Relationships Among Musculoskeletal Symptoms, Self-Rated Health, and Work Locations in Studies of Computer Work or Coronavirus Diagnosis

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Objective: To clarify work location's association with musculoskeletal symptoms. **Methods:** Study 1 surveyed 246 working adults who usually felt pain, in general, and increased pain from computer work. Study 2 surveyed a nationally representative sample of 1084 working adults. **Results:** In study 1, 32.5% of the participants sought treatment for their increased pain from computer work. Education differed by work location. When education was considered, there were no significant work location differences in pain intensity, pain interference, or self-rated health. In study 2, COVID-19 diagnoses, education, and gender differed by work location. Age and work location explained self-rated health. Self-rated health was associated with musculoskeletal ache. Work location did not significantly predict musculoskeletal ache. **Conclusion:** Working at home was associated with fewer COVID-19 diagnoses and higher self-rated health than working at employers' locations.

Keywords: musculoskeletal, symptoms, employment, setting

Musculoskeletal pain is prevalent among workers and working-age adults.[1–3] It is also a leading reason for worker compensation[4] and disability claims.[5,6] Thus, musculoskeletal pain has been insufficiently prevented and managed.[7]

Many factors are known to influence people's musculoskeletal symptoms. However, the impact of work location (eg, collocated, home, or hybrid) on musculoskeletal symptoms is uncertain. A study by Giménez-Nadal et al.[8] found that people who commuted to work reported more pain than those who did not commute to work. In contrast, a study by Song and Gao[9] indicated no significant differences in pain between people who worked at their homes or at employers' locations. Additional studies have concluded that people recalled more musculoskeletal symptoms when working at their homes during the coronavirus (COVID-19) pandemic than when previously working at their employers' locations.[10,11] However, these recalled measures were potentially confounded by the many factors that changed (eg, stress) because of the pandemic.[12,13]

A few studies have compared the musculoskeletal symptoms of people working at their homes or their employers' locations during the pandemic. Two such studies indicated that people working at their homes during the pandemic reported more symptoms than people working at their employers' locations.[14,15] The study by Donalonso Siqueira et al.[14] also found that people working at their homes during the pandemic recalled more symptoms than before the pandemic, whereas people working at employers' locations did not recall any difference in symptoms before and during the pandemic.

These studies have measured musculoskeletal symptoms differently. For example, Donalonso Siqueira et al.[14] measured the presence or absence of pain. Toprak Celenay et al.[15] measured the presence or absence of pain, ache, *or* discomfort, which may have included fatigue or stiffness. Neither study controlled for demographic differences between people who were working at their homes or employers' locations. However, there are reports of differences in demographic variables, such as education levels between those who can and cannot work from home.[16,17] Additional studies about the health impacts of work locations are needed because the percentage of people completing some or all of their work from home increased from 19% in 2003 up to 48% in 2020.[18,19]

We conducted two cross sectional studies that advance the literature on work locations' health impacts by considering demographic differences between people who were working at their homes or at employers' locations during the COVID-19 pandemic. Study 1 innovatively measured pain intensity and pain interference with daily activities. We collected data from a convenience sample without measurement of COVID-19 diagnoses. In study 2, we conducted secondary analyses of musculoskeletal ache and COVID-19 diagnoses within a nationally representative sample.

In these studies, we examined both musculoskeletal symptoms and self-rated health. Self-rated health has been associated with musculoskeletal pain.[20,21] Self-rated health is commonly measured in a more standardized way[22] than musculoskeletal symptoms.[23] The relationship between work location and self-rated health is unknown.

Because people working at home have higher education levels than those working at employers' locations[16,17] and education level is positively associated with self-rated health,[24] we hypothesized that better self-rated health and less musculoskeletal symptoms would be reported by people working at homes than at employers' locations. We additionally hypothesized, in study 2, that COVID-19 diagnoses would be less frequent within people who worked at their homes than their employers' locations because physical distancing has been recommended to avoid COVID-19 transmission.[25]

STUDY 1

Materials and Methods

Participants

We recruited a convenience sample of participants by distributing an advertisement via university mass emails, a publicly accessible website, and community bulletin boards. Our inclusion criteria were the following: (1) 18 years or older; (2) employed full- or part-time or self-employed; (3) used a computer for a current job for the past 6 months; (4) computer work had not significantly changed for the past 6 months; (5) completed at least 4 hours of computer work on a usual weekday during the past week; (6) worked consistently from either home or an employer's location for the past week; (7) felt musculoskeletal pain during the past week; (8) felt increased pain from

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Conflicts of interest: None declared.

Ethical approval: This project was approved by an institutional review board.

Data availability statement: The data that support the findings of this study are available from the corresponding author,(E.A.D.), upon reasonable request.

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computer work during the past week; and (9) usually felt a minimum pain intensity of “3” or higher on a “0, no pain” to “10, worst pain you can think of” scale during the past week. After participants completed the survey, they were given the option to request compensation.

Procedures

We programmed an online survey using the Research Electronic Data Capture (REDCap) software. With institutional review board approval, the survey began with a consent page and eligibility screening questions. If participants were eligible to participate, conditional logic programming enabled them to advance to the remainder of the survey. The survey asked closed questions about demographics, health and employment history, and recent work experiences with nominal and ordinal response scales. Pain intensity during the past week was measured with a “0, no pain” to “10, worst pain you can think of” rating scale; we chose the scale's maximal anchor from the Patient-Reported Outcome Measurement Information System (PROMIS).[26] Increased pain intensity during the past week’s computer work was measured with a “0, no increase in pain” to “10, extreme increase in pain” rating scale. Pain interference (“During the past 7 days, how much has the pain interfered with your daily activities?”) and self-rated health (“How is your health in general?”) were measured with five-point ordinal response scales. These ordinal scales were also selected from PROMIS.[26] In addition, “usual” pain location/s was measured with “yes” or “no” response options for 20 body areas (eg, “head”). Questions also asked if participants had asked an expert to evaluate their body’s positions during computer work and asked a health care provider to treat increased pain from computer work. Furthermore, participants were asked for their experience with and expectations of wearable products for improving posture, but their responses to these questions are not reported here.

The survey questions were asked in the same order for all participants. A warning message appeared if participants skipped a question. However, the participants could skip questions and freely move backward and forward within the survey. They also could save their survey answers and return to the survey later.

We pilot tested the survey’s content, usability, and functionality by administering it to two patient advisors, who had experience with musculoskeletal pain and evaluating surveys, and three additional research team members. Based on the feedback received, we completed several revisions of the survey instructions and appearance. Once the survey was finalized, we distributed a study advertisement that contained a uniform resource locator (URL) for the survey.

Data Analyses

Chi-squared tests, Fischer's exact tests, Mann-Whitney *U* tests, and independent-samples *t*-tests compared the demographic variables of the eligible participants who did and did not complete the survey. We defined “survey completion” as answering 98% of the survey questions. Subsequent analyses were run on only the data from the participants who completed the survey. The education variable had fewer than five responses per response category so we recoded it into just three categories—no bachelor's degree, bachelor's degree, some graduate school.

Chi-squared tests, Mann-Whitney *U* tests, and independent-samples *t* tests compared the demographic variables of the participants who worked at their homes (ie, HOMES cohort) and at employers' locations (ie, EMPLOYERS' cohort). The cohorts only differed significantly on education level (see the results below).

Because pain interference and self-rated health were measured with ordinal scales, Spearman correlations examined their relationships with each other and the pain intensity ratings. Mann-Whitney *U* tests compared the work location cohorts' pain interference and self-rated health at each education level. Analyses of covariance examined cohort differences in pain intensity and increased pain intensity from computer work with education level entered as a covariate. Data were analyzed using IBM SPSS (Version 27). All *P* values were two-sided, and *P* values less than 0.05 were considered indicators of statistical significance.

RESULTS

Of the 260 respondents who were eligible to participate, most were women (81.5%). More of these eligible women (96.2%) completed the survey than the eligible men (86.4%; Fischer's exact test = 6.15, $P = 0.04$, Phi = 0.17). No other demographic variables were significantly different between the eligible participants who did and did not complete the survey.

The survey completion rate for eligible respondents was 94.6%. The final sample included 246 participants, most of whom were women (82.9%). The participants' average age was 36.35 years (SD = 13.94) and the majority were white (87.4%). There were about as many participants who had not completed a bachelor's degree (38.6%) as had completed some graduate coursework (38.6%) (see Table 1).

Pain and Self-Rated Health of Total Sample

The participants tended to rate their usual pain intensity, increased pain intensity from computer work, pain interference, and self-rated health near the midpoints of the different response scales (see Table 1). Their most frequent locations of usual pain were neck (80.1%), lower spine (68.7%), and shoulder (52%). Their most frequent locations of increased pain from computer work were neck (76.8%), lower spine (58.1%), and upper spine (41.5%). To manage their increased pain from computer work, 17.1% of the participants had an expert evaluate their body's positions during computer work.

TABLE 1. Descriptive Statistics for Study 1's Demographic Variables

	HOMES Cohort (n = 131)	EMPLOYERS' Cohort (n = 115)	Total (N = 246)
Gender	109 Women (83.2%)	95 Women (82.6%)	204 Women (82.9%)
Age (yr)	37.34 ± 14.46	35.21 ± 13.30	36.35 ± 13.94
Race	113 White (86.3%)	102 White (88.7%)	215 White (87.4%)
Education	39 without Bachelor's (29.8%)*	56 without Bachelor's (48.7%)*	95 without Bachelor's (38.6%)
Pain intensity (0 “no pain” to 10 “worst pain you can think of” scale)	4.68 ± 1.55	4.70 ± 1.50	4.69 ± 1.52
Increased pain intensity from computer work (0 “no increase in pain” to 10 “extreme increase in pain” scale)	4.98 ± 1.87	4.97 ± 1.83	4.98 ± 1.84
Pain interference (5-pt scale)	2.67 ± 0.73	2.61 ± 0.85	2.64 ± 0.78
Self-rated health (5-pt scale)	2.47 ± 0.81	2.55 ± 0.72	2.51 ± 0.77

M ± SD are displayed for age, pain intensity, increased pain from computer work, pain interference, and self-rated health.
*Cohorts were statistically different ($P < 0.05$).

A larger percentage of the participants (32.5%) had asked a health care provider to treat their increased pain from computer work.

Cohort Differences in Demographic Variables

There were no significant differences between the work location cohorts in gender, age, or race. However, the HOMES cohort had completed higher levels of education than the EMPLOYERS' cohort (Mann-Whitney U = 9118, $P < 0.01$, $r = 0.19$). For example, 29.8% of the HOMES cohort and 48.7% of the EMPLOYERS' cohort had not completed a bachelor's degree. Thus, subsequent cohort comparisons considered participants' education level (see Table 1).

Relationships Among Pain, Self-Rated Health, and Work Location

None of the pain measures were significantly correlated with self-rated health (r's = 0.02–0.08, P's > 0.05). There were no significant work location cohort differences in pain interference across education levels (Mann-Whitney U's = 347.50–1041.00, P's > 0.05, r's < 0.02). There were also no significant cohort differences in self-reported health across education levels (Mann-Whitney U's = 374.00–1051.00, P's > 0.05, r's < 0.01) (see Table 2). In addition, there were no significant cohort differences in pain intensity ($F_{1,243} = 0.04$, $P > 0.05$, $\eta^2 < 0.01$) or increased pain intensity from computer work ($F_{1,243} = 0.01$, $P > 0.05$, $\eta^2 < 0.01$) with educational level as a covariate (see Table 3).

DISCUSSION

A methodological strength of Study 1 was that it innovatively measured pain intensity from computer work and pain interference per work location. It did not detect significant differences in pain intensity or pain interference between participants working at their homes or employers' locations. These results are similar to Song and Gao's[9] pre-pandemic findings, but are different from two reports of more pain in people working at their homes than at employers' locations during the pandemic.[14,15]

Different pain measurement methodologies may partially explain the discordant results. Song and Gao[9] measured pain level while Donalonso Siqueira et al.[14] and Toprak Celenay et al.[15] measured the presence or absence of musculoskeletal symptoms. Dichotomous choice questions about pain have not related strongly to pain intensity ratings such as the ratings we collected in our study.[27] In addition, we specifically sampled people who usually felt pain, in general, and increased pain from computer work while the prior studies had less restrictive inclusion criteria (eg, working adults).

Many studies of work locations' impacts have measured pain or discomfort felt during computer work instead of pain that increased during computer work.[14,15,28–31] In our study, the participants rated their increased pain from computer work near the midpoint of the "no increase in pain" to "extreme increase in pain" response scale. Almost one third of the participants asked a health care provider to treat their increased pain from computer work. Thus, among our participants, pain from computer work was insufficiently prevented and managed regardless of work location.

In contrast to prior studies,[20] none of the pain measures in Study 1 were significantly correlated with self-rated health. It is possible that the association was impaired by the sample's size and/or characteristics. For example, our convenience sample of 246 participants was mostly composed of college-educated participants (61.4%) and female participants (82.9%). The prior study by Evangelos et al.[20] sampled 486 men and 514 women, of whom only 29.3% and 19.5%, respectively, had any college-level education. Our sample was also offered compensation for participation, which may have increased selection bias.

COVID-19 diagnoses within the participants' households were not measured in Study 1. It is possible that COVID-19 diagnoses for participants and/or a household member were less common among the participants working at their homes than their employers' locations because of physical distancing recommendations.[25] Such a difference could have differentially impacted the musculoskeletal pain reports by work locations because musculoskeletal pain is a common symptom of COVID-19.[32–36] To explore this possibility, a second study with a nationally representative sample and measures of COVID-19 diagnoses was needed.

STUDY 2

Materials and Methods

Participants

We filtered the COVID-19 Impact Survey's[37] third wave data so that all of the participants for Study 2 were (1) 18 years old or older and (2) employed full- or part-time or self-employed. The COVID-19 Impact Survey sought to measure physical health, mental health,

TABLE 2. Ranks and Mann-Whitney U Results per Education Level for Study 1's Pain Interference and Self-Rated Health

		N	Mean Rank	Mann-Whitney U	P	r
No bachelor's degree						
Pain interference	HOMES cohort	39	46.69			
	EMPLOYERS' cohort	56	48.91			
	Total	95		1041.00	0.68	0.04
Self-rated health	HOMES cohort	39	49.04			
	EMPLOYERS' cohort	56	47.28			
	Total	95		1051.00	0.74	0.03
Bachelor's degree						
Pain interference	HOMES cohort	32	29.64			
	EMPLOYERS' cohort	24	26.98			
	Total	56		347.50	0.51	0.09
Self-rated health	HOMES cohort	32	28.29			
	EMPLOYERS' cohort	24	28.92			
	Total	56		374.00	0.86	0.02
Some graduate coursework						
Pain interference	HOMES cohort	60	50.38			
	EMPLOYERS' cohort	35	43.91			
	Total	95		907.00	0.23	0.12
Self-rated health	HOMES cohort	60	47.08			
	EMPLOYERS' cohort	35	49.57			
	Total	95		995.00	0.64	0.05

TABLE 3. ANCOVA Results for Study 1's Pain Intensity and Increased Pain Intensity From Computer Work

Dependent Variables	Independent Variables	Df	MS	F	P	η^2
Pain intensity	Education	1	6.50	2.82	0.10	0.01
	Work location	1	0.09	0.40	0.84	<0.01
	Error	243	2.31			
Increased pain intensity from computer work	Education	1	0.15	0.04	0.84	<0.01
	Work location	1	0.03	0.01	0.93	<0.01
	Error	243	3.43			

ANCOVA, analysis of covariance.

economic security, and social dynamics during the COVID-19 pandemic. The participants came from the National Opinion Research Center's (NORC's) AmeriSpeak Panel®. NORC identifies as an independent research organization that is governed by a Board of Trustees. The AmeriSpeak panel included one member of randomly selected households from within the NORC's National Sample Frame. This sample frame was created using stratified and systematic sampling methods that were statistically representative of 97% of the US household population. NORC personnel contacted the households by mail, email, telephone, and/or field interviews. NORC offered participants compensation for their participation.

Procedures

Recruitment materials invited household members to complete the COVID-19 Impact Survey in English or Spanish. These materials provided (1) a URL and unique personal identification number for completing the survey via the Internet and (2) a toll-free telephone number for completing the survey via telephone with NORC personnel. The survey asked closed questions with nominal and ordinal response scales about demographics and health and employment history. Work location ("Are you working from home in response to the coronavirus?") and the presence of musculoskeletal ache ("Have you experienced muscle or body aches in the past 7 days, or not?") were measured with a nominal response scale. Self-rated health was measured in the same manner as in Study 1.

Participants could refuse to answer and skip questions. However, participants' data were removed from the final data set if they completed less than half of the survey questions, responded in a pattern, or finished the survey in less than one-third of the median single-session web interview length.[38] The COVID-19 Impact Survey's publicly accessible information did not describe its process for pilot testing the survey.[37]

Data Analyses

The COVID-19 Impact Survey offered "not sure" and "refused" response options for all of our variables of interest except work location. We recoded these response options as "missing," which removed them from subsequent analyses. We also recoded one of the COVID-19 Impact Survey's education variables ("EDUCATION") to create a new education variable with categories that matched the education categories in Study 1.

We completed chi-squared tests to compare the COVID-19 diagnosis variables of the HOMES and EMPLOYERS' cohorts. Next, we filtered out all the respondents with a self or household member COVID-19 diagnosis and completed chi-Squared tests to compare the demographic variables of the work location cohorts. We subsequently examined the association between the presence of musculoskeletal ache and self-rated health with a chi-squared test. Fisher's exact tests were used whenever more than 20% of the expected counts were less than 5.

We applied the COVID-19 Impact Survey's national weighting variable for subsequent analyses. This variable was calculated using an iterative raking process after data collection was completed. The raking variables were age, gender, race/ethnicity, education, and county.[39] A logistic regression model with gender, race/ethnicity, education, and age variables was fitted to assess the association between musculoskeletal ache and self-rated health. Then, we fitted a multinomial logistic regression model to assess the effect of work location on self-rated health when controlling for possible confounding variables (eg, gender, race/ethnicity, education, and age). Finally, we fitted a binary logistic regression model to assess the effect of work location on musculoskeletal ache when controlling for possible confounding variables. Age was treated as a continuous variable for the regression analyses. Wald chi-squared tests were used to evaluate the overall models and individual contributions of predictor variables. Data were analyzed using IBM SPSS (Version 27) and SAS® (Version 9.4). All P values were two-sided and P values of less than 0.05 were considered indicators of statistical significance.

RESULTS

The COVID-19 Impact Survey reported an overall survey completion rate of 19.7%. However, it did not calculate the eligible participants' survey completion rate. The third wave dataset included 7505 participants. Of these participants, 3831 were employed and 1084 of them were nationally weighted cases. Most of these participants completed the survey online (97.9%) and a small majority were men (52.9%). The most frequently selected age category was 25 to 35 years old (28.6%). The majority of the participants were White/Non-Hispanic (59.0%) and had not completed a bachelor's degree (58.6%). About half of the sample worked at home (50.1%) (see Table 4).

Cohort Differences in COVID-19 Diagnosis and Demographic Variables

Of the 1084 participants whose responses were nationally weighted, 6 reported self and household member COVID-19 diagnoses and 19 reported a self or a household member COVID-19 diagnosis. Thus, 25 total participants (2.3%) reported a COVID diagnosis in their household. The work location cohorts differed in the number of participants with household COVID-19 diagnoses (chi-squared = 6.97, $P < 0.01$, Cramer's V = 0.08). For example, of the participants with COVID-19 diagnoses in their households, 24.0% worked at their homes while 76.0% worked at their employers' locations.

Among the participants without COVID-19 diagnoses (n = 1041), the HOMES cohort had completed higher levels of education than the EMPLOYERS' cohort (Mann-Whitney U = 181,782, $P < 0.01$, r = 0.34). For example, 42.5% of the HOMES cohort and 74.9% of the EMPLOYERS' cohort had not completed a bachelor's degree. In addition, the cohorts differed by gender (chi-squared = 4.79, $P = 0.03$, Phi = 0.07). The HOMES cohort was 50.2% women while the EMPLOYERS' cohort was 43.4% women. Thus, education level and gender were considered in subsequent analyses. There were no significant differences between the cohorts in age or race/ethnicity (see Table 4).

Relationships Among Musculoskeletal Ache, Self-Rated Health, and Work Location

A chi-squared analysis found the presence of musculoskeletal ache was significantly correlated with self-rated health

TABLE 4. Unweighted Descriptive Statistics for Study 2's Demographic Variables

	HOMES Cohort With a COVID-19 Diagnosis (n = 6)	EMPLOYERS' Cohort With a COVID-19 Diagnosis (n = 19)	HOMES Cohort Without a COVID-19 Diagnosis (n = 532)	EMPLOYERS' Cohort Without a COVID-19 Diagnosis (n = 509)	Total (N = 1084)
Gender	4 women (66.7%)	11 women (57.9%)	267 women (50.2%)*	221 women (43.4%)*	511 women (47.1%)
Age	3; 25–34 yr (50.0%)	5; 25–34 yr (62.5%)	150; 25–34 yr (28.2%)	144; 25–34 yr (28.3%)	310; 25–34 yr (28.6%)
Race/ethnicity†	3 White/non-Hispanic (50.0%)	7 White/non-Hispanic (36.8%)	329 White/non-Hispanic (61.8%)	296 White/non-Hispanic (58.2%)	640 White/non-Hispanic (59.0%)
Education	2 Without bachelor's (33.3%)	14 Without bachelor's (73.7%)	226 Without bachelor's (42.5%)*	381 Without bachelor's (74.9%)*	635 Without bachelor's (58.6%)

Eighteen participants (1.7%) had missing responses to the questions about COVID-19 diagnoses.
*Within the participants without a COVID-19 diagnosis, these cohorts were statistically different ($P < 0.05$).
†Disclosure risk analysis led to the removal of the race/ethnicity variable for 23 (2.2%) of the participants without a COVID-19 diagnosis.

(chi-squared = 21.02, $P < 0.01$, Cramer's V = 0.15). Similarly, a logistic regression model indicated that self-rated health significantly predicted the presence of musculoskeletal ache (Wald chi-squared = 17.40, df = 4, $P < 0.01$) without unique contributions from gender, race/ethnicity, education, or age. When keeping all other predictors constant, the odds of musculoskeletal ache being present were 86 [OR = 0.14] times less likely when self-rated health was "excellent" (see Table 5).

In addition, a multinomial regression model significantly predicted the participants' self-rated health. The overall model, which contained the demographic variables of age, gender, education, race, and work location, was significant (Global Wald chi-squared = 54.72, df = 36, $P = 0.02$). Age and work location uniquely explained variance in self-rated health (Wald chi-squared = 12.71, df = 4, $P = 0.01$ and Wald chi-squared = 12.20, df = 4, $P = 0.02$, respectively). The odds of "excellent" self-rated health were slightly higher [odds ratio (OR) = 1.01] for every 10-year increase in age. In addition, the odds of "excellent" self-rated health were 43 [OR = 0.56] times less likely when working from employers' location than working from home (see Table 6). However, a logistic regression model, which contained gender, race/ethnicity, education, age, and work location variables, did not significantly predict the presence of musculoskeletal ache (Wald $\chi^2 = 0.02$, $P = 0.88$) (see Table 7).

DISCUSSION

A methodological strength of study 2 was its inclusion of a nationally representative sample of working adults. Such a sample facilitates generalizing the research results to our population of interest.[40] Another strength of study 2 was that it measured COVID-19 diagnoses within participants and their households. COVID-19 is a contagious disease and a common symptom of COVID-19 is musculoskeletal pain.[32–36] Thus, COVID-19 diagnoses within participants' households could obscure work locations' influence on musculoskeletal symptoms during the pandemic. In fact, study 2 detected that significantly fewer of the participants working at home had COVID-19 diagnoses within their households compared with those working at employer locations. This finding is consistent with reports of COVID-19 transmissions at employers' locations[41,42] and increased absenteeism among workers who could not work from home during the COVID-19 pandemic.[43] These results suggest that working at home may be beneficial for reducing COVID-19 diagnoses.

Study 2 measured the presence of musculoskeletal ache. It did not detect significant differences in musculoskeletal ache between participants working at their homes and at employers' locations. These results differ from two reports of more pain in people working at their homes than at employers' locations during the pandemic.[14,15] Donalonso Siqueira et al.[14] measured the presence or absence of pain. Toprak Celenay et al.[15] measured the presence or absence of pain, ache, *or* discomfort, which may have included fatigue or stiffness. Specific measures of ache may be less sensitive than other measures of musculoskeletal symptoms. However, in study 2, musculoskeletal ache was significantly correlated with self-rated health.

Study 2 had several limitations. NORC provided limited information about the methods of participant recruitment and survey development and administration. In addition, the COVID Impact Survey's purpose was to measure physical health, mental health, economic security, and social dynamics during the COVID-19 pandemic. It did not

TABLE 5. Summary of Logistic Regression Analysis for Predicting Study 2's Musculoskeletal Ache

Parameter		Musculoskeletal Ache	Estimate	SE	Chi-Squared	Pr > Chi-Squared	OR	95% CI OR	
Intercept		(1) Yes	−0.96	0.66	2.09	0.14			
Age		(1) Yes	0.09	0.07	1.46	0.23	1.09	0.95	1.25
Gender	(1) Male	(1) Yes	0.06	0.10	0.37	0.54	1.13	0.76	1.70
Race/ethnicity	(1) White/non-Hispanic	(1) Yes	0.13	0.21	0.40	0.53	0.80	0.19	3.41
Race/ethnicity	(2) Black/non-Hispanic	(1) Yes	−0.50	0.35	2.03	0.15	0.43	0.09	2.14
Race/ethnicity	(3) Hispanic	(1) Yes	−0.14	0.28	0.27	0.61	0.61	0.13	2.77
Race/ethnicity	(4) Other/non-Hispanic	(1) Yes	0.15	0.33	0.21	0.65	0.82	0.17	3.98
Education	(1) No bachelor's degree	(1) Yes	0.28	0.15	3.45	0.06	2.18	1.12	4.25
Education	(2) Bachelor's degree	(1) Yes	0.21	0.17	1.48	0.22	2.03	0.98	4.18
Self-rated health	(1) Excellent	(1) Yes	−1.96	0.68	8.42	<0.01	0.14	0.04	0.53
Self-rated health	(2) Very good	(1) Yes	−1.87	0.62	9.08	<0.01	0.15	0.05	0.52
Self-rated health	(3) Good	(1) Yes	−1.17	0.62	3.60	0.06	0.31	0.09	1.04
Self-rated health	(4) Fair	(1) Yes	−1.44	0.67	4.61	0.03	0.24	0.06	0.88

Variables' reference categories were the following: musculoskeletal ache (2), no; gender (2), female; race/ethnicity (88), removed for disclosure risk; education (3), some graduate coursework; self-rated health (5), poor. The sample size for this analysis was 1036.

TABLE 6. Summary of Multinomial Regression Analysis for Predicting Study 2's Self-Rated Health

Parameter		Self-Rated Health	Estimate	SE	Chi-Squared	Pr > ChiSq	OR	95% CI OR	
Intercept		(1) Excellent	5.15	66.34	0.01	0.94			
Age		(1) Excellent	0.01	0.21	0.00	0.97	1.01	0.66	1.53
Gender	(1) Male	(1) Excellent	−0.15	0.31	0.22	0.64	0.75	0.22	2.52
Race/Ethnicity	(1) White/non-Hispanic	(1) Excellent	−2.22	66.33	0.00	0.97	0.00	0.00	999.99
Race/Ethnicity	(2) Black/non-Hispanic	(1) Excellent	−0.41	66.35	0.00	0.99	0.00	0.00	999.99
Race/Ethnicity	(3) Hispanic	(1) Excellent	−2.79	66.33	0.00	0.97	0.00	0.00	999.99
Race/Ethnicity	(4) Other/non-Hispanic	(1) Excellent	−2.59	66.34	0.00	0.97	0.00	0.00	999.99
Education	(1) No bachelor’s degree	(1) Excellent	−0.63	0.58	1.18	0.28	0.24	0.02	3.62
Education	(2) Bachelor's degree	(1) Excellent	−0.16	0.66	0.06	0.81	0.39	0.02	7.18
Work at home	(0) No	(1) Excellent	−0.29	0.34	0.72	0.40	0.56	0.15	2.12
Intercept		(2) Very good	6.03	66.35	0.01	0.93			
Age		(2) Very good	0.08	0.21	0.17	0.68	1.09	0.73	1.63
Gender	(1) Male	(2) Very good	−0.10	0.30	0.10	0.75	0.83	0.25	2.71
Race/Ethnicity	(1) White/non-Hispanic	(2) Very good	−2.24	66.33	0.00	0.97	0.00	0.00	999.99
Race/Ethnicity	(2) Black/non-Hispanic	(2) Very good	−0.82	66.35	0.00	0.99	0.00	0.00	999.99
Race/Ethnicity	(3) Hispanic	(2) Very good	−2.81	66.33	0.00	0.97	0.00	0.00	999.99
Race/Ethnicity	(4) Other/non-Hispanic	(2) Very good	−2.38	66.34	0.00	0.97	0.00	0.00	999.99
Education	(1) No bachelor's degree	(2) Very good	−0.67	0.57	1.38	0.24	0.30	0.02	4.33
Education	(2) Bachelor's degree	(2) Very good	0.13	0.65	0.04	0.84	0.66	0.37	11.83
Work at home	(0) No	(2) Very good	−0.41	0.33	1.54	0.21	0.44	0.12	1.61
Intercept		(3) Good	5.0.30	66.34	0.01	0.94			
Age		(3) Good	0.16	0.21	0.58	0.45	1.17	0.78	1.76
Gender	(1) Male	(3) Good	−0.13	0.30	0.18	0.67	0.77	0.23	2.54
Race/Ethnicity	(1) White/non-Hispanic	(3) Good	−2.21	66.33	0.00	0.97	0.00	0.00	999.99
Race/Ethnicity	(2) Black/non-Hispanic	(3) Good	−0.50	66.35	0.00	0.99	0.00	0.00	999.99
Race/Ethnicity	(3) Hispanic	(3) Good	−2.79	66.33	0.00	0.97	0.00	0.00	999.99
Race/Ethnicity	(4) Other/non-Hispanic	(3) Good	−2.09	66.34	0.00	0.97	0.00	0.00	999.99
Education	(1) No bachelor's degree	(3) Good	−0.47	0.57	0.67	0.41	0.33	0.02	4.84
Education	(2) Bachelor's degree	(3) Good	−0.17	0.66	0.07	0.79	0.44	0.03	8.04
Work at home	(0) No	(3) Good	−0.21	0.33	0.42	0.52	0.65	0.18	2.40
Intercept		(4) Fair	3.72	66.34	0.00	0.96			
Age		(4) Fair	0.31	0.22	2.10	0.15	1.37	0.90	2.09
Gender	(1) Male	(4) Fair	0.08	0.32	0.06	0.81	1.16	0.34	4.03
Race/Ethnicity	(1) White/non-Hispanic	(4) Fair	−2.49	66.33	0.00	0.97	0.00	0.00	999.99
Race/Ethnicity	(2) Black/non-Hispanic	(4) Fair	−0.36	66.35	0.00	0.99	0.00	0.00	999.99
Race/Ethnicity	(3) Hispanic	(4) Fair	−2.41	66.33	0.00	0.97	0.00	0.00	999.99
Race/Ethnicity	(4) Other/non-Hispanic	(4) Fair	−2.22	66.34	0.00	0.97	0.00	0.00	999.99
Education	(1) No bachelor's degree	(4) Fair	−0.64	0.59	1.20	0.27	0.24	0.02	3.61
Education	(2) Bachelor's degree	(4) Fair	−0.16	0.67	0.05	0.82	0.39	0.02	7.27
Work at home	(0) No	(4) Fair	−0.05	0.34	0.02	0.88	0.91	0.24	3.49

Variables' reference categories were the following: self-rated health (5), poor; gender (2), female; race/ethnicity (88), removed for disclosure risk; education (3), some graduate coursework; work at home (1), yes. We treated the survey's age variable, which contained seven response categories, as a continuous variable for ease of interpretation. The sample size for this analysis was 1036.

include questions specifically about the participants' computer work or musculoskeletal symptoms from computer work as was done in study 1.

GENERAL DISCUSSION

Both studies 1 and 2 found significant demographic differences between the participants working at their homes and at employers'

TABLE 7. Summary of Logistic Regression Analysis for Predicting Study 2's Musculoskeletal Ache

Parameters		Musculoskeletal Ache	Estimate	SE	Chi-Squared	Pr > Chi-Squared	OR	95% CI OR	
Intercept		(1) Yes	−2.59	0.32	67.20	<0.01			
Age		(1) Yes	0.10	0.07	1.94	0.16	1.10	0.96	1.26
Gender	(1) Male	(1) Yes	0.06	0.10	0.39	0.53	1.14	0.76	1.69
Race/ethnicity	(1) White/non-Hispanic	(1) Yes	0.14	0.21	0.47	0.49	0.91	0.22	3.83
Race/ethnicity	(2) Black/non-Hispanic	(1) Yes	−0.48	0.35	1.96	0.16	0.49	0.10	2.40
Race/ethnicity	(3) Hispanic	(1) Yes	−0.10	0.27	0.12	0.73	0.72	0.16	3.23
Race/ethnicity	(4) Other/non-Hispanic	(1) Yes	0.20	0.33	0.37	0.54	0.96	0.20	4.64
Education	(1) No bachelor's degree	(1) Yes	0.34	0.16	4.54	0.03	2.32	1.17	4.58
Education	(2) Bachelor's degree	(1) Yes	0.17	0.17	0.94	0.33	1.96	0.95	4.02
Work at home	(0) No	(1) Yes	0.02	0.11	0.02	0.88	1.03	0.68	1.56

Variables' reference categories were the following: musculoskeletal ache (2), no; gender (2), female; race/ethnicity (88), removed for disclosure risk; education (3), some graduate coursework; work at home (1), yes.

locations. More educated participants and more women worked at their homes than at employers' locations during the pandemic. These differences align with the findings of other studies.[16,17] Thus, future investigations of work locations' impacts on health need to consider demographic differences as our studies did.

Study 1 primarily sampled college-educated, white women. It found pain ratings were not significantly correlated with self-rated health. However, in study 2, which had a larger and more diverse sample, the presence of musculoskeletal ache was significantly correlated with worse self-rated health regardless of gender, race/ethnicity, education, and age. Other studies with large samples of more diverse people with chronic musculoskeletal pain have also found significant relationships between pain and self-rated health.[20,21]

Neither study found significant differences in musculoskeletal pain or ache between participants working at their homes or at employers' locations when demographic variables were considered. Thus, the sample of primarily college-educated, white women with usual pain, in general, and increased pain from computer work exhibited nonsignificant differences in a similar manner as the nationally representative sample of adult workers. These results may be interpreted as good news for employers and employees who want to offer and/or work at collocated and/or home locations. However, about one third of the participants in Study 1 reported asking a health care provider to treat their increased pain from computer work. Thus, more efforts to improve musculoskeletal symptoms, regardless of work location, are needed. Other studies have reported that the musculoskeletal symptoms of both collocated workers[28,30] and home workers[44,45] have related to characteristics of their computer workstations.

Study 1 found no significant difference in self-rated health between work locations. However, in study 2, higher self-rated health was more probable for participants working at their homes than at employers' locations. In addition, fewer of the study 2 participants who worked at home had COVID-19 diagnoses for themselves and their household members than the participants working at employers' locations. Thus, working at home instead of employers' locations may offer other health benefits than decreasing musculoskeletal symptoms.

The results of studies 1 and 2 support the need for a nationally representative survey of work locations' impacts on musculoskeletal symptoms and self-rated health. Ideally, the survey should collect detailed information about health history (eg, COVID-19 diagnoses), work and workstation characteristics (eg, duration of computer work and characteristics of commonly used chairs), reasons for current work location/s (eg, physical distancing, quarantine, or isolation), and multidimensional measures of pain (eg, location, intensity, and interference). Future samples should additionally include adults who are working at both their homes and employers' locations in a hybrid manner. Employers and employees need such evidence for their decisions about collocated, home, and hybrid work locations.

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