**STUDY INFORMATION**

Title: Characterization of youth with headaches who report neck pain

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Description:

This study aims to present the prevalence of self-reported neck pain, headache burden, and headaches characteristics using a registry database of pediatric/adolescent patients presenting to a tertiary pediatric headache neurology department.

Primary Hypothesis: Patients with continuous/daily headache are more likely to report neck pain than those with non-daily headache

Secondary Hypothesis: Patients that self-report neck pain will have distinct headache characteristics from those that do not

Background:

The prevalence of neck pain is higher in patients with headaches (Al-Khazali 2022, Ashina 2015). It is also more prominent in chronic migraine when compared to episodic migraine (Al-Khazali 2022). Though neck pain is less prevalent feature in children under 18 years of age with headaches compared to their adult counterparts it is still significant. The prevalence of associated neck pain in children aged 15-18 years was found to be 38.9% with migraine and 22.6% with TTH when compared to 14.1% in those without headache (Blaschek 2012). Though there is not a consensus on the interaction of neck pain and headaches some studies demonstrate a correlation with increased headache frequency and disability (Ford 2008, Haytoglu 2019).

The interpretation of neck pain and headaches therefore can be challenging. Increased understanding of neck pain in headache is important to help facilitation more accurate diagnosis, improve treatment response, understand the potential pathophysiological role and to reduce disability. Utilizing a large database registry of patients self-reported headache intake at a pediatric tertiary headache center will provide helpful insight to prevalence of neck pain, impact to headache burden and presentation of headache to establish potential distinctions in phenotype.

**DESIGN PLAN**

This study will include data from a large self-reported headache registry to establish the prevalence of neck pain, distinct headache characteristics that may be attributed to neck involvement and comparing the headache burden between patient with and without neck pain.

Inclusion criteria: Youth must meet the following inclusion criteria. (1) ages 6 to 17 years old at the time the questionnaire was filled out (2) includes answers on the main predictor and main outcome; (3) any sex, any race/ethnicity; (4) filled out the CHOP intake headache questionnaire between June 2017 and January 2023; (5) any headache diagnosis

Exclusion criteria: (1) data outside of the designated age (2) outside the date collection range

Primary predictor: Continuous/daily vs. intermittent headache

Primary outcome: neck pain vs. no neck pain. This is measured by neck pain reported as a headache pain location and/or as an associated symptom

Participant demographics including age, sex (or gender including the categories of cisgender male, cisgender female, transgender male, transgender female, non-binary if data are available), and race/ethnicity will be assessed

Other variables of interest will include additional headache characteristics and comorbid conditions as follows:

* Pain quality
  + Neuralgiform
  + Migrainous
  + Tension
* Overall pain severity (mild, moderate, severe)
* pedMIDAS grade (non, mild, moderate, severe)
* Frequency of headache exacerbations
* Exacerbation by physical activity
* ICHD-3 diagnostic category (as determined by algorithm applied to patient responses as described in previous work Patterson Gentile et al, 2023)
* Associated symptoms
  + Lightheadedness
  + Ear ringing
  + Room spinning
  + Balance problems
  + Difficulty thinking
  + Blurry vision
  + Sensory sensitivity (count variable, light, sound, smell)
  + Numbness/tingling (bilateral, unilateral, both, neither)
* Pain laterality (side locked vs. bilateral vs. unilateral alternating vs. combination)
* Comorbid stomach/abdominal pain
* Comorbid POTS/dysautonomia
* Positional headache (none, worse lying down, worse standing up, both)
* Valsalva trigger (yes, no)

**ANALYSIS PLAN**

All analyses will be carried out through Matlab®.

We will perform univariate analysis comparing the presence or absence of neck pain across patient demographics, and headache characteristics, and comorbid pain conditions as described above. Proportions will be reported for binary and categorical data, median and interquartile range for ordinal and non-normal continuous data, and mean and standard error of the mean for normal interval data. Chi squared will be reported for binary and categorical data, Kruskal-Wallis will be reported for ordinal data and non-normal interval data, and ANOVA will be reported for normal interval data. Benjamini-Hochberg correction will be used to determine significance in the case of multiple comparisons (eg. associated symptoms). Given the large dataset, we will also report effect sizes of significant variables. Associated symptoms will be compared individually and as a count variable.

We will perform logistic regression analysis. Our main predictor will be continuous/daily versus intermittent headaches, and our main outcome will be the presence or absence of neck pain. The following covariates will be included in analyses regardless of significance on univariate testing: age, sex/gender, race, ethnicity. Additional headache characteristic covariates will be included if they are significantly associated with the presence or absence of neck pain, or the presence of continuous vs. intermittent headache (p>0.1, or p>0.1 corrected for Benjamini-Hochberg in the case of multiple comparisons like associated symptoms or pain quality).

We will also perform a sensitivity analysis for participants who report neck pain in the musculoskeletal review of systems that was not specifically related to headache.

For missing data, we will compare those excluded based on missing data to those who were included across demographics and headache characteristics. We will report missing data rates for all statistical comparisons and plan to employ propensity scoring if there is a large amount of missing data (>5%) and/or are substantial differences between those excluded based on missing data.

We will perform exploratory factor analysis (polychoric or multiple correspondence analysis depending on whether there are predominately binary or ordinal data included) to understand underlying relationships across multiple headache characteristics in their relation to neck pain.

Sample size: Not applicable given large dataset

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