original study, thus all participants in sample 4 reported moderate to severe headaches over the past month.

Headache frequency.

MIDAS question A³²: “On how many days in the last 3 months did you have a headache (if a headache lasted more than 1 day, count each day)?” was used to assess for headache frequency across all samples.

Data Analysis

Participant characteristics.

Descriptive statistics characterized data pertaining to participant characteristics (age, gender, race, employment status, highest education level completed, marital status, number of headache days over a 30-day period, and migraine diagnosis).

Component Structure & Reliability.

To determine the component structure of the HSLC scale and the number of components to extract, the current study used 1) Principal Components Analysis with orthogonal (Varimax)

rotation 2) Horn's Parallel Analysis 3) and the Minimum Average Partial test. Principal component analysis is a useful data reduction technique that aims to account for the largest amount of total variance between variables in the correlation matrix.³³ Horn's Parallel analysis creates a random dataset that has equal characteristics as the original dataset.³⁴ Eigenvalues from the original dataset are then compared to eigenvalues from comparable components in the random dataset. Components in the original dataset that have an eigenvalue larger than the corresponding eigenvalue from the random dataset are retained. Actual eigenvalues are compared against randomly generated eigenvalues for the 95th percentile of the distribution, as this is a stringent cut off.³⁵ Velicer's Minimum Average Partial test³⁶ first presents a principal component analysis. Components are extracted from the correlation matrix, as the average of the squared partial correlations is calculated. The number of components is decided based on the minimum average of the squared partial correlations, which comprises the common variance.³⁷ The current study utilizes the original Minimum Average Partial test, as it is more accurate than a recent revised version in detecting the number of components.³⁷

Reliability (internal consistency).

Cronbach's alpha, the ratio of the variance of the true score to that of the observed score, measures the relationship between items (internal consistency) of the scale.³⁸ A high alpha indicates that items in the scale are measuring the same construct. An alpha level of .7 for each subscale is considered acceptable.³⁹

Construct validity.

Pearson-product moment correlation coefficient evaluated the relationship between HSLC subscale scores and migraine-related quality of life. Interpretation of correlation effect sizes were based on Cohen's criteria.⁴⁰ An independent samples *t*-test examined significant differences in the HSLC subscale scores between people with severe disability (MIDAS scores 21) and people without severe disability (MIDAS score 0–20). Linear regression assessed significant differences in new HSLC subscale scores based on the number of headache days/30 days.

For all validity analyses, tests were two-tailed with alpha set at .05. The Bonferroni method corrected for family-wise error.

Supplementary analysis.

All validity analyses were run first with observed data. Sensitivity analyses used multiple imputations with regression method to impute missing data to evaluate whether results found with observed data were robust when missing data were imputed. Covariates in the regression model were age, education, employment, and gender.

SPSS version 22.0 was used to conduct all analyses in the study.

RESULTS

Participant Characteristics.

Table 1 presents combined participants' demographic data. Participants' ages ranged from 18 to 75 years ($M = 40.8$, $SD = 11.3$). The majority were female ($N = 610$, 87.8%), Caucasian ($N = 603$, 86.9%), employed ($N = 543$, 78.7%), held an undergraduate degree or higher ($N = 412$, 60.1%), and were married ($N = 428$, 62.2%). Participants recorded an average of 10.5 days with migraine ($SD = 6.2$) over a 30-day period. The majority of participants met criteria for episodic migraine ($N = 557$, 83.3%).

Component structure.—Six hundred and ninety-five participants completed the entirety of the HSLC scale and were therefore included in the scale development analyses. The Kaiser-Meyer-Olkin ($KMO = 0.85$) and Bartlett's test of Sphericity [$X^2(528) = 7003.3$, $p < .001$] indicated Principal Components Analysis was appropriate, and correlations between the components ($-.02$ to $.48$) supported using an orthogonal rotation. Using the traditional cut-off of eigenvalue 1, seven components emerged and explained 55.2% of the variance in HSLC items. However, evaluation of the scree plot showed one clear point of inflection, which indicated retaining five components. Further, both the Minimum Average Partial test (Table 2) and Horn's Parallel Analysis (Figure 1) indicated five significant components.

Therefore, the final Principal Components Analysis extracted five components, which explained 48.6% of the variance in HSLC items. An orthogonal rotation (Varimax) was used to interpret the components and develop subscales. Based on content analysis, the components appear to evaluate *Presence of Internal* (eigenvalue = 5.7, 17.3% variance), *Lack of Internal* (eigenvalue = 4.0, 12.0% variance), *Luck* (eigenvalue = 2.9, 8.7% variance), *Doctor* (eigenvalue = 2.0, 6.1% variance), and *Treatment* (eigenvalue = 1.5, 4.5% variance) HSLC beliefs.

Reliability and Distribution.—In total, the 33 HSLC items demonstrated adequate internal consistency ($\alpha = .79$) (Table 3). Subscale alpha's ranged from .69 (*Doctor*) to .88 (*Presence of Internal*) (Table 3). Item-total correlations were small, ranging from $-.09$ ("My doctors' treatment can help my headaches") to $.49$ ("If I remember to relax I can avoid some of my headaches"). Total scores on the HSLC scale ranged from 43 to 139. The mean HSLC score was 94.6 ($SD = 13.3$). Kurtosis and skewness statistics suggested the HSLC total and subscale scores were normally distributed.

Construct Validity (Table 4).

Quality of Life—Higher scores on the *Lack of Internal* subscale were associated with higher overall migraine specific quality of life impairments ($r = -.12$, $p = .004$), emotional function impairments ($r = -.13$, $p = .002$), and role function-preventive impairments ($r = -.12$, $p = .005$). There was no significant association between scores on the *Lack of Internal* subscale and role function-restrictive impairments ($p = .02$).

Higher scores on the *Doctor* subscale were associated with higher overall migraine specific quality of life impairments ($r = -.20$, $p < .001$), emotional function impairments ($r = -.18$,

$p < .001$), role function-preventive impairments ($r = -.23$, $p < .001$), and role function-restrictive impairments ($r = .18$, $p < .001$).

Higher scores on the *Treatment* subscale were associated with higher overall migraine specific quality of life impairments ($r = -.12$, $p = .004$) and higher role function-preventive impairments ($r = -.12$, $p = .003$). There was no significant association between scores on the *Treatment* subscale and emotional function impairments ($p = .01$) or role function-restrictive impairments ($p = .01$).

There were no significant associations between scores on the *Presence of Internal* subscale and overall migraine specific quality of life impairments ($p = .04$), emotional function impairments ($p = .09$), role function-preventive impairments ($p = .02$) or role function-restrictive impairments ($p = .09$).

There were no significant associations between scores on the *Luck* subscale and overall migraine specific quality of life impairments ($p = .28$), emotional function impairments ($p = .75$), role function-preventive impairments ($p = .08$) or role function-restrictive impairments ($p = .32$).

Disability.—People who had severe disability ($M = 20.3$, $SD = 5.2$) had higher scores on the *Lack of Internal* subscale than people without severe disability ($M = 18.8$, $SD = 5.0$); $t(678) = -4.02$, $p < .001$, $d = .31$). People without severe disability ($M = 19.5$, $SD = 4.7$) had higher scores on the *Doctor* subscale than people with severe disability ($M = 18.4$, $SD = 4.4$); $t(679) = -3.12$, $p = .002$, $d = .24$).

There were no significant differences in scores on the *Presence of Internal* ($p = .30$), *Luck* ($p = .17$), and *Treatment* ($p = .12$) subscales for people with severe disability and people without severe disability.

Migraine Diagnosis/ Number of Headache Days.

People who had chronic migraine ($M = 15.6$, $SD = 2.8$) had higher scores on the *Lack of Internal* subscale than people who had episodic migraine ($M = 15.6$, $SD = 2.7$; $t(659) = -4.02$, $p < .001$, $d = .02$). Higher headache days/30 days predicted higher scores on *Lack of Internal* subscale ($F(1,670) = 18.25$, $p < .001$), $R^2 = .027$.

There were no significant differences in scores on the *Presence of internal* ($p = .09$), *Luck* ($p = .92$), *Doctor* ($p = .15$) and *Treatment* ($p = .83$) subscales based on migraine diagnosis (chronic vs. episodic). Headache days/30 days did not predict scores on the *Presence of Internal* ($p = .39$), *Luck* ($p = .17$), *Doctor* ($p = .07$) and *Treatment* ($p = .26$) subscales.

Supplementary Analysis.—Sensitivity analyses using multiple imputations showed that none of the validity analyses using multiple imputation datasets differed from the validity analyses using observed data.

DISCUSSION

This cross-sectional study evaluated the psychometric properties (component structure, reliability, and construct validity) of the Headache Specific Locus of Control (HSLC) scale in several clinical migraine populations. Martin and colleagues originally conceptualized HSLC as the extent to which people believe the onset and development of their headaches are either due to their own behavior (internal HSLC), or something external to themselves, including their healthcare professional's actions (healthcare professional HSLC), or chance (chance HSLC).¹⁰ Results from the current study suggest that five components comprise the HSLC scale; *Presence of Internal*, *Lack of Internal*, *Luck*, *Doctor*, and *Treatment HSLC*. Findings suggest that the HSLC scale is multidimensional and therefore more complex than its current use. Ultimately, this may change our understanding of the role of control in migraine and help us further evaluate and refine the HSLC measurement tool to evaluate control beliefs in migraine; this is particularly important given the role control beliefs are thought to play in day-to-day behavioral management of migraine, including both lifestyle management and medication adherence.

The current study found a more complex factor structure than that identified in the original development paper¹⁰. As both professional and lay understandings of how migraine attacks initiate and determinants of migraine attack frequency have changed in the past thirty years, it is not entirely surprising that the original three-component HSLC structure no longer fit the data provided by people with migraine. Sample composition may also account in part for these differences: the original development sample included college students with problematic recurrent headache, which could be migraine, tension-type, or mixed in origin. The samples included in this study all included treatment-seeking people with migraine, who likely have more severe and disabling disease, which could impact control beliefs. Relationships with quality of life were small, which is consistent with the original development study where relationships with the Sickness Impact Profile ranged from .16 (Internal) to .23 (Chance); however, several of the subscales identified (*Presence of Internal* and *Luck*) had no significant relationships with migraine-specific quality of life, casting doubt onto the clinical utility of these subscales. It is possible that current scale items do not fully capture current patient control beliefs regarding migraine. Mixed methods qualitative and quantitative investigation of control beliefs in migraine could help shed further light on control beliefs in migraine.

Within the current sample, the original Healthcare professional HSLC subscale comprised two separate components (*Doctor* and *Treatment*). *Doctor* HSLC refers to an individual's belief that the onset and development of their migraine attacks are due to their doctor's actions or simply due to having contact with their providers. *Treatment* HSLC refers to an individual's belief that the onset and development of their migraine attacks is due to their treatment and medication regimen. The current study found that higher scores on the *Doctor* subscale were associated with migraine specific quality of life impairments in terms of emotional function, role function-restriction, and role function-prevention. Interestingly, people without severe disability reported higher scores on the *Doctor* subscale compared with those who reported severe disability. Together, these findings suggest that people who hold *Doctor* beliefs may feel restricted in their lifestyle,²² rely on their providers for

migraine management, believe that they need regular contact with their doctors, and may avoid pleasurable experiences that may help their symptoms and functioning. However, despite feeling that their quality of life is impaired as their migraines limit and interrupt work and leisure activities, people with these beliefs still seem to report good productivity and engagement in social interactions.

Higher scores on the *Treatment* subscale were associated with higher overall and role function-preventive migraine specific quality of life impairments. People who hold these beliefs may believe that their treatment and medication regimen prevent them from engaging in their daily activities such as work and family responsibilities; however, they may believe that they are able to exert an influence on more controllable aspects of their migraine attacks, such as adhering to their treatments and thus feel less limited. Future research should examine the benefits of providers who communicate the role that patients can take in their own migraine treatment, such as engaging in self-management behaviors (e.g., stress management⁴¹), resulting in less dependence on their providers, which may reduce migraine-related quality of life impairments.

The *Presence of Internal* subscale contained all items from the original Internal HSLC subscale; the original Chance HSLC subscale comprised two separate components (*Lack of Internal* and *Luck*). *Presence of Internal* HSLC beliefs refer to an individual's belief that the onset and development of their migraine attacks are due to the own actions, such as managing stress, emotions, and taking care of themselves. *Lack of Internal* HSLC beliefs refer to an individual's belief that their own actions have no impact on the onset and development of their migraine attacks. *Presence of Internal* and *Lack of Internal* subscales are distinct subscales that accounted for distinct variation in the scores; although their content appears to be separate sides of the same construct, they are not the same component. Further, these subscales accounted for a combined 29.31% of variance in scores, suggesting that an individual's beliefs about how much or little they control the onset and course of migraine attacks is the primary construct measured by the HSLC. In the current study, only higher scores on the *Lack of Internal* subscale were associated with emotional function and role function-preventive migraine specific quality of life impairments, higher headache days, and were more commonly reported in people with chronic migraine. Findings suggest that people who believe that they have no impact on the onset and development of their migraine attacks, likely experience a higher emotional burden and believe that their migraines prevent them from engaging in daily activities (e.g., having to cancel work). Future studies should examine associations between HSLC beliefs, emotions of guilt and blame, psychiatric symptoms (depression and anxiety), and other headache related cognitions (pain catastrophizing and self-efficacy) to gain further insight into the impact and role of control beliefs.

Findings from the current study suggest that people with migraine may vary with regards to the factors they believe impact their migraine attacks. Understanding control beliefs remains important and should continue to be examined within the context of contemporary notions of how control impacts pain, types of treatment recommendations, and the way providers communicate the role patients play in their migraine management. For example, "third wave" behavioral therapies that focus on acceptance and mindfulness have increased our

understanding about the role of control beliefs for migraine and pain disorders broadly. McCracken and colleagues⁴² encourage acceptance and continued engagement in daily activities for patients in spite of their pain. They suggest that trying to control pain is not valuable, as active acceptance results in less disability and distress. Similarly, Day and colleagues²³ highlight that present moment, non-judgmental awareness is central in Mindfulness-Based Cognitive Therapy where people are encouraged to increase acceptance and decrease catastrophizing thoughts. Findings from the current study suggest that control beliefs in migraine are multidimensional and more complex than previously thought. Further, current measurement strategies yield subscales that have only small associations with quality of life. Accurate measurement of control beliefs in migraine is necessary to investigate the mechanisms of both traditional behavioral treatment approaches and third-wave therapy approaches. Mixed methods qualitative and quantitative investigation of control beliefs in patients with migraine could help optimize measurement of HSLC.

Limitations and Future Directions

We combined participants from five different studies, which limited our ability to control for non-random variance within the samples. However, there were minimal differences in participant characteristics observed, which increases generalizability of the findings. Furthermore, combining these samples resulted in a larger sample size, which increased the power of the study.

Despite having increased power due to our larger sample size, the effect sizes from our validity analyses were small. However, when compared to previous literature the observed effect sizes were comparable and as expected.

This study only examined people with a diagnosis of migraine; findings may not generalize to other headache diagnoses. However, given that migraine is the second most common primary headache disorder¹ and accounts for the most disability worldwide among the headache disorders,⁸ it is beneficial to first examine HSLC beliefs in a homogenous headache sample before examining the component structure in other headache populations.

The cross-sectional nature of this study limited our ability to draw causal inferences from the results. Future research may consider use of prospective data collection to further evaluate theoretically relevant relationships. Additionally, the use of self-report measures may result in recall bias. However, within the current study, four out of the five of the samples used daily diary methods to capture headache characteristics, which is an acceptable and more accurate method for collecting data about headache frequency.^{43–45}

Conclusions

Migraine is a chronic and extremely disabling and prevalent disease with episodic attacks that are often unpredictable. People with migraine may differ in their beliefs about what factors they expect will influence the onset and development of their migraine attacks. Headache Specific Locus of Control (HSLC) beliefs may influence migraine attack development and how a person responds to their migraine attacks.¹¹ Findings from this study suggest that five components comprise the 33-item HSLC scale; *Presence of Internal*, *Lack of Internal*, *Luck*, *Doctor*, and *Treatment*. Within this study, the HSLC scale exhibited

adequate internal consistency. This study provided evidence of construct validity as demonstrated by observed associations between HSLC, migraine specific quality of life, disability, and number of headache days. Additional examination of associations between HSLC beliefs, emotions, psychiatric symptoms, and headache-related cognitions may elucidate the impact and role of control beliefs in people with migraine. Future studies should use the five new HSLC subscales to provide additional evidence of construct validity, broaden our understanding of the HSLC construct, and then further examine HSLC as a potential change mechanism for migraine treatment.

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Abbreviations

HSLC	Headache Specific Locus of Control
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References

1. The International Classification of Headache Disorders, 3rd edition (beta version). Cephalalgia. 2013;33(9):629–808. [PubMed: 23771276]
2. Smitherman TA, Burch R, Sheikh H, Loder E. The prevalence, impact, and treatment of migraine and severe headaches in the United States: a review of statistics from national surveillance studies. Headache. 2013;53(3):427–36. [PubMed: 23470015]
3. Buse DC, Manack AN, Fanning KM, Serrano D, Reed ML, Turkel CC et al. Chronic migraine prevalence, disability, and sociodemographic factors: results from the American Migraine Prevalence and Prevention Study. Headache. 2012;52(10):1456–70. [PubMed: 22830411]
4. Leonardi M, Steiner TJ, Scher AT, Lipton RB. The global burden of migraine: measuring disability in headache disorders with WHO's Classification of Functioning, Disability and Health (ICF). J Headache Pain. 2005;6(6):429–40. [PubMed: 16388337]
5. Lipton RB, Bigal ME, Diamond M, Freitag F, Reed ML, Stewart WF. Migraine prevalence, disease burden, and the need for preventive therapy. Neurology. 2007;68(5):343–9. [PubMed: 17261680]
6. Lipton RB, Stewart WF, Diamond S, Diamond ML, Reed M. Prevalence and burden of migraine in the United States: data from the American Migraine Study II. Headache. 2001;41(7):646–57. [PubMed: 11554952]
7. Stovner L, Hagen K, Jensen R, Katsarava Z, Lipton R, Scher A et al. The global burden of headache: a documentation of headache prevalence and disability worldwide. Cephalalgia. 2007;27(3):193–210. [PubMed: 17381554]
8. Martelletti P, Birbeck GL, Katsarava Z, Jensen RH, Stovner LJ, Steiner TJ. The Global Burden of Disease survey 2010, Lifting The Burden and thinking outside-the-box on headache disorders. J Headache Pain. 2013;14(1):13. [PubMed: 23565711]
9. Bandura A, Walters RH. Social learning theory. 1977.
10. Martin NJ, Holroyd KA, Penzien DB. The headache-specific locus of control scale: adaptation to recurrent headaches. Headache. 1990;30(11):729–34. [PubMed: 2074167]
11. Nicholson RA, Houle TT, Rhudy JL, Norton PJ. Psychological Risk Factors in Headache. Headache. 2007;47(3):413–26. [PubMed: 17371358]
12. Haut SR, Bigal ME, Lipton RB. Chronic disorders with episodic manifestations: focus on epilepsy and migraine. Lancet Neurol. 2006;5(2):148–57. [PubMed: 16426991]

13. Cano-Garcia FJ, Rodriguez-Franco L, Lopez-Jimenez AM. A shortened version of the Headache-Specific Locus of Control Scale in Spanish population. *Headache*. 2010;50(8):1335–45. [PubMed: 20039958]
14. Hansen JS, Bendtsen L, Jensen R. Psychometric properties of the Danish versions of headache-specific locus of control scale and headache management self-efficacy scale. *J Headache Pain*. 2009;10(5):341–7. [PubMed: 19690940]
15. Heckman BD, Berlin KS, Watakosol R, Pierre VS. Psychosocial headache measures in Caucasian and African American headache patients: Psychometric attributes and measurement invariance. *Cephalalgia*. 2010.
16. VandeCreek L, O'Donnell F. Psychometric characteristics of the Headache-Specific Locus of Control scale. *Headache*. 1992;32(5):239–41. [PubMed: 1628962]
17. Penzien DB, Andrasik F, Freidenberg BM, Houle TT, Lake AE 3rd, Lipchik GL et al. Guidelines for trials of behavioral treatments for recurrent headache, first edition: American Headache Society Behavioral Clinical Trials Workgroup. *Headache*. 2005;45 Suppl 2:S110–32. [PubMed: 15921503]
18. Czajkowski SM, Powell LH, Adler N, Naar-King S, Reynolds KD, Hunter CM et al. From ideas to efficacy: The ORBIT model for developing behavioral treatments for chronic diseases. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association*. 2015;34(10):971–82..
19. Buse DC, Andrasik F. Behavioral medicine for migraine. *Neurol Clin*. 2009;27(2):445–65. [PubMed: 19289225]
20. Scharff L, Turk DC, Marcus DA. The relationship of locus of control and psychosocial-behavioral response in chronic headache. *Headache*. 1995;35(9):527–33. [PubMed: 8530276]
21. French DJ, Holroyd KA, Pinell C, Malinoski PT, O'Donnell F, Hill KR. Perceived Self-efficacy and Headache-Related Disability. *Headache*. 2000;40(8):647–56. [PubMed: 10971661]
22. Grinberg AS, Seng EK. Headache-Specific Locus of Control and Migraine-Related Quality of Life: Understanding the Role of Anxiety. *Int J Behav Med*. 2016.
23. Day MA, Thorn BE, Ward LC, Rubin N, Hickman SD, Scogin F et al. Mindfulness-based cognitive therapy for the treatment of headache pain: a pilot study. *Clin J Pain*. 2014;30(2):152–61. [PubMed: 23446085]
24. Hayes SC, Pistorello J, Levin ME. Acceptance and Commitment Therapy as a Unified Model of Behavior Change. *Couns Psychol*. 2012;40(7):976–1002.
25. The International Classification of Headache Disorders: 2nd edition. *Cephalalgia*. 2004;24 Suppl 1:9–160. [PubMed: 14979299]
26. Seng EK, Robbins MS, Nicholson RA. Acute migraine medication adherence, migraine disability and patient satisfaction: a naturalistic daily diary study. *Cephalalgia* 2017;37(10):955–964. [PubMed: 27489178]
27. Seng EK, Buse DC, Klepper JE, Mayson SJ, Grinberg AS, Grosberg BM, Pavlovic JM, Robbins MS, Vollbracht SE, Lipton RB. Psychological factors associated with chronic migraine and severe migraine-related disability: an observational study in a tertiary headache center. *Headache*. 2017;57(4):593–604. [PubMed: 28139000]
28. Classification Classification I. and diagnostic criteria for headache disorders, cranial neuralgias and facial pain. *Headache Classification Committee of the International Headache Society*. *Cephalalgia*. 1988;8 Suppl 7:1–96.
29. Holroyd KA, Cottrell CK, O'Donnell FJ, Cordingley GE, Drew JB, Carlson BW et al. Effect of preventive (beta blocker) treatment, behavioural migraine management, or their combination on outcomes of optimised acute treatment in frequent migraine: randomised controlled trial. *BMJ*. 2010;341:c4871. [PubMed: 20880898]
30. Jhingran P, Osterhaus JT, Miller DW, Lee JT, Kirchdoetfer L. Development and validation of the Migraine-Specific Quality of Life Questionnaire. *Headache*. 1998;38(4):295–302. [PubMed: 9595870]
31. Stewart WF, Lipton RB, Dowson AJ, Sawyer J. Development and testing of the Migraine Disability Assessment (MIDAS) Questionnaire to assess headache-related disability. *Neurology*. 2001;56(6 Suppl 1):S20–8. [PubMed: 11294956]

32. Stewart WF, Lipton RB, Kolodner KB, Sawyer J, Lee C, Liberman JN. Validity of the Migraine Disability Assessment (MIDAS) score in comparison to a diary-based measure in a population sample of migraine sufferers. *Pain*. 2000;88(1):41–52. [PubMed: 11098098]
33. Field A *Discovering Statistics using IBM SPSS Statistics*. Sage Publications Ltd.; 2013.
34. Horn JL. A rationale and test for the number of factors in factor analysis. *Psychometrika*. 1965;30(2):179–85. [PubMed: 14306381]
35. Glorfeld LW. An improvement on Horn's parallel analysis methodology for selecting the correct number of factors to retain. *Ed Psychol Meas*. 1995;55(3):377–93.
36. Velicer WF. Determining the number of components from the matrix of partial correlations. *Psychometrika*. 1976;41(3):321–7.
37. Garrido LE, Abad FJ, Ponsoda V. Performance of Velicer's Minimum Average Partial Factor Retention Method With Categorical Variables. *Ed Psychol Meas*. 2011;71(3):551–70.
38. Miller LA, Lovler RL, McIntire SA *Foundations of psychological testing: A practical approach*. 4th ed. Thousand Oaks, CA: SAGE Publications, Inc; 2013.
39. Nunnally JC, & Bernstein IH. *Psychometric theory*. 3rd ed. New York: McGraw-Hill Inc; 1994.
40. Cohen J *A power primer*. *Psych Bull*. 1992;112(1):155–9.
41. Penzien DB, Irby MB, Smitherman TA, Rains JC, Houle TT. Well-Established and Empirically Supported Behavioral Treatments for Migraine. *Curr Pain Headache Rep*. 2015;19(7):34. [PubMed: 26065542]
42. McCracken LM, Vowles KE, Eccleston C. Acceptance of chronic pain: component analysis and a revised assessment method. *Pain*. 2004;107(1–2):159–66. [PubMed: 14715402]
43. Houle TT, Turner DP. Natural experimentation is a challenging method for identifying headache triggers. *Headache*. 2013;53(4):636–43. [PubMed: 23534852]
44. Lipton RB, Pavlovic JM, Haut SR, Grosberg BM, Buse DC. Methodological issues in studying trigger factors and premonitory features of migraine. *Headache*. 2014;54(10):1661–9. [PubMed: 25339181]
45. Wells RE, Burch R, Paulsen RH, Wayne PM, Houle TT, Loder E. Meditation for migraines: a pilot randomized controlled trial. *Headache*. 2014;54(9):1484–95. [PubMed: 25041058]

Figure 1.
Scree Plot from Horn's Parallel Analysis Illustrating Actual Eigenvalues (solid line) by Component for 33 Items on the HSLC Scale and Randomly Generated Eigenvalues (dashed line) for the 95th Percentile of the Distribution.

Table 1.

Sample Characteristics

Characteristic	M (SD) or N (%)
Age [†]	40.8 (11.3)
Gender [†]	
Male	85 (12.2)
Female	610 (87.8)
Race [†]	
Caucasian	603 (86.9)
Non-Caucasian	91 (13.1)
Employment	
Working	543 (78.7)
Not working	147 (21.3)
Education ^{††}	
Undergraduate degree or higher	412 (60.1)
Less than undergraduate degree	274 (39.9)
Marital Status ^{††}	
Married	428 (62.2)
Not married	260 (37.8)
HA days over 30-day period	10.5 (6.24)
Migraine Diagnosis [□]	
Episodic	557 (80.1)
Chronic	112 (16.7)

[†]N = 695[†]N = 694

N = 690

^{††}N = 686^{††}N = 688

N = 678

[□]N = 669

Table 2.

Velicer's Minimum Average Partial (MAP) Test Average Partial Correlations

Component Number	Squared	Power ⁴
1	.0394	.0057
2	.0240	.0018
3	.0162	.0007
4	.0110	.0005
5	.0104	.0003

Table 3.

Items, Component Loading and, Item to Subscale Total Correlations for Five Component Solution for HSLC Scale

Components and Items	Component Loading	Item-Subscale Total Correlation
<i>Component 1: Presence of Internal ($\alpha = .88$)</i>		
I can prevent some of my headaches by not getting emotionally upset ^a	0.74	0.67
When I worry or ruminate about things I am more likely to have headaches ^a	0.72	0.63
When I drive myself too hard I get headaches ^a	0.72	0.64
I can prevent some of my headaches by avoiding certain stressful situations ^a	0.71	0.64
My headaches are worse when I'm coping with stress ^a	0.71	0.59
By not becoming agitated or overactive I can prevent many headaches ^a	0.70	0.63
If I remember to relax I can avoid some of my headaches ^a	0.70	0.63
When I have not been taking proper care of myself, I am likely to experience headaches ^a	0.62	0.56
My actions influence whether I have headaches ^a	0.62	0.54
I am directly responsible for getting some of my headaches ^a	0.60	0.52
My headaches are sometimes worse because I am overactive ^a	0.53	0.46
<i>Component 2: Lack of Internal ($\alpha = .75$)</i>		
My headaches are beyond all control ^b	0.68	0.49
I am completely at the mercy of my headaches ^b	0.67	0.50
No matter what I do, if I am going to get a headache, I will get a headache ^b	0.65	0.54
When I have a headache, there is nothing I can do to affect its course ^b	0.61	0.41
Often I feel that no matter what I do, I will still have headaches ^b	0.61	0.49
I'm likely to get headaches no matter what I do ^b	0.57	0.50
When I get headaches I just have to let nature run its course ^b	0.43	0.34
<i>Component 3: Luck ($\alpha = .77$)</i>		
My not getting headaches is largely a matter of good fortune ^b	0.78	0.67
Luck plays a big part in determining how soon I will recover from a headache ^b	0.73	0.59
It's a matter of fate whether I have a headache ^b	0.72	0.56
I'm just plain lucky for a month when I don't get headaches ^b	0.64	0.51
<i>Component 4: Doctor ($\alpha = .69$)</i>		
Just seeing my doctor helps my headaches ^c	0.63	0.44
When I have headaches, I should consult a medically trained professional ^c	0.60	0.47
Having regular contact with my physician is the best way for me to control my headaches ^c	0.56	0.40

Components and Items	Component Loading	Item-Subscale Total Correlation
Health professionals keep me from getting headaches ^c	0.55	0.41
When my doctor makes a mistake I am the one to suffer with headaches ^c	0.51	0.36
Only my doctor can give me ways to prevent my headaches ^c	0.49	0.32
My headaches can be less severe if medical professionals (doctors, nurses, etc.) take proper care of me ^c	0.44	0.43
<i>Component 5: Treatment ($\alpha = .70$)</i>		
If I don't have the right medication, my headaches will be a problem ^c	0.71	0.39
My doctor's treatment can help my headaches ^c	0.67	0.54
I usually recover from a headache when I get proper medical help ^c	0.65	0.53
Following the doctor's medication regimen is the best way for me not to be laid-up with a headache ^c	0.61	0.49

Note.

^a. original internal

^b original chance

^c. original healthcare professional subscale items

Table 4.

Correlations between New HSLC Subscale Scores and Migraine Specific Quality Of Life

Variables	Component				
	Presence of Internal	Lack of Internal	Luck	Doctor	Treatment
Overall MSQL impairments	−.09	−.12	.05	.20	.12
MSQL Emotional Function	−.07	−.13	.01	.17	.11
MSQL Role Function-Preventive	−.10	−.12	.08	.23	.12
MSQL Role Function- Restrictive	−.07	−.10	.04	.18	.11

Note. Significant values based on Bonferroni correction ($p < .01$) are bolded and italicized ($p < .001$)