Relationship between Physical Activity and Pain in U.S. Adults

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[1]*Department of Health and Human Sciences, Bridgewater College, Bridgewater, VA;* [2]*Department of Emergency Medicine, University at Buffalo, Buffalo, NY;* [3]*Department of Physical Medicine and Rehabilitation, University of Pittsburgh Medical Center, Pittsburgh, PA;* [4]*Department of Biostatistics, University at Buffalo, Buffalo, NY; and* [5]*Private practice, Cincinnati, OHIO*

ABSTRACT

RAY, B. M., K. J. KELLERAN, J. E. EUBANKS, N. NAN, C. MA, and D. MILES. Relationship between Physical Activity and Pain in U.S. Adults. *Med. Sci. Sports Exerc.*, Vol. 55, No. 3, pp. 497–506, 2023. **Purpose:** We sought to assess the relationship between physical activity (PA) and pain within the available sample, with secondary aims to assess prevalence of pain, PA levels, health care seeking behaviors, and impact of pain on daily activities and work. **Methods:** We conducted an epidemiological cross-sectional observational study utilizing National Health Interview Survey data from 2020. We examined the self-reported adherence to current PA guidelines and the prevalence of pain. We hypothesized those dealing with pain were less likely to meet PA guidelines. The PA levels, pain prevalence, frequency, and intensity were assessed via the survey and relationships explored via modeling. **Results:** Of 31,568, 46% were men and 53.99% women with mean age of 52.27 yr (±17.31 yr). There were 12,429 (39.37%) participants that reported pain on some days, 2761 (8.75%) on most days, and 4661 (14.76%) every day. The odds of engaging in PA decreased in a stepwise fashion based on frequency and intensity of pain reporting when compared with no pain. Importantly, PA is a significant correlate affecting pain reporting, with individuals engaging in PA (strength and aerobic) demonstrating two times lower odds of reporting pain when compared with those not meeting the PA guidelines. **Conclusions:** There is a significant correlation between meeting PA guidelines and pain. Meeting both criteria of PA guidelines resulted in lower odds of reporting pain. In addition, the odds of participating in PA decreased based on pain frequency reporting. These are important findings for clinicians, highlighting the need for assessing PA not only for those dealing with pain but also as a potential risk factor for minimizing development of chronic pain. **Key Words:** PAIN, PHYSICAL ACTIVITY, CLINICAL PRACTICE

According to the International Association for the Study of Pain, pain is defined as, "An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage." (1) The multifactorial phenomenon of pain is typically dichotomized as acute versus chronic based on temporality (2). Although the relationship between pain reporting and tissue status is variable, most assume acute pain is related to noxious stimuli (e.g., thermal, mechanical, or chemical) resulting in nociceptive activation potentially giving rise to pain experiences to protect the organism's existential integrity (3–5). Alternatively, chronic pain (CP) is considered persisting or recurring pain lasting longer than 3 to 6 months, depending on citation, and often lacks an identifiable pathophysiological or pathoanatomical cause (2,6,7). In general, CP is one of the most common reasons adults seek medical care (8). Approximately 1.5 billion people worldwide experience CP (9). Based on the 2019 data, in the United States, approximately 20.5% of adults (50.2 million) are dealing with CP on most days or every day, leading to limitations in social, daily, and work-related activities (10). Exercise is recommended to individuals dealing with CP (11,12) and is defined as, "Planned, structured, repetitive and purposive in the sense that improvement or maintenance of one or more components of physical fitness is the objective" (13). Alternatively, physical activity (PA) is broadly defined as, "Any bodily movement produced by skeletal muscles that requires energy expenditure" (14). Most individuals, with or without CP, are not meeting PA guidelines, defined as follows:

1. 150 to 300 min of moderate intensity cardiorespiratory activity per week;
2. 75 to 150 min of vigorous intensity cardiorespiratory activity per week;
3. An equivalent combination of 1 and 2; and
4. 2 $d \cdot wk^{-1}$ of resistance training for all major muscle groups (14)

According to the Centers for Disease Control, only 23.2% of adults older than 18 yr are meeting the above guidelines

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in the United States (15). Although data from countries outside of the United States demonstrate those experiencing CP are also not meeting minimal recommendations for PA (16–19), such data have been lacking for the United States until recently. Prior data demonstrate PA can modulate individuals' pain experience and mitigate the risk for developing CP (20–23). In addition, meeting these PA guidelines over time while minimizing sedentary behavior is an important variable in the larger holistic health and well-being of the individual experiencing pain to minimize long-term risk for chronic disease states while maintaining functional ability throughout life (24–26). It is important to assess whether a representative sample of the U.S. general population is meeting PA guidelines while exploring the relationship with pain.

To date, these data have been unavailable until the most recent National Health Interview Survey (NHIS) of 2020. According to the United States Census Bureau, NHIS "… is the principal source of information on the health of the civilian noninstitutionalized population of the United States and is one of the major data collection programs of the National Center for Health Statistics." (27). The survey has been ongoing since the 1960s and provides insight into a broad array of pertinent health information for Americans. The most recent redesign of the survey included questions specific to pain (e.g., prevalence rates, impact, intensity, health seeking behaviors) and PA (e.g., aerobic, strengthening, leisure).

The NHIS also captured pertinent descriptive data on participants, such as age, sex, race, and body mass index (BMI). Prior data demonstrated a higher prevalence of chronic pain among women, non-Hispanic White adults, those age 65 yr and older, and a higher BMI classification for overweight and obesity (28,29). A recent study found a U-shaped correlation between BMI and chronic pain, where those who were underweight, overweight, and obese had an increased prevalence of chronic pain (30). Collectively, these data demonstrate an important relationship exists between pain and PA, potentially moderated by descriptive population characteristics.

OBJECTIVES

The primary purpose of our investigation was to assess the relationship between PA levels and pain within a large U.S. representative general population sample. We had secondary aims to assess prevalence rate of pain based on frequency and intensity, PA levels, health care seeking behaviors, and pain impact on activities of daily living and work. Our tertiary aim was to explore how descriptive characteristics may moderate engagement of PA, as well as pain reporting. Overall, we hypothesized that those dealing with pain were less likely to meet PA guidelines when compared with those not reporting pain.

METHODS

This study report is written in accordance with guidelines for reporting observational studies (31). We conducted an epidemiological assessment of the NHIS 2020 cross-section survey data. The NHIS is an annual household interview survey conducted in-person, targeting noninstitutionalized individuals located within the 50 United States and District of Columbia. The 2020 NHIS survey sample (n) was 31,568. Overall, 14,521 participants were men (46%), and 17,045 were women (53.99%). Included sample age ranges from 18 to 84 yr of age, for those 85 yr and older, their age was coded as 85 to maintain confidentiality. Mean age of the sample was 52.27 yr (±17.31 yr). The largest age groups represented were 30 to 39 yr of age with 4885 (15.47%), 50 to 59 yr of age with 5241 (16.6%), and 60 to 69 yr of age with 6115 (19.37%). See Table 1 for complete sample demographics.

Excluded individuals were those lacking a household address (e.g., homeless and/or in a transitory process), active-duty military personnel and civilians residing on military bases, residents of long-term care facilities (e.g., nursing homes and hospitals), and U.S. nationals living in foreign countries. According to NHIS, sampling is completed via geographically clustered techniques and is conducted throughout the calendar year; the sample is considered nationally representative.

Beginning in 2019, the NHIS implemented a questionnaire redesign. This redesign moved questions on PA to the rotating core content beginning in 2020 (section PHY) and continuing in 2022, 2024, and 2026 (26). As part of the 2019 questionnaire redesign, a section on pain (section PAI) was added to the survey in 2020 that is also fielded on a rotating basis continuing in 2021, 2023, 2025, and 2027 (26). The NHIS 2020 survey was particularly unique in that it included PA and pain components in the same survey. We primarily examined the self-reported adherence to the current PA guidelines, prevalence

TABLE 1. NHIS sample demographics.

Demographics	Frequency *n* = 31,568	%
Gender		
Male	14,521	46.00
Female	17,045	53.99
Refused	1	0.00
Don't know	1	0.00
Age (yr)		
18–19	341	1.08
20–29	3313	10.49
30–39	4885	15.47
40–49	4575	14.49
50–59	5241	16.6
60–69	6115	19.37
70–79	4586	14.53
80–84	1259	3.99
85+	1183	3.75
Refused	63	0.20
Don't know	7	0.02
Race		
White only	24,155	76.52
Black/African American only	3309	10.48
Asian	1705	5.40
AIAN	240	0.76
AIAN and any other group	291	0.92
Other single and multiple races	378	1.20
Refused	15	0.05
Not ascertained	1465	4.64
Don't know	10	0.03
Hispanic/Latinx		
Yes	3833	12.14
No	27,735	87.86
Refused	0	0.00

of pain, and the relationship between these two factors. The PA levels of the sample population were assessed based on leisure time activity and meeting federal guidelines. Participants were specifically assessed and categorized based on meeting aerobic activity, resistance training, both, and neither aspect of the PA guidelines (page 418 of the NHIS survey codebook). Pain questions were asked in a vignette style, where each question subsequently sampled from participants specifically reporting pain over the past 3 months. Pain prevalence and frequency was assessed by asking participants, "In the past 3 months, how often did you have pain? Would you say never, some days, most days, or every day?" (page 374 of the NHIS survey codebook). Prior survey studies have considered those reporting pain on most days or every day over the prior 3 months meet the classification for chronic pain (10,32,33).

In addition, pain intensity was assessed with a verbal pain rating scale by asking participants, "Thinking about the last time you had pain, how much pain did you have? Would you say a little, a lot, or somewhere in between?" (page 375 of the NHIS survey codebook). Verbal pain rating in this manner is an acceptable measurement of pain intensity (34).

To investigate the impact of pain and PA on the population, we converted some of the NHIS reported percentages to reflect the whole population surveyed (n = 31,568) rather than the specific subset of a given question; the NHIS reported frequencies remained unchanged. Two models were developed to assess the relationship between PA levels and pain. Participants with incomplete data were excluded from these models. The first model assessed an outcome of meeting PA guidelines (i.e., more physically active) with predictors of pain (frequency and intensity), sex, age, race, and BMI. Specifically, the model sought to elucidate if the predictors increased, decreased, or had no effect on the odds of meeting PA guidelines. The second model assessed an outcome of the frequency of pain (i.e., less frequent pain) with predictors of meeting PA guidelines, sex, age, race, and BMI. This model sought to investigate if the odds of pain reporting is affected by the predictors, that is, increasing, decreasing, or no effect. Finally, two additional models were developed (1a and 2a) to explore the interactions between predictors and effects on PA (i.e., more physically active) and pain reporting (i.e., less frequent pain).

Statistical analyses on these models were performed in SAS 9.4 (SAS Institute, Cary NC) utilizing a cumulative logit model to determine the predictive odds ratios (OR) for the outcomes of interest (model 1 and 1a for PA and model 2 and 2a for pain frequency).

RESULTS

Pain

The majority of the sample (62.88%) reported pain over the past 3 months. In total, 12,429 (39.37%) reported pain on some days, 2761 (8.75%) on most days, and 4661 (14.76%) every day. Pain intensity was quantified by reporting as "a little," "a lot," or "somewhere in between a little and a lot." There were 8548 (27.08%) participants that reported the intensity as a little, 3402 (10.78%) as a lot, and 7874 (24.94%) somewhere in between. There were 5557 (17.60%) participants of the sample that reported being limited by pain in their life or work activities on some days over the past 3 months, 1148 (3.64%) reported most days, and 1308 (4.14%) reported every day. See Table 2 for complete pain reporting information.

Pain Management Strategies

There were 22,385 participants (70.91%) that reported receiving prescription medication in the prior 12 months. Of those having pain, 15,262 (48.35%) participants reported utilizing over the counter medication (e.g., Tylenol, Advil, or Aleve) to manage their experience. There were 3840 participants (12.16%) that reported taking prescription opioids in the past 12 months and 2177 (6.90%) in the past 3 months. One thousand three hundred four (4.13%) and 1247 (3.95%) reported using opioid medication for acute and chronic pain, respectively. There were 3807 participants (12.06%) that reported receiving a prescription for pain management from their health care professional (e.g., doctor, dentist, etc.). There were 3062 (9.70%) participants that reported seeking relief via massage. Only 2294 (7.27%) of those reporting pain sought care via physical therapy, rehabilitative therapy, or occupational therapy, and 1969 (6.24%) sought chiropractic care. Although only 392 (1.24%) participants reported seeking aid via talk therapies (e.g., cognitive-behavioral therapy). See Table 3 for full details regarding clinician mediated pain management strategies. Participants also utilized various self-management pain strategies. There were 1970 (6.24%) participants that reported engaging in Yoga, Tai Chi, or Qi Gong, and 2927 (9.27%) participants reported seeking relief via relaxation techniques (e.g., meditation). See Table 4 for full details of self-management strategies.

TABLE 2. Pain reporting.

	Frequency	
Pain Experience	**n = 31,568**	**%**
In the past 3 months how often did you have pain?		
Never	11,275	35.72
Some days	12,429	39.37
Most days	2761	8.75
Every Day	4661	14.76
Refused	17	0.05
Not ascertained	405	1.28
Don't know	20	0.06
Thinking about the last time you had pain, how much pain did you have?		
A little	8548	27.08
A lot	3402	10.78
Somewhere in between a little and a lot	7874	24.94
Refused	7	0.02
Not ascertained	2	0.01
Don't know	18	0.06
Did not report being in pain	11,717	37.12
Over the past 3 mo how often did your pain limit your life or work activities?		
Never	8148	25.81
Some days	5557	17.60
Most days	1148	3.64
Every day	1308	4.14
Refused	5	0.02
Not ascertained	7	0.02
Don't know	7	0.02
Did not report being in pain	15,388	48.75

BASIC SCIENCES

TABLE 3. Clinician mediated pain management.

Over the past Three Months Did You Use Any of the Following to Manage Your Pain?	Frequency	
	n = 31,568	%
A pain reliever prescribed by a doctor, dentist, or other health professional?		
Yes	3807	12.06
No	16,006	50.70
Refused	15	0.05
Not ascertained	10	0.03
Don't know	13	0.04
Did not report being in pain	11,717	37.12
Physical therapy, rehabilitative therapy, occupational therapy?		
Yes	2294	7.27
No	17,542	55.57
Refused	3	0.01
Not ascertained	11	0.03
Don't know	1	0.00
Did not report being in pain	11,717	37.12
Spinal manipulation or other forms of chiropractic care?		
Yes	1969	6.24
No	17,864	56.59
Refused	2	0.01
Not ascertained	12	0.04
Don't know	4	0.01
Did not report being in pain	11,717	37.12
Talk therapies, such as cognitive-behavioral therapy (CBT)		
Yes	392	1.24
No	19,430	61.55
Refused	3	0.01
Not ascertained	12	0.04
Don't know	14	0.04
Did not report being in pain	11,717	37.12
Massage?		
Yes	3062	9.70
No	16,766	53.11
Refused	3	0.01
Not ascertained	16	0.05
Don't know	4	0.01
Did not report being in pain	11,717	37.12

TABLE 4. Pain self-management.

Over the past Three Months Did You Use Any of the Following to Manage Your Pain?	Frequency	
	n = 31,568	%
Over the counter medications such as Tylenol, Advil, or Aleve?	15,262	48.35
Yes	15,262	48.35
No	4555	14.43
Refused	10	0.03
Not ascertained	10	0.03
Don't know	14	0.04
Did not report being in pain	11,717	37.12
Yoga, Tai Chi, or Qi Gong (chee-GONG)?		
Yes	1970	6.24
No	17,862	56.58
Refused	2	0.01
Not ascertained	13	0.04
Don't know	4	0.01
Did not report being in pain	11,717	37.12
Other forms of exercise, such as walking, swimming, bike riding, stretching, or strength training?		
Yes	11,400	36.12
No	8431	26.71
Refused	2	0.01
Not Ascertained	15	0.05
Don't Know	3	0.01
Did not report being in pain	11,717	37.12
Meditation, guided imagery, or other relaxation techniques?		
Yes	2927	9.27
No	16,896	53.52
Refused	5	0.02
Not ascertained	17	0.05
Don't Know	6	0.02
Did not report being in pain	11,717	37.12
Did you use other approaches to manage your pain?		
Yes	3030	9.60
No	16,798	53.21
Refused	2	0.01
Not ascertained	18	0.06
Don't know	3	0.01
Did not report being in pain	11,717	37.12

Unadjusted Model Results

Unadjusted model 1 examined the effects of pain on PA, demonstrating a stepwise decrease in the odds of engaging PA based on the frequency of pain reporting. When comparing those reporting pain on most days and every day to those not reporting pain, we found reduced odds of 0.756 and 0.497, respectively, for engaging PA when compared with those never reporting pain. Unadjusted model 2 examined the effects of PA on the outcome of pain frequency, and we found that participants meeting PA criteria showed higher odds for less frequent pain. When comparing participants meeting strength only, aerobic only, and both to participants meeting neither PA criteria, we found the odds of having less frequent pain was 1.381, 1.632, and 2.274, respectively. See Tables 5 and 6 for complete details of unadjusted models.

Model 1—Outcome of meeting PA guidelines with predictors of pain, sex, age, race, and BMI. The total available sample for this analysis was 28,293, with 1045 participants excluded because their data were not ascertained. The majority of individuals from the sample are not meeting PA guidelines. Only 6815 (24.1%) met both criteria (i.e., aerobic and resistance training activities) of the PA guidelines. There were 6822 (24.11%) participants that met only the aerobic guidelines, and 1929 (6.82%) met only the resistance training guidelines.

When holding other predictors constant, participants reporting pain over the prior 3 months showed lower odds to be more physically active compared with those reporting no pain. Specifically, the odds of engaging in PA decreased based on the frequency of pain reporting when compared with no pain. In addition, the intensity of pain negatively affected the odds of engaging PA. See Figures 1 and 2.

When exploring other predictors' effect on PA engagement, we found that women showed lower odds of being more active than men. Race was classified as Black/African American only, Asian only, American Indian Alaskan Native (AIAN) only, AIAN and any other group, Other single and multiple races, and White/Caucasian only. African Americans, Asians, and AIAN had lower odds of being more physically active compared with Caucasians. When assessing BMI classification, we found lower odds of PA for underweight, overweight, and obese groups when compared with healthy weight. Finally,

TABLE 5. Unadjusted odds of having less frequent pain based on PA.

	OR	95% CI
PA **Guidelines**		
Meets strength only vs meets neither criteria	1.381	1.264–1.508
Meets aerobic only vs meets neither criteria	1.632	1.546–1.724
Meets both criteria vs meets neither criteria	2.274	2.151–2.403

TABLE 6. Unadjusted odds of engaging PA based on pain frequency.

	OR	95% CI
Pain frequency		
Some days vs never	0.756	0.720–0.794
Most days vs never	0.497	0.458–0.539
Every day vs never	0.346	0.322–0.371

when comparing participants in the age group 18 to 84 yr, those older than 85 yr had lower odds of engaging in PA. See Table 7 for odds of PA engagement based on descriptive statistics.

Model 1a—Odds of meeting PA guidelines based on predictor interactions comparing women with men. Model 1a explored whether meeting PA guidelines was affected by the interaction between sex and each predictor (i.e., age, pain, race, and BMI). Overall, the results from model 1a demonstrate influential interactions between sex and each predictor on meeting PA guidelines, except for sex and age interaction. Specifically, women reporting pain on most days and who were Africa American, Asian, or other single and multiple race categories showed lower odds for being more physically active than men. The relationship between women and BMI was nuanced, where women who were underweight showed two times higher odds (OR, 1.998; 95% confidence interval [CI], 1.254–3.184) to be more active than men, but those classified as healthy weight, overweight, or obese demonstrated lower odds to be more active than men. Sex and age interaction did not show any statistically meaningful effect on the outcome of PA. See Table 8 for odds of PA based on predictor interactions.

Model 2—Outcome of prevalence of chronic pain with predictors of meeting PA guidelines, sex, age, race, and BMI. Model 2 found PA is an important correlate affecting pain reporting. Individuals who engaged in PA demonstrated an increased odds of reporting less frequent pain compared with those not physically active. Notably, individuals who engaged in and met both criteria (strength and aerobic) of the PA guidelines demonstrated two times higher odds (OR, 1.994; 95% CI, 1.883–2.111) of reporting less frequent pain in comparison to those not meeting either criterion of the guidelines. See Figure 3.

When examining other predictors effect on frequency of pain over the prior 3 months (i.e., never, some days, most days, or every day), women showed lower odds for reporting less frequent pain compared with men. African Americans, Asians, and other single and multiple races had higher odds of reporting less frequent pain when compared with Caucasians. However, AIAN and any other group demonstrated lower odds of reporting less frequent pain when compared with Caucasians. When assessing the effects of BMI on pain reporting, overweight and obese individuals had lower odds of reporting less frequent pain when compared with healthy weight participants. Finally, when comparing with participants in age group 18 to 84 yr, those older than 85 yr had lower odds for reporting less frequent pain. See Table 9 for odds of pain reporting based on descriptive statistics.

Model 2a—Odds of pain based on predictor interactions comparing women with men. Model 2a explored whether pain reporting was affected by the interaction between sex and each predictor (i.e., age, PA, race, and BMI). Overall, the results from model 2a demonstrated influential interactions between sex and each predictor on the outcome of pain reporting, except for sex and age interaction. Specifically, female participants who met neither PA criteria showed lower odds for reporting less frequent pain compared with men. Regarding sex interaction with race, Asian only and White only females showed lower odds for reporting less frequent pain compared with men. When assessing sex interactions with BMI, obese females demonstrated lower odds for reporting less frequent pain compared with men. Sex and age interaction did not show any statistically meaningful effect on the outcome of pain. See Table 10 for odds of pain based on predictor interactions comparing women with men.

DISCUSSION

The 2020 NHIS surveyed 31,568 people and was unique because both questions on pain and PA were addressed in

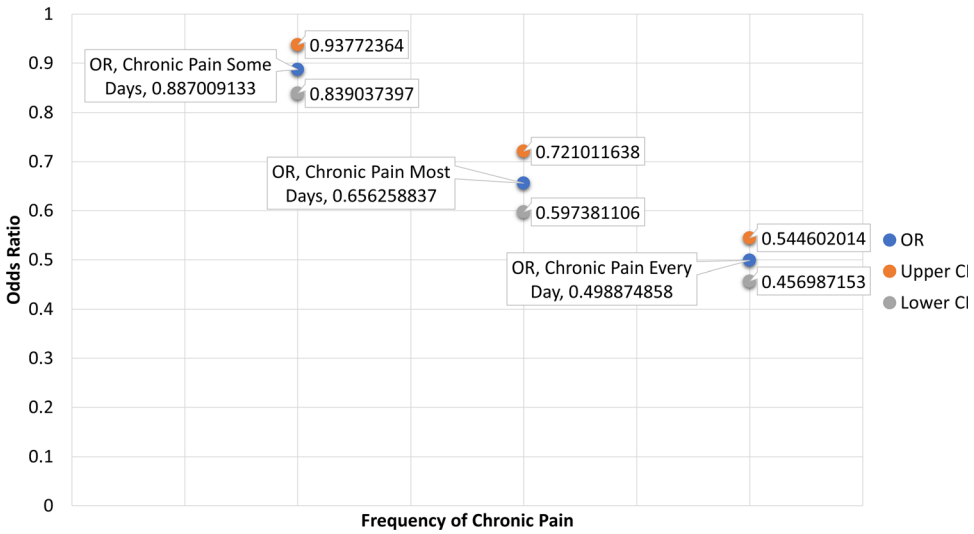

FIGURE 1—Odds of engaging PA based on frequency of chronic pain.

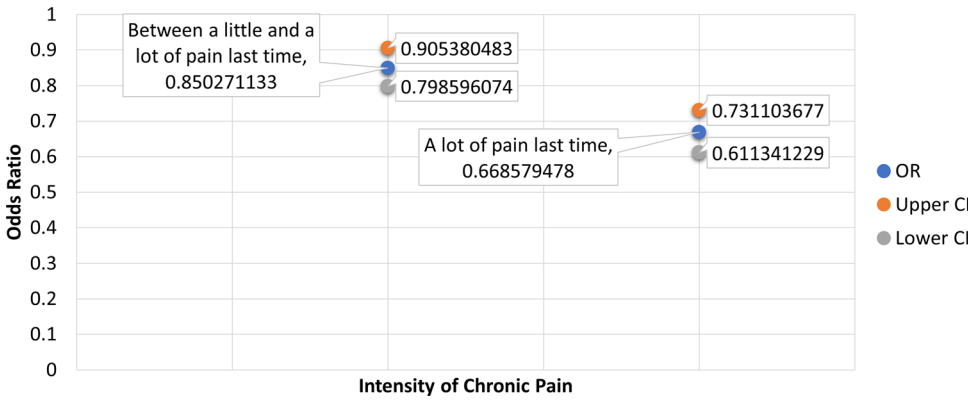

FIGURE 2—Odds of engaging PA based on intensity of chronic pain.

one survey. According to NHIS staff and documentation these two metrics will be on alternating rotating core cycles and are not planned to be synched again for the foreseeable future, PA in 2022, 2024, and 2026, and CP in 2021, 2023, 2025, and 2027 (35). Data from this large national survey demonstrate a high prevalence of pain over the prior 3 months, with 23.51% of the sampled population reporting CP, defined as pain on most days or every day over the prior 3 months (10,34,35). This is a slight increase from the 20.5% based on 2019 data (10). 25.38% of participants reported being limited by pain in their daily life or work activities, a substantial increase from 8.0% of U.S. adults reporting high-impact CP (i.e., limits daily life and work activities) based on 2016 data (32).

Most of the sampled population, with or without CP, are not meeting PA guidelines. Only 24.1% of participants met both criteria (aerobic and resistance training activities), 24.11% met aerobic only, and 6.82% met resistance training only. This is in line with worldwide estimates of 27.5% individuals not meeting PA guidelines from 2018, which used a more liberal definition of PA of 150 min of moderate-intensity or 75 min of vigorous-intensity activity and did not include a delineation between aerobic and strengthening activities (36).

Based on model 1, a correlation was identified between pain reporting and PA outcomes.

Specifically, the odds of participating in PA decreased in a stepwise fashion based on pain frequency reporting. Individuals reporting pain every day showed 50% lower odds for being more physically active than those not reporting pain. In addition, the intensity of pain also reduced the odds of engaging in PA in a stepwise fashion. Those reporting a lot of pain showed 33% lower odds of engaging more activity than those reporting a little pain. This is in line with data from numerous diagnoses specific studies in which individuals presenting with pain are less active than the non–pain-reporting population (37). In one cohort of individuals diagnosed with lumbar spinal stenosis, only 4% of participants were meeting PA guidelines (38). Our findings align with research from countries outside of the United States demonstrating those experiencing CP are also not meeting minimal recommendations for PA (16–20).

Model 1 data also suggest a difference in PA participation by gender, race, BMI, and age. Women showed 31% lower odds of being more physically active than men. Data from multiple studies found similar results globally with women being less active (39–41). The PA gender gap is well established, and a full discussion is beyond the scope of this article. However, one of the major contributing factors to reduced PA engagement by women comparatively to men relates to sociocultural expectations. In early childhood, women have reported gaining less

TABLE 7. Odds of PA outcome based on descriptive statistics.

	OR	95% CI
Sex		
Females vs males	0.692*	0.662–0.724
Race		
Black/African American only vs White only	0.811*	0.754–0.873
Asian only vs White only	0.828*	0.754–0.911
American Indians only vs White only	0.737*	0.569–0.956
American Indians and any other group vs White only	1.145	0.914–1.434
Other single and multiple races vs White only	1.077	0.888–1.305
BMI		
Underweight vs healthy weight	0.571*	0.474–0.688
Overweight vs healthy weight	0.755*	0.715–0.796
Obese vs healthy weight	0.436*	0.412–0.462
Age		
85+ yr vs 18–84 yr	0.332*	0.292–0.378

*Statistically significant.

TABLE 8. Odds of PA based on predictor interactions comparing females to males.

	OR	95% CI
Pain frequency*sex		
Never	0.855	0.686–1.065
Some days	0.830	0.667–1.032
Most days	0.755*	0.584–0.977
Every day	0.794	0.625–1.008
Sex*race		
Black/African American only	0.749*	0.604–0.929
Asian only	0.616*	0.482–0.786
American Indians only	1.304	0.758–2.245
American Indians and any other group	0.910	0.565–1.464
Other single and multiple races	0.628*	0.413–0.954
White only	0.905	0.764–1.072
Sex*BMI		
Underweight	1.998*	1.254–3.184
Overweight	0.567*	0.466–0.691
Obese	0.537*	0.438–0.658
Healthy weight	0.754*	0.620–0.916
Sex*Age		
85+ yr	0.791	0.580–1.078
18–84 yr	0.856	0.721–1.017

*Statistically significant.

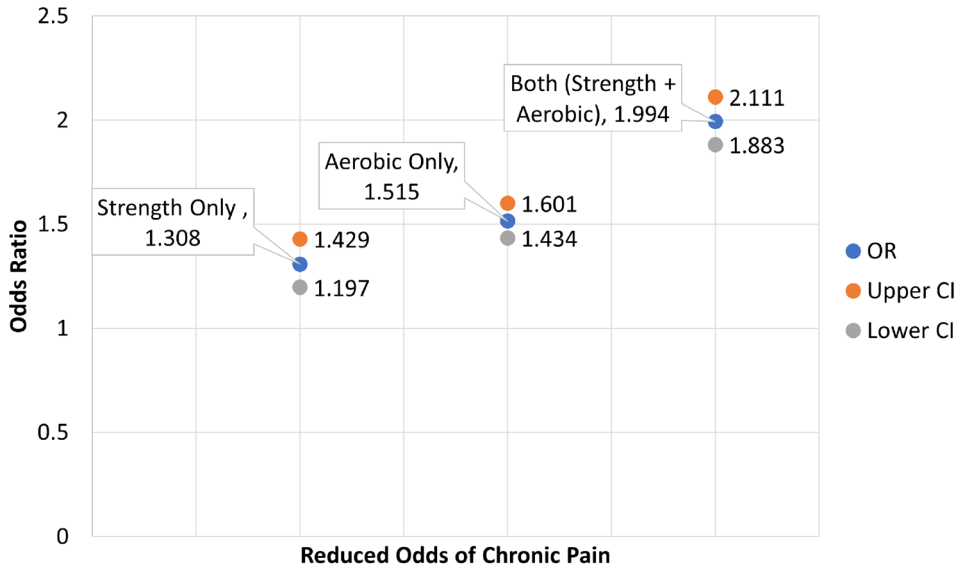

FIGURE 3—Reduced odds of chronic pain based on meeting PA guidelines.

enjoyment from PA. The lack of enjoyment is multifactorial but related to societal imposed gender roles and norms affecting willingness and time to participate in PA. Women's sports often receive less funding, attention, and access for engagement comparatively to male sports. Collectively these early childhood issues mold PA behaviors into adulthood, where many of the socio-cultural norms and expectations are maintained (42).

Based on Model 1, race also had an influence on activity participation with African Americans, Asians, and AIAN demonstrating between 17% and 26% lower odds in being more physically active than Caucasians in Northern America. When exploring sex interaction with race in model 1a, we found further evidence of decreased odds of being more physically active for women by 25%, 38%, and 37% for African American, Asian, or Other single and multiple race categories, respectively in comparison to male counterparts.

Regarding BMI, model 1 demonstrated those who were underweight, overweight, or obese showed decreased odds for being more physically active than healthy weight comparators, with the obesity category showing the largest reduction at 56%. Model 1a further assessed the relationship between sex and BMI effects on the outcome of PA. We found those who were women and overweight, obese, or healthy weight showed lower odds to be more physically active by 43%, 46%, and 25%, respectively, when compared with male counterparts. Interestingly, we found women who were underweight demonstrated 99.8% higher odds for being more physically active compared with men. This is perhaps important when considering clinical issues, such as relative energy deficiency syndrome necessitating a multifaceted approach for recovery (43).

Although the current study did not look at socioeconomic status (SES), the roles of gender, race, and SES are interrelated with the combination of women, non-White, low SES being much less likely to meet PA recommendations. Mielke et al (44) found Caucasian men, in the highest quartile of income met PA guidelines 48% of the time where non-White, women, with low income only met PA 9.8% of the time. Research demonstrates a delineation in benefits conferred related to if PA is associated with leisure

TABLE 9. Odds of pain reporting based on descriptive statistics.

	OR	95% CI
Sex		
Females vs males	0.874*	0.836–0.913
Race		
Black/African American only vs White only	1.125*	1.048–1.207
Asian only vs White only	2.122*	1.921–2.345
American Indians only vs White only	0.888	0.693–1.138
American Indians and any other group vs White only	0.587*	0.472–0.731
Other single and multiple races vs White only	1.220*	1.006–1.480
BMI		
Underweight vs healthy weight	0.944	0.787–1.132
Overweight vs healthy weight	0.839*	0.794–0.885
Obese vs healthy weight	0.569*	0.538–0.602
Age		
85+ yr vs 18–84 yr	0.672*	0.601–0.752

*Statistically significant.

TABLE 10. Odds of pain based on predictor interactions comparing females to males.

	OR	95% CI
PA*Sex		
Meets strength only	0.840	0.654–1.079
Meets aerobic only	0.821	0.663–1.017
Meets both criteria	0.838	0.675–1.041
Meets neither criteria	0.771*	0.632–0.941
Sex*Race		
Black/African American only	0.862	0.705–1.055
Asian only	0.730*	0.573–0.931
American Indians only	0.834	0.498–1.399
American Indians and any other group	0.796	0.503–1.259
Other single and multiple races	0.866	0.573–1.309
White only	0.822*	0.705–0.959
Sex*BMI		
Underweight	0.778	0.504–1.200
Overweight	0.844	0.700–1.017
Obese	0.747*	0.616–0.905
Healthy weight	0.909	0.756–1.094
Sex*age		
85+ yr	0.763	0.577–1.010
18-84 yr	0.875	0.741–1.033

*Statistically significant.

or occupational activities as well, with leisure PA demonstrating increased benefit where occupational activity does not offer the same benefit (45). This further demonstrates the multivariate nature that influences participation in PA and that single variables, such as gender or race, do not convey a comprehensive picture for meeting PA guidelines.

When examining the data via model 2, PA increased the odds of reporting less frequent pain. Notably, meeting both criteria of PA guidelines resulted in two times higher odds of reporting less frequent pain. Meeting the aerobic only and strength only criteria also demonstrated a large increase in odds of reporting less frequent pain, 52% and 31%, respectively. The PA interventions remain a mainstay as guideline recommended care for CP (11,12). Although causation between CP and not meeting PA cannot be established from the design of the current study, we do have sufficient evidence to recommend broadly individuals should engage in PA on a regular basis for the mitigation and treatment of CP. Prior data show PA can modulate individuals' pain experience and mitigate the risk for developing CP (9,21–23). Additionally, meeting these PA guidelines over time while minimizing sedentary behavior is an important variable in the larger holistic health and well-being of the individual experiencing pain to minimize long-term risk for chronic disease states while maintaining functional ability throughout life (24). Even small increases in PA have been shown to have an effect in increasing the health of the population while decreasing mortality (46,47).

Like Model 1 outcomes, Model 2 found relevant descriptive statistics associated with the outcome of pain frequency reporting. Notably, women, AIAN combined with any other group, those who were overweight or obese, and those over the age of 85 showed lower odds for reporting less frequent pain. However, Black/African Americans, Asians, and Other single and multiple races demonstrated higher odds for reporting less frequent pain compared with Caucasians. When further assessing the relationship between sex with other predictors via model 2a, we found women who were not active had 23% lower odds of reporting less frequent pain compared with men who were not active. This aligns with our model 1 and 2 findings, where women had 31% lower odds for being more physically active compared with men and 13% lower odds of reporting less frequent pain compared with men. Interestingly, when examining sex interaction with race effects on pain reporting, we found Asian only and White only females had lower odds, by 27% and 18% respectively, for reporting less frequent pain when compared with males. As a single predictor, BMI classified as overweight or obese demonstrated statistically meaningful lower odds of reporting less frequent pain by 16% and 43%, respectively. However, sex interaction with BMI showed significance with only the obesity classification as female, where these individuals demonstrated 25% lower odds of reporting less frequent pain.

Overall, these findings align with prior data demonstrating sex, race, age, and BMI have a correlation with increased chronic pain reporting (28,29). Pain is a multifactorial phenomenon where such experiences are often framed through the BioPsychoSocial model, seeking to explain the interrelatedness of biological, psychological, and sociological correlates (48,49). The BioPsychoSocial model is not without limitations; however, a full discussion of pain models is beyond the scope of this article (50). An underrepresented variable worth mentioning in the relationship of chronic pain and descriptive statistics is socio-cultural influence affecting health care (51). Although access to pain management is considered a basic human right, there are innumerable attributes for which a cohort may become socially marginalized (52). Social marginalization is a systemic issue in the world and contributes to health disparities, such as health care access, as well as quality of care for those dealing with chronic pain. Prior data demonstrate marginalization leads to health disparities among populations, such as homeless individuals, refugees, trauma survivors, indigenous populations, Lesbian, Gay, Bisexual, Transgender, Queer, and Two-Spirit, individuals with HIV, and U.S. black veterans (52). A limitation of the NHIS survey is lack of capturing information from groups (e.g., imprisoned or active-duty military personnel on base) which may lead to under-representation in the data. The limitation of access and quality of health care may be a contributing factor to increased frequency and impact of chronic pain. Further research is needed to explore these social determinants of health and specifically chronic pain patients' access to quality health care.

When examining pain management strategies from the data, there was a preference for medication. Approximately 71% of individuals reported utilizing some form of medication in the prior 12 months; 48.35% using over-the-counter medications, 12.16% opioids, and 12.06% some form of prescription for pain management from their health care provider. According to numerous guidelines, medication should be at best an adjunct treatment option for CP management (53,54).

Meanwhile, only 7.27% sought care via physical therapy, rehabilitative therapy, and occupational therapy and 6.24% consulted for chiropractic care. These professions are uniquely positioned to educate patients about pain and PA while identifying important facilitators or barriers to engagement of PA. In doing so, these professionals would be aligning with guideline care advocating for education and exercise interventions as first-line treatments (53,55). Most of the sampled population experiencing pain is not utilizing forms of PA as self-management strategies. There were 6.24% that reported engaging in Yoga, Tai Chi, or Qi Gong, and 36.12% engaged other forms of exercise (e.g., walking, swimming, bike riding, stretching, or strength training). Given most of the sampled population is either not engaging in PA or engaging below guideline recommendations for PA, health care professionals should be assessing and advocating for PA.

To date, we do not have sufficient data to state a specific mode of activity or dosage is ideal for aiding or mitigating the development of chronic pain (9). Instead, health care professionals should focus on individuals understanding of multifactorial nature of pain experiences while identifying facilitators and barriers to engagement of PA (56). Over time, the dosage of activity can be titrated to meet PA guidelines. Although the long-term goal is an improvement in meeting PA guidelines in the United States, small increases above baseline have demonstrated increased health benefits (57). Evidence suggests that interventions by primary health care providers result in increased odds

of PA participation by as much as 33% and on average individuals increased activity by 14 min·wk^{-1} (58). Interventions to address PA do not require specific equipment and no one form of exercise has emerged as best. It is imperative that the population, and especially those experiencing chronic pain are encouraged to move more, become more active, and work toward meeting guidelines.

Although the data presented and analyzed in this study are novel and have the potential to inform clinicians and researchers about the prevalence of pain and its association with PA levels, health care seeking behaviors, and impact on activities of daily living and work in the United States, there are some notable limitations inherent to an observational design. These include the retrospective nature of the data collection, and inability to determine causation due to possible confounding as well as information and selection bias. With these limitations in mind, we cannot determine if the relationship between pain and PA is bidirectional or unidirectional in nature. The data are clear that a low percentage of the North American population are meeting PA guidelines and that individuals experiencing pain, most especially chronic, are less likely to engage in PA than the population at large. Future research should seek to further explore the relationship between PA and pain with a specific emphasis on general population and health care professional beliefs surrounding these topics, as well as prospective interventional studies examining PA as a modifiable protective factor and treatment for CP.

CONCLUSIONS

In conclusion, over half of the sampled U.S. population reported pain over the prior 3 months, with 23.51% reporting chronic pain on most days or every day. There were 25.4% that reported pain limited their life or work activities. Almost half of those reporting pain sought aid from over the counter or prescription medications, whereas less than 10% sought conservative care from a health care professional (e.g., physical therapy, occupational therapy, or chiropractic care). In addition, most individuals are not meeting the PA guidelines, whereas those who met both criteria showed a two times increase in odds of reporting less frequent pain compared with those not engaging PA. Given this information and guideline recommendations for chronic pain management, assessing and improving PA for this population is an important clinical focus while having the potential of mitigating future chronic pain development (25).

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