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Cervical musculoskeletal impairments and pressure pain sensitivity in office workers with headache

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ABSTRACT

Background: Office workers are specifically vulnerable to headache conditions. Neck pain is reported by almost 80% of patients with headaches. Associations between currently recommended tests to examine cervical musculoskeletal impairments, pressure pain sensitivity and self-reported variables in headache, are unknown. The aim of this study is to evaluate whether cervical musculoskeletal impairments and pressure pain sensitivity are associated with self-reported headache variables in office workers.
Methods: This study reports a cross-sectional analysis using baseline data of a randomized controlled trial. Office workers with headache were included in this analysis. Multivariate associations, controlled for age, sex and neck pain, between cervical musculoskeletal variables (strength, endurance, range of motion, movement control) and pressure pain threshold (PPT) over the neck and self-reported headache variables, such as *frequency*, *intensity,* and the *Headache-Impact-Test-6,* were examined.
Results: Eighty-eight office workers with a 4-week headache frequency of 4.8 (±5.1) days, a moderate average headache intensity (4.5 ± 2.1 on the NRS), and "some impact" (mean score: 53.7 ± 7.9) on the headache-impact-test-6, were included. Range of motion and PPT tested over the upper cervical spine were found to be most consistently associated with any headache variable. An adjusted R^2 of 0.26 was found to explain headache intensity and the score on the Headache-Impact-Test-6 by several cervical musculoskeletal and PPT variables.
Discussion: Cervical musculoskeletal impairments can explain, irrespective of coexisting neck pain, only little variability of the presence of headache in office workers. Neck pain is likely a symptom of the headache condition, and not a separate entity.

1. Background

The working-age population, especially women, are typically affected by headache conditions (Stovner et al., 2018; Vos et al., 2020). Globally, migraine or tension-type headache (TTH), the most frequent headache types, are reported by every second women at some point in their lives (Vos et al., 2020). Cervicogenic headache, a secondary headache, affects between <0.2 and 4% of the headache population (Knackstedt et al., 2010; Sjaastad and Bakketeig, 2008).

Office workers may be even more vulnerable to headache conditions due to perceived (psychosocial) stress during work related to lack of job control, harassment or lack of social support (Mäki et al., 2008; Min et al., 2014; van der Doef and Schelvis, 2019), as well as time at the computer, with the consequence of reduced physical activity (Li et al., 2020; Medin-Ceylan et al., 2021). In Canadian office workers, working from home at the start of the pandemic, more than 60% reported suffering from headache and neck pain (Houle et al., 2021). The notion of being always available increased the risk for headache and neck pain

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in Norwegian office workers (Knardahl and Christensen, 2022).

Neck pain is a very common feature in all mentioned headaches (Ashina et al., 2015). The odds of suffering from neck pain are 2.5–6 times greater for those with migraine or TTH compared to headache-free persons (Ashina et al., 2015). Nevertheless, there is a controversial discussion on whether the neck pain presenting with headache is related to hypersensitivity and the neck pain is therefore a symptom of headache, or whether the neck pain is related to cervical musculoskeletal dysfunction (Anarte-Lazo et al., 2021; Bragatto et al., 2019; Di Antonio et al., 2022, 2023; Dugailly et al., 2017; Liang et al., 2019, 2022). For example, it has been shown that neck pain and disability measured in people with headache (notably primary headache) does not always relate to the presence of cervical musculoskeletal dysfunction (Liang et al., 2022). In contrast, the presence of neck pain can be highly associated with the presence of cervical musculoskeletal impairments in cervicogenic headache (Antonaci et al., 2001).

Luedtke et al. (2016) developed a consensus between physiotherapy headache experts on the most useful physical examination tests to examine cervical musculoskeletal impairments in headache patients (Luedtke et al., 2016). Tests recommended were: range of motion (ROM), the Flexion-Rotation-Test (Hall et al., 2008, 2010); motor control (Cranio-Cervical-Flexion-Test (Falla, 2004)) and joint palpation of segmental mobility including pain response (Jull et al., 2007). Many of these tests have been confirmed to discriminate migraine patients from controls in a subsequent systematic review (Szikszay et al., 2019). When considering movement control (MC), a recent longitudinal study reported a two-fold risk for future headaches in those with headache and neck pain at baseline plus >2/7 positively rated MC tests of the cervical spine (Ernst et al., 2022). Further systematic reviews examined pressure pain sensitivity tests together with neck muscle strength or endurance in headache patients (Anarte-Lazo et al., 2021; Castien et al., 2018; Liang et al., 2019; Nahman-Averbuch et al., 2018). All systematic reviews reported differences between headache patients and asymptomatic controls (Castien et al., 2018; Liang et al., 2019; Nahman-Averbuch et al., 2018). Although, studies reporting associations between self-reported headache outcomes and quantitative measures of cervical musculoskeletal impairment or pressure pain sensitivity are sparse (Ashina et al., 2023; Di Antonio et al., 2022).

Therefore, the aim of this study was to evaluate the strength of associations between cervical musculoskeletal impairments as well as pressure pain sensitivity with headache defined by variables such as *headache intensity, frequency*, and its *impact on daily life* in a cohort of office workers with headache. Due to the lack of evidence regarding these association, we hypothesized that, when controlled for age, sex and the presence of neck pain which are typical confounding variables (Ashina et al., 2015; Stovner et al., 2018), cervical musculoskeletal impairments and/or pressure pain sensitivity will show little to moderate associations with the presence of headache.

2. Methods

2.1. Study design

This study reports a cross-sectional analysis using baseline data of a cluster-randomized controlled trial (RCT), that used a multi-component intervention (Aegerter et al., 2022). The ethics committee (of the Canton Zurich (Ref-No.2019-01678)) approved the study. The trial was prospectively registered at clinicaltrials.gov (NCT04169646). For strengthening the reporting of this observational study, the STROBE Statement checklist was used (von Elm et al., 2007).

2.2. Participants and recruitment

Participating office workers were recruited from two public organizations at the end of 2019. A project coordinator informed participating organizations by email, flyers, and announcements. Interested participants received further information on a website. Participants were screened for eligibility before participating in the study and written informed consent was obtained prior to any measurements.

Inclusion criteria were age between 18 and 65 years, regularly working ≥25 h/week in predominantly sedentary office work (Aegerter, 2020). Exclusion criteria were in alignment with the European taskforce on neck pain and its associated disorders (Haldeman et al., 2008) and included pregnancy, reasons that exercise was contraindicated (e.g., medical advice, own beliefs), or a prolonged absence from work (≥ four consecutive weeks) during the study period.

2.3. Procedures

Measurements consisted of an online questionnaire on headache and neck pain using Unipark© (Berlin, Germany) and a physical examination of the cervical spine (Supplementary file).

2.3.1. Headache outcome variables

As part of the online questionnaire, *headache frequency* (half or entire headache days) was recorded and participants rated their *average headache intensity* using a numeric rating scale (NRS) from 0 to 10 points (Jensen et al., 1986). Participants additionally completed the *Headache-Impact Test (HIT-6)*. The HIT-6 assesses the impact of headache on daily life, including work and social function of an individual with headache, and has strong internal consistency and construct validity (Haywood et al., 2018). The HIT-6 produces scores between 36 and 78 points, with higher scores indicating greater impact of the headache condition (Rendas-Baum et al., 2014). Answers are given by recalling the last four weeks.

2.4. Physical examination of the cervical spine

The following tests were examined:

2.4.1. Isometric neck muscle strength

Maximal isometric strength of the neck flexor, neck extensor and bilateral shoulder abductor muscles were measured using a NOD dynamometer (NOD, OT Bioelettronica, Italy). Peak values were recorded in Newton (N) and the mean of three repetitions for neck strength and for one repetition of left/right shoulder abduction values were calculated and used for further analysis.

2.4.2. Neck muscle endurance

Neck flexor and neck extensor muscle endurance tests were performed once according to established criteria (Domenech et al., 2011; Florencio et al., 2019; Juul et al., 2013). Holding times for both tests were measured in seconds.

2.4.3. Pressure pain thresholds (PPT)

PPT measurements over the upper trapezius muscle (UT) and upper cervical spine (UCS) were carried out with the NOD algometer (NOD, OT Bioelettronica, Italy), using a one cm^2 probe. Values were given in kilogram-force (kgf). Each side, left and right was measured twice, and the mean of both measurements was used (Castien et al., 2015; Rebbeck et al., 2015).

2.4.4. Sagittal and rotational range of motion of the upper cervical spine

ROM of the UCS was tested by using the CROM device and by guiding participants into UCS flexion, extension, and rotation bilaterally (Satpute et al., 2019; 2021). Two measurements were conducted for each direction.

2.4.5. Movement control

Participants were asked to perform movement control tests for flexion, extension, and rotation independently for the upper and lower cervical spine as a test of their ability to dissociate UCS and LCS movement. Participants received verbal and visual (standardized videos) instructions on how to perform each test.

A detailed description for all tests including reliability values, established beforehand in twenty office workers, can be found in the supplementary file.

2.4.6. Assessors

All test conditions were standardized and were conducted in the same order as described above. Six physiotherapists, who were trained for approximately 4 h before the start of the trial, carried out the measurements. They had an average work experience of 11.4 years (SD: 9.7). Testers were kept blind to the potential headache status and other information obtained by the online questionnaire.

2.4.7. Timeline

Data (online questionnaire and variables obtained from the physical examination of the cervical spine) from all participants were obtained in January 2020 at the office workers' workplace and within a time interval of approximately two weeks.

2.5. Statistical methods

2.5.1. Sample size calculation

No sample size calculation was carried out, as data from the baseline measurement of the RCT (n = 120) was used (Aegerter et al., 2022). Data of only those who reported headache in the last four weeks before entering the study were analysed (n = 88).

2.5.2. Data processing

Descriptive statistics for all outcomes, cervical musculoskeletal impairments and PPT tests were calculated. Neck extensor endurance tests were not normally distributed, and were dichotomized in "completers", those who completed the test for 360 s and those who did not complete ("non-completers"). Mean values for PPT measurements from left and right sides were computed for both the UCS and UT, as no significant side differences were found. For UCS ROM, mean values from two repetitions for the sagittal ROM and rotational ROM were further processed. For the movement control tests, separate scores for UCS (range from 0 = all negative to 3 = all positive), and similar for the lower cervical spine (LCS) (range from 0 to 4) were computed and used for further analysis.

Bivariate correlations between measures of cervical musculoskeletal impairments, PPT and each headache-outcome variable were computed. Coefficients, irrespective of the direction, of <0.25 indicate no or little, 0.25–0.5 fair, >0.5–0.75 moderate to good, and >0.75 denoted strong correlations. Only, at least fair correlation coefficients (≥+0.25 or ≤ −0.25) with 95% confidence intervals are presented (Portney and Watkins, 2000).

2.5.3. Headache frequency

For quantifying age, sex and neck pain adjusted effects on *headache frequency*, a negative binominal generalized linear model (GLM) with log-link was conducted, with all physical examination findings as covariates. Backwards stepwise regression based on Akaike's information criterion (AIC), with the smallest possible model including only age, sex and neck pain in the last four weeks, was conducted.

2.5.4. Average headache intensity and HIT-6

For quantifying age, sex and neck pain adjusted effects on average *headache intensity* and *HIT-6*, multiple GLM were conducted with all covariates. Backwards stepwise regression based on AIC were executed to determine models that best explain variance in outcome variables. Models with fewer variables are preferred, indicated by lower AIC values, with the smallest model including only age, sex, and neck pain in the last four weeks. An adjusted coefficient of determination (R^2) was calculated to establish the amount of variance in the outcome variable that can be explained by the physical examination findings.

For all analyses, data was analysed with the statistical program R (version 3.6.3) (R Core Team, 2020). Significance level was set at alpha = 0.05.

3. Results

3.1. Participants

Data from 88 participants (68 females) was included in this study. The sample reported an average headache frequency of 4.8 (±5.1) headache days, a moderate average headache intensity (4.5 ± 2.1 on the NRS), and on average, "some impact" (mean score: 53.7 ± 7.9) due to headache on the HIT-6 within the last four weeks. All characteristics, including descriptive data for the physical examination findings are summarized in Table 1.

Bivariate correlations ≤ or ≥ ±0.25 are shown in Table 2. There was a negative fair correlation between *strength of the neck flexors* (r = −0.34, 95% Confidence interval (CI) = −0.51 to −0.14) and *neck extensors* (r = −0.28, 95% CI -0.47 to −0.08) with *headache intensity*. There was a negative fair correlation between *MC of the LCS* and the *HIT-6* score (r = −0.27, 95% CI -0.46 to −0.06) (Table 2).

After adjusting for age, sex, and neck pain in the last four weeks, *PPT at the UCS*, *strength of the neck flexors*, *MC of the LCS* and *rotational ROM* remained in the model that could best explain *headache frequency* (Table 3).

The final summary model of multiple linear backwards regression for *mean headache intensity* is presented in Table 4. Overall, the model demonstrated an adjusted R^2 value of 0.26, which means that after adjusting for age, sex, and neck pain in the last four weeks, *PPT over the UCS, strength and endurance of the neck extensors and sagittal ROM* remained in the model and could explain 26% of the variability for average *headache intensity* (Table 4).

The final summary model of multiple linear backwards regression for *HIT-6* is presented in Table 5. Overall, the model demonstrated an adjusted R^2 value of 0.26, which means that *PPT over the UCS*, *MC of the LCS* and *rotational ROM* remained in the model and could explain 26% of

Table 1
Descriptive statistics, including cervical musculoskeletal variables (n = 88).

Variable	Mean (SD) (or indicated)
Age [years]	43.2 ± 9.7
sex [female/male]	68/20
Headache frequency (number of days in 4 weeks)	4.8 (5.1)
Average headache Intensity on NRS [0–10] (last 4 weeks)	4.5. ± 2.1
Headache impact test (HIT-6) (score from 36 to 78 points) (In the last 4 weeks)	53.7 (7.9)
Neck pain in the last 4 weeks (yes/no)	71/17
Neck pain frequency (number of days in 4 weeks)	6.1 (7.2)
Average neck pain intensity on NRS (0–10) (last 4 weeks)	3.0 (1.8)
Neck disability index (NDI) (score from 0 to 50 points) (in the last 4 weeks)	6.5 (5.1)
Strength neck flexor [Newton]	45.0 ± 13.4
Strength neck extensor [Newton]	46.9 ± 13.9
Strength shoulder abduction [Newton]	130.7 ± 34.2
Endurance neck flexor [seconds] max. 180 s	70.1 ± 25.6
Endurance neck extensor [seconds] max. 360 s	328.9 (70.14)
[completers/non-completers]	66/22
Pressure pain threshold upper trapezius [kilogram force/cm^2]	3.1 ± 1.8
Pressure pain threshold upper CS [kilogram force/cm^2]	3.3 ± 1.6
Sagittal range of motion [in degrees]	55.4 (10.2)
Rotational range of motion [in degrees]	38.8 (8.0)
Positive movement control tests upper CS (out of 3) (Median, Min- Max)	0 (0–3)
Positive movement control tests lower CS (out of 4) Median, Min - Max	1.5 (0–4)

Abbreviations: CS= Cervical spine; NRS = numeric rating scale; SD = Standard deviation.

Table 2
Bivariate correlations.

	Independent variables		
Outcome variables	Strength neck flexors	Strength neck extensors	Movement control lower cervical spine
Headache frequency (Days, whole or half-days, with headache in the last month)	NA	NA	NA
Headache intensity (Average intensity of headache episodes in the last month, 0 to 10)	−0.34 (−0.51 to −0.14)	−0.28 (−0.47 to −0.08)	NA
Headache impact test-6 (Score from 36 to 78 points in the last month)	NA	NA	−0.27 (−0.46 to −0.06)

Bivariate correlations (95% confidence intervals). Only correlations coefficient ≥0.25 or ≤ −0.25 denoting at least little correlations, irrespective of their statistical significance are shown.

Table 3
Final regression model to explain *headache frequency*.

	Estimate	95% CI	P-value
Intercept	2.56	1.22 to 3.91	1.3e-04
Age	−0.03	−0.05 to −0.02	1.0e-03
Sex (male)	−0.79	−1.29 to −0.29	1.8e-03
Neck pain, last four weeks	0.51	0.05 to 0.97	0.03
PPT UCS	0.12	0.03 to 0.21	0.02
Strength neck flexors	0.02	8.55e-03 to 0.04	2.05e-03
Movement control LCS (0–4 positive tests)	−0.13	−0.30 to 0.04	0.12
Rotational ROM	−0.03	−0.05 to −0.01	3.63e-03

Log-likelihood −427.61, Akaike's information criterion 445.6. Dispersion parameter for negative binominal: 3.122.
LCS = lower cervical spine; PPT = pressure pain threshold, UCS = upper cervical spine; ROM = range of motion.

Table 4
Final regression model to explain *mean headache intensity*.

	Estimate	95% CI	P-value
Intercept	12.35	8.18 to 16.51	8.4e-08
Age	−0.08	−0.12 to −3.53e-02	4.6e-04
Sex (male)	−1.13	−2.19 to −0.08	0.04
Neck pain, last four weeks	−0.35	−1.38 to 0.69	0.51
PPT UCS	0.33	0.08 to 0.58	9.82e-03
Strength neck extensors	−0.03	−0.07 to −2.40e-04	0.05
Neck extensor endurance	−0.98	−1.93 to −0.04	0.04
Sagittal ROM	−0.05	−0.09 to −6.85e-03	0.02

Residual standard error: 1.83 on 80 degree of freedom. **Adjusted $R^{2:}$ 0.26**; F-statistic: 5.42 on 7 and 80 DF, p-value: 4.12e-05.
PPT = pressure pain threshold, UCS = upper cervical spine; ROM = range of motion.

the variability for the total score of the HIT-6 (Table 5).

4. Discussion

The aim of the current study was to examine to what extent cervical musculoskeletal impairments and PPT are associated with *headache frequency*, *headache intensity* and *impact of headache* in a cohort of office workers with headache. Only few bivariate correlation coefficients with at least "little" strength (r ≥ or ≤ ±0.25) were found (Table 2). When controlled for age, sex and neck pain in the last four weeks, multiple regression models showed that cervical musculoskeletal impairments and PPT variables, with differing combinations for strength, endurance,

Table 5
Final regression model to explain *headache impact test (HIT-6)*.

	Estimate	95% CI	P-value
Intercept	73.81	62.32 to 85.29	2.e−16
Age	−0.26	−0.42 to −0.10	1.6e-03
Sex (male)	−6.57	−10.40 to −2.74	1.0e-03
Neck pain, last four weeks	3.04	−0.80 to 6.88	0.12
PPT UCS	0.73	−0.20 to 1.66	0.12
Movement control LCS (0–4 positive tests)	−1.63	−3.10 to 0.17	0.03
Rotational ROM	−0.25	−0.45 to −0.05	0.02

Residual standard error: 6.83 on 80 degree of freedom. **Adjusted $R^{2:}$ 0.26**; F-statistic: 5.9 on 6 and 80 DF, p-value: 3.9e-05.
LCS = lower cervical spine; PPT = pressure pain threshold, UCS = upper cervical spine; ROM = range of motion.

PTT over the UCS, UCS ROM and movement control, explained approximately a fourth of the variability in *headache variables.*

While age and sex had large effects on associations, only neck pain within the last four weeks significantly affected headache frequency, which may indicate that reported neck pain is primarily referred from the headache and not attributed to a cervical musculoskeletal cause.

Both neck flexor and extensor strength showed "fair" bivariate correlations with *headache frequency and intensity* respectively. Estimates remained significant after controlling for co-variates, suggesting that neck strength might be important to assess in office workers with headache, irrespective of the presence of neck pain. Strength estimates were nearly equal for flexor and extensor strength (Table 1), which is not in line with former studies (Anarte-Lazo et al., 2021; Benatto et al., 2019; Madsen et al., 2016), that reported larger extensor strength in headache populations. These differences are likely to be related to the test-set-up used in this study, which gave the extensor muscles shorter leverages during the test (Supplementary file, Figs. 1 and 2).

Only neck extensor *endurance* was associated with *headache intensity* within the current sample. Those who could not complete the 360 s endurance test showed more frequently higher headache intensity values (Table 3). Neck pain had little effect on this association as has also recently been shown in people with migraine with versus without neck pain (Florencio et al., 2019; 2021). Even though the results for the neck flexor endurance test were normally distributed in the current sample (Table 1), neck flexor endurance was not associated with any headache outcome. The extensor endurance test, on the contrary, showed ceiling effects in a quarter of participants (Table 1). Longer test durations were disregarded, as both tests were the most time-consuming within a tight test schedule. However, one might consider adapting the current protocol by adding more weight to the head during extensor endurance testing, bearing in mind that endurance testing can be provocative of migraine attacks (Carvalho et al., 2021; Florencio et al., 2019).

PPT over the UCS contributed to each headache outcome model, although not significantly for the HIT-6. Unexpectedly, all beta values in multivariate regression models were positive, meaning, the higher the threshold, the higher the *headache frequency, -intensity* or *HIT-6 score* (Tables 3–5). Nevertheless, large associations between PPT and headache were not expected as Di Antonio et al. (2022) reported similar PPT values for episodic migraine patients during an attack, and found no association towards headache frequency, intensity, or disability (Di Antonio et al., 2022). Ashina et al. (2023) also did not identify any association between PPT measured over the temporalis muscle and headache frequency in migraine and TTH patients (Ashina et al., 2023). The same authors found an overall tenderness test, which involved standardized pressures at seven spots in the cranial region and asking patients to report the pain intensity felt during testing, to be more useful.

Among all tests for cervical musculoskeletal impairments, ROM of the UCS was most consistently and significantly associated with headache outcomes. Reported values for the sagittal plane are within the same range as those reported by former headache studies (Table 1) (Ernst et al., 2015; Zito et al., 2006), and in the rotational plane our values are only slightly larger than those reported for migraine patients by Satpute and colleagues (Satpute et al., 2021). Cervical ROM is commonly reduced in cervicogenic headache, but has also been reported to be reduced in migraine or TTH in some studies (Anarte-Lazo et al., 2021; Di Antonio et al., 2022; Liang et al., 2019). In the current study, values for both sides (rotation) and directions (flexion and extension) were collated, as it was not the intention to determine limitations in the ROM to a specific side or direction (Hall and Robinson, 2004), and only subtle side-differences, such as for rotation would have been detected (Satpute et al., 2021).

Last, impaired *movement control* of the LCS was found to be related to headache frequency and *HIT-6* score, though only significantly for the later. Bivariate and multivariate models indicate that better movement control can be expected in those with more impact by their headache (Table 5). It is hypothesized that people with a larger impact have adopted a compensatory movement pattern, by preferably moving the LCS, acquiring better control for that region, while limiting movements in the UCS, maybe due to restricted, pain-inhibited UCS-ROM which has been discussed in the section before and by other studies (Di Antonio et al., 2022; Janani et al., 2018; Kantak et al., 2022). Variability in test scores among participants were larger for LCS-, compared to UCS control tests (Table 1), which can be explained by a larger variability in the level of difficulty for LCS control tests.

4.1. Methodological considerations

Some limitations of this study need to be considered. As all participants entered the study in January 2020, headache outcome variables and the physical examination were not necessarily sampled on the same day but were done within one to two weeks. For that reason, participants were asked to report their average *headache intensity* across a period of four weeks. However, the headache status at the time of completing the questionnaire may have influenced that reporting.

Further, performance of muscle strength and endurance tests might have been affected by pain reproduction. However, participants were instructed that it was their decision when to terminate any test. Based on the study protocol (Aegerter, 2020), all assessors were unaware of a potential headache and/or neck pain condition and did not ask about symptoms during the physical examination.

Headache was not classified according to current guidelines by the International Headache Society (IHS) (International Headache society, 2018). Regarding coexisting neck pain, this might be of minor importance, as neck pain is a common feature of many headache conditions. However, cervical musculoskeletal impairments (Anarte-Lazo et al., 2021) and pressure pain sensitivity (Castien et al., 2018) may differ between headache conditions.

Among the 88 participants, neck pain was common (Table 1). However, most participants had only mild symptoms and disability, while headache intensity and impact, measured by the HIT-6, were somehow more severe (Table 1). This indicates that reported neck pain was, for most participants, likely a symptom of their headache and not attributed to cervical musculoskeletal impairments (Liang et al., 2022). A further consideration is that headache participants were included if they had reported at least one headache in the last four weeks. This may have led to the inclusion of infrequent headache conditions too.

4.2. Clinical considerations

When controlled for age, sex and the presence of neck pain in the last four weeks, cervical physical examination findings have only little to fair associations with self-reported headache outcomes in office workers with frequent headache of moderate intensity. Positive associations between pressure pain sensitivity measurements and self-reported headache outcomes were unexpected. This calls for further studies which include a range of quantitative sensory tests which incorporate pain intensity ratings. Due to the nature of the study design, no causal associations can be determined, as headache can lead to secondary cervical musculoskeletal impairments or vice versa. Nevertheless, testing for cervical musculoskeletal impairments should be incorporated during the physical examination of headache patients, while bearing in mind that positive findings does not necessarily imply that the neck is the source of the headache.

In conclusion, cervical musculoskeletal impairments can occur in office workers with headache but can explain only little of the variability in *headache frequency*, *intensity*, and *impact* reported by individuals.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author.

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Authors' contributions

MJE is a PhD student supervised by DF, AG and KL. MJE, AA and HL set up and conducted the study. AM analysed the data. MJE, NS prepared the first draft of the manuscript. DF, AG and KL reviewed and revised the manuscript. All authors read and approved the final manuscript. MJE is guarantor.

Declaration of competing interest

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.msksp.2023.102816.

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