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Applying the NIA Health Disparities Research Framework to Identify Needs and Opportunities in Chronic Musculoskeletal Pain Research

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Abstract

Disparities in the experience of chronic musculoskeletal pain in the United States stem from a confluence of a broad array of factors. Organized within the *National Institute on Aging Health Disparity Research Framework*, a literature review was completed to evaluate what is known and what is needed to move chronic musculoskeletal pain research forward specific to disproportionately affected populations. Peer-reviewed studies published in English, on human adults, from 2000 to 2019, and conducted in the United States were extracted from PubMed and Web of Science. Articles were reviewed for key words that focused on underrepresented ethnic/race groups with chronic musculoskeletal pain applying health factor terms identified in the *NIA Health Disparity Research Framework* four levels of analysis: 1) environmental, 2) sociocultural, 3) behavioral, and 4) biological. A total of 52 articles met inclusion criteria. There were limited publications specific to underrepresented ethnic/race groups with chronic musculoskeletal pain across all levels with particular research gaps under sociocultural and biological categories. Current limitations in evidence may be supplemented by a foundation of findings specific to the broader topic of “chronic pain” which provides guidance for future investigations. Study designs

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including a focus on protective factors and multiple levels of analyses would be particularly meritorious.

Perspective: Chronic musculoskeletal pain unequally burdens underrepresented ethnic/race groups. In order to move research forward and to systematically investigate the complex array of factors contributing toward health disparities, an organized approach is necessary. Applying the *NIA Health Disparities Research Framework*, an overview of the current state of evidence specific to chronic musculoskeletal pain and underrepresented ethnic/race groups is provided with future directions identified.

Keywords

Health disparities; chronic musculoskeletal pain; aging; ethnicity/race; health factors

Chronic musculoskeletal pain, pain experienced in areas of the body involving muscles, joints, ligaments, and/or tendons; affects 116 million Americans and is a leading cause of disability, loss of work, and loss of participation in life activities.^{10,33,39,103} A number of factors contribute toward the development and persistence of chronic musculoskeletal pain: biological (co-morbidities and age-related health changes); sociocultural (depression, anxiety, coping patterns, and social support); behavioral (smoking, lack of exercise, and poor-quality diet); and environmental (low education, lack of quality health care, and poverty).^{19,46,102,105,121,155} The confluence of contributing factors is not equitable, with a number of ethnic/race groups experiencing a greater incidence, prevalence, and severity of chronic musculoskeletal pain compared to non-Hispanic Whites.^{3,17,29,161,162} The consequences of chronic musculoskeletal pain extend beyond functional limitations and reduced quality of life to include increased psychosocial distress, comorbidities, and greater risk of mortality.^{18,35,100,104}

Health disparities are not unique to pain, as disproportionately affected groups carry a greater disease burden across a wide array of health conditions and outcomes.^{57,97,106,125} Research efforts across disciplines have provided evidence of a broad array of factors across multiple levels contributing to health disparities among underrepresented ethnic and/or race groups. Factors extend from the macro level (environment and societal influences) to the micro level (individual) with varying influences across the life course.^{27,31,36,67,88,119,146} Theoretical and conceptual models are evolving to reflect the complex and dynamic array of factors contributing to health disparities and organizational efforts are underway to inform, guide, and fund research efforts moving forward.^{8,20,50,113}

In 2015, the National Institute on Aging (NIA) developed a *Health Disparities Research Framework* with the goal of providing a structure in which to evaluate health disparity research to promote the health of adults across the life span. The intentions underlying these efforts were to develop an organizational framework to promote an interdisciplinary research focus; evaluate existing research and identify gaps; improve the integration between mechanisms and pathways; and promote the infrastructure to assist in the identification of novel approaches and targets. The *NIA Framework* was designed to facilitate an “age-

related, multidimensional, across the life course” focus comprised of 4 levels of analyses: environmental, sociocultural, behavioral, and biological.⁷⁷

In order for research specific to disparities in the experience of chronic musculoskeletal pain to move forward, an organized approach is necessary to understand what has been addressed and identify current gaps. Therein lies the intention of this initial literature review. Applying the *NIA Health Disparities Research Framework* (<https://www.nia.nih.gov/research/osp/framework>), we evaluate published research specific to identified health factor terms across priority areas within each level of analysis in the area of chronic musculoskeletal pain and underrepresented ethnic/race groups. The goal of this review is to help determine what is known and what is needed to advance research to reduce disparities in chronic musculoskeletal pain and improve health outcomes.

Methods

We conducted a review of the literature with health factor search terms defined by the priority areas listed under each level of analysis (see Table 1) identified in the *NIA Health Disparities Research Framework*, Fig 1. The search included health factor *NIA Framework* terms combined with pain-related terms such as “pai” “chronic pai” “musculoskeletal pain,” or “chronic musculoskeletal pain” and one of the following terms “health disparities” or “ethnicity” or “race.” Additionally, based on the productivity of the search term combinations, variations were included such as reducing the number of terms in the search or exploring alternative phrasing associated with the health factor terms (eg, emotional regulation – emotion, emotion dysregulation; physical activity – exercise; occupation – job, work, employment).

Peer-reviewed articles were identified using PubMed, Web of Science, and the reference lists of identified articles. We restricted our search to articles published in English and conducted in the United States between the years 2000 to 2019, on human adults (≥ 18 years old). Inclusion criteria included: 1) studies specific to chronic musculoskeletal pain, chronic musculoskeletal pain conditions (eg, low back pain, osteoarthritis pain, rheumatoid arthritis, fibromyalgia), or associated with chronic musculoskeletal pain conditions; and 2) analyses specific to underrepresented ethnic/race groups. Articles were excluded if they addressed acute or sub-acute musculoskeletal pain lasting less than 3 months, were study protocols, or systematic reviews. Additional exclusion criteria included: pain after stroke, diabetic peripheral neuropathy, post-amputation, cancer-related pain, or chronic pelvic pain. In the first step of data extraction, titles and abstracts were searched by a minimum of 2 coauthors for each level of analysis outlined in the *NIA Health Disparities Research Framework*: MP and DF – Environmental; SQB, SP, AMM, MP – Sociocultural; EJB, AJJ, LD - Behavioral; and KPR, ELT, AMM – Biological. Full-text articles were reviewed by the level of analysis team (above), to determine inclusion. Final decisions were determined by a consensus of three authors when applicable (AJJ, AMM, and KTS). Due to the broad and overlapping nature of search terms, some articles were applicable to more than one level of analysis. Fifty-two articles (7 articles addressing 2 different levels of analyses) aligned with the above criteria and were included in the review. Included articles are presented in Tables 2–5.

Terms used to identify ethnic/race groups in the Results section are consistent with the phrasing used in the original publications. The National Institutes of Health (NIH) requires funded clinical researchers to collect and report data on ethnicity/race.¹¹⁶ A 2-question format in the order of ethnicity first and race second is the suggested data collection approach.⁸¹ Current Ethnicity categories are limited to Hispanic or Latino and non-Hispanic or Latino. Race categories include: 1) American Indian or Alaska Native, 2) Asian, 3) Black or African American, 4) Native Hawaiian or Other Pacific Islander, and 5) White. Where applicable, we will incorporate phrasing in line with NIH guidelines (eg, *Introduction* and *Discussion* sections).

Results

Environmental Level

The priority areas identified under the Environmental level of analysis in the *NIA Health Disparities Research Framework* are: 1) geographical and political; 2) socioeconomic; and 3) health care.⁷⁷ Population-level experiences result in a variety of differential exposures and influence health outcomes. Research on environmental factors, ethnic and/or race groups, and chronic musculoskeletal pain is critical to better understand and address the disparities in outcomes. Our search resulted in 18 articles specific to the Environmental level of analysis (Table 2).

Geographical and political factors are recognized as influencing health outcomes. Health factor terms under this priority area include structural bias, immigration and documentation, criminalization, residential segregation, urban and/or rural residence, and toxin exposure.⁷⁷ Our search did not reveal studies specific to geographical and political factors and chronic musculoskeletal pain. Further research in the area of geographical and political factors and chronic musculoskeletal pain with consideration for underrepresented ethnic/race groups are needed.

Socioeconomic status (SES) is a second priority focus area under the Environmental level of analysis. Health factors identified under the priority area of SES includes education, income and/or wealth, occupation, and English language proficiency.⁷⁷ In a study of individuals with knee pain with or at risk for knee osteoarthritis, SES has been shown to interact with ethnic/race groups such that non-Hispanic Black individuals below the federal poverty line reported greater clinical pain compared with non-Hispanic White individuals who were also below the federal poverty line.¹⁵⁶ Among young women (ages 22–26 years old), African American individuals reported lower SES and more widespread musculoskeletal pain than their Caucasian counterparts.⁵⁵ Body pain was also significantly associated with lower subjective SES and worse reported health in individuals with chronic musculoskeletal pain.⁵⁵ Low educational attainment, regardless of ethnicity/race is associated with poor outcomes in both radiographic and symptomatic knee osteoarthritis.^{26,69} Language can also be a significant barrier in forming meaningful physician-patient interactions in accessing care. Findings highlight the importance of considering SES and English literacy when evaluating health disparities in chronic musculoskeletal pain.

Health care factors are the third priority area under the Environmental level of analysis with identified health factor terms to include access, insurance, quality, literacy and numeracy.⁷⁷ As previously noted, African American individuals report higher levels of clinical pain compared to non-Hispanic White individuals.^{28,161,162} Findings also suggest disparities in health care treatment such that African American patients generally receive less opioid and non-steroidal anti-inflammatory prescriptions compared to White patients with chronic musculoskeletal pain.^{24,42,43,74} Further, findings suggest that African American adults undergo increased opioid monitoring and receive fewer referrals to pain specialists compared to Hispanic and non-Hispanic White adults.⁷² Another study found among black patients who “demanded specific narcotics or exhibited anger” were more likely to receive a higher and/or stronger opioid dose with the opposite treatment pattern found for white patients, a higher and/or stronger opioid dose for those with “non-challenging” verbal behaviors.²² African American persons experiencing chronic musculoskeletal pain are also less likely to receive diagnostic imaging tests and surgical interventions, particularly in individuals with lower education and income levels.^{71,79,153} Additionally, physician characteristics (eg, gender, ethnicity, resident and/or attending, pain management training) were indicated in a pilot study of treatment plans in individuals with chronic low back and lower extremity pain. Although the sample size was limited, findings indicated male physicians were more likely to prescribe valium and physical therapy with female physicians more likely to prescribe psychological counseling. Additionally, resident status was associated with more condition-related instruction.¹¹⁴ A survey of workers’ compensation claimants with occupational low back pain found that African American workers had higher disability ratings and medical costs following claims.¹⁵⁰ Further, researchers have reported ethnic/race group differences in the use of non-pharmacological interventions and self-management strategies for chronic musculoskeletal pain.^{4,51} Importantly, the *Arthritis Foundation Self-Help Program*, comprised of 6 weekly small group sessions on exercises, cognitive coping, relaxation and other pain related self-care skills performed at 3 community centers in New York City, found improvements across all outcome measures particularly with reductions in pain intensity and increases in physical activity. However, there was higher attendance and greater positive improvements by Hispanic participants. The Spanish program differed from the English program in that Spanish participants had sessions in Spanish, with time to perform exercises during session and take home instructional CDs not offered in the English program.¹²² Although findings are inconsistent regarding ethnic/race group differences in health care related factors,^{23,28} it is evident that health care plays a key role in improving health outcomes in individuals from underrepresented ethnic/race groups with chronic musculoskeletal pain.

Sociocultural Level

The Sociocultural level of analysis in the *NIA Health Disparities Research Framework* includes the following priority areas: 1) cultural; 2) social; and 3) psychological.⁷⁷ Six articles were identified from searches for studies that investigated chronic musculoskeletal pain, ethnic/race groups, and factors within the sociocultural level of analysis (Table 3). Although, there were limited references specific to chronic musculoskeletal pain, findings illuminate a direction for future research.

Cultural factors are the first priority area under the Sociocultural level of analysis with health factors to include values, prejudice, norms, traditions, religion, and collective responses.⁷⁷ Cultural factors indeed play an important role in influencing health beliefs and health behaviors.^{2,49,75,90} Unfortunately, the evidence specific to cultural factors, chronic musculoskeletal pain, and ethnic/race groups is limited. In a qualitative study of older adults randomly assigned vignettes describing a family member with chronic pain associated with osteoarthritis found older African American adults reported a more optimistic perspective of the benefits of health care and indicated greater willingness to provide care to the family member compared to White adults.¹¹¹ In another qualitative study of patients with chronic back or knee pain, Hispanic patients indicated religion and faith to be important factors involved in medical and/or health-related decision-making and were more likely to let their physicians take the lead role in their medical care decisions compared to their non-Hispanic white peers.⁸⁹ Passive coping skills such as praying and hoping was more prevalent in Hispanic patients than non-Hispanic whites.¹²² Additionally, African American individuals with chronic knee or hip pain expressed in regards to their care, faith was important however, physician's ethnicity and/or race or religion was not.⁸⁰ Further research providing an improved understanding of the relationships between cultural factors and chronic musculoskeletal pain would be beneficial.

Social factors are the second priority area under the Sociocultural level of analysis. Health factor terms in this priority area include family stress, financial stress, occupational stress, residential stress, social mobility, social networks, and institutional racism.⁷⁷ Social factors are associated with stress and pain^{25,46,85,94,95,114,120,142} and health disparities.^{1,40} McIlvane (2007) reported that psychological well-being, as measured by the Center for Epidemiological Studies Depression Scale and the Satisfaction with Life Scale, was significantly impacted by both education and race by education, such that African American women with low education had higher depressive symptoms than African American women with high education, but that these differences were not present in White women. Additionally, African American women with arthritis-related pain reported more religious coping, wishful-thinking, emotional expression, and seeking social support compared to White women with arthritis-related pain, irrespective of education.¹⁰⁷ Researchers have also demonstrated the importance of social networks on perceived benefits of arthritis interventions, including surgery. It was shown that Black individuals with hip and knee pain tended to report knowing fewer people for whom surgery was beneficial, and therefore perceived such procedures to be less helpful.¹⁶ African American adults who were single with lower education, lower income, and greater unemployment were less familiar with total knee replacement outcomes and were less likely to undergo surgery.⁷⁹ Although limited, findings highlight the influence of social factors on musculoskeletal pain and the need for further research.

Psychological factors are the third priority area under the Sociocultural level of analysis with health factor terms to include self-concepts, stigma, bias, loneliness and stereotypes.⁷⁷ These health factors may shape individual health care decisions further influencing inequalities in the experience of chronic musculoskeletal pain. The literature search did not identify studies specific to the identified health factor terms, ethnicity/race, and chronic musculoskeletal pain. Research is needed to appreciate the relevance of psychological factors within the

sociocultural level of analysis that impact individual and population health behaviors contributing to health disparities.

Behavioral Level

The Behavioral level of analysis in the *NIA Health Disparities Research Framework* includes the following 3 priority areas: 1) coping factors; 2) psychosocial risk and/or resilience factors; and 3) health behaviors.⁷⁷ Psychosocial and behavioral factors are well-recognized as highly relevant to health outcomes.^{52,134} Similarly, pain-related coping styles, psychosocial factors, and health behaviors have been associated with ethnic/race differences in chronic musculoskeletal pain and related functional limitations.^{109,119} A total of 34 studies were identified specific to the Behavioral level of analysis (Table 4).

Coping factors are the first priority area under the Behavioral level of analysis and includes the following health factors: active coping, problem solving, stress management, cognitive reframing, and emotional regulation.⁷⁷ Passive coping patterns are associated with greater psychological distress and pain severity.^{34,99} Research on coping factors specific to chronic musculoskeletal pain suggest that non-Hispanic Black individuals engage in passive coping strategies such as catastrophizing, emotion-focused coping, praying, and hoping to a greater degree than non-Hispanic White individuals.^{48,107} Additionally, perceived stress was reported as having a stronger negative impact on pain and function in older non-Hispanic Black individuals compared to non-Hispanic White peers.¹⁸ Difficulty with emotional regulation was positively associated with pain severity in African American individuals reporting greater pain and emotion-focused coping and decreased function; however, the relationship was not seen in Caucasian individuals.^{6,98} A pilot study found no association between total coping score and pain level but did find ethnic and/or race groups differed between total coping score (problem-focused and emotion-focused) and pain level with white participants having a positive correlation and nonwhite participants having a negative correlation.⁵ Interventions targeting cognitive reframing and stress management may provide strategies for mitigating negative effects associated with stress and health disparities in chronic musculoskeletal pain. Interestingly, however, a 6-week positive psychological skills program was minimally successful for improving pain and functioning in non-Hispanic Black and non-Hispanic White veterans.⁷³ Similarly, a culturally tailored pain coping skills training program for 248 African American adults with hip or knee osteoarthritis did not show improvements in pain intensity although key measures of pain coping and perceived ability to manage pain improved compared to a wait list control group.⁷ Findings highlight the need to further understand the role of coping factors and how to effectively target clinically-relevant skills in the treatment of chronic musculoskeletal pain in diverse ethnic/race groups.

Psychosocial risk and resilience factors are the second priority area included in the Behavioral level of analysis with social support, discrimination, pessimism, optimism, and control as identified as the relevant health factors.⁷⁷ A few studies have explored ethnic/race differences across social support factors specific to chronic musculoskeletal pain. Though non-Hispanic Black individuals report seeking more social support than non-Hispanic White peers,¹⁰⁷ one study found that non-Hispanic Black adults with severe hip

and/or knee osteoarthritis reported a lower quality of social support than non-Hispanic White adults.⁶⁶ However, in a similar study among non-Hispanic Black and non-Hispanic White individuals with knee pain, no group differences in perceived social support were found.¹³ Lifetime experience of discrimination was the strongest predictor of back pain in non-Hispanic Black adults, particularly among women explaining 13% of the variance in pain reported.⁴⁷ Similarly, in women with osteoarthritis, greater levels of everyday discrimination and financial stress explained significantly more variance in depressive symptoms in African American adults relative to White peers.¹⁰⁸ In experimentally evoked pain, one study found non-Hispanic Black adults with knee osteoarthritis were more sensitive to heat pain and reported greater perceived racial discrimination than non-Hispanic White peers⁶¹; however, discrimination was not associated with pain-induced cortisol reactivity or cold pressor pain ratings among non-Hispanic Black adults.⁷⁶ Resilience factors are known contributors to pain adaptation.^{13,62,76} Higher optimism was associated with less movement-evoked pain in non-Hispanic Black individuals with knee pain, but not among non-Hispanic White individuals.¹³ Another study of perceived control found Black participants reported lower levels of perceived control over their pain compared to non-Hispanic White participants.¹⁵¹ Research in the area of resilience is minimal, indicating a clear need for future investigations. Additionally, a pattern of findings suggest that relationships between psychosocial risk and resilience factors and chronic musculoskeletal pain may differ by ethnic/race groups and warrants further investigation.^{5,13,18,98,107}

Health behaviors are the third priority area under the Behavioral level of analysis which includes the following health factors: smoking, anger and violence, alcohol and/or drugs, nutrition, and physical activity.⁷⁷ Smoking (current or previous) and race were both significant predictors of persistent back pain among older adults.¹³¹ Smoking rates tend to be high among underrepresented ethnic/race groups including African American and Native American individuals with chronic musculoskeletal pain^{54,84}) and is associated with increased pain reporting.^{46,163} Studies specific to ethnic/race group differences in anger and/or violence and chronic musculoskeletal pain were not found. The role of alcohol or recreational drug use as contributing to health disparities in persons with chronic musculoskeletal pain is also unclear. In a study of patients with chronic knee osteoarthritis pain, Native American and Hispanic individuals reported higher levels of pain compared with non-Hispanic White peers, however, those who reported regular alcohol consumption reported significantly lower pain.⁴⁶ Unfortunately, rates of alcohol consumption among the different ethnic/race groups were not reported, making it difficult to interpret findings.⁴⁶ In another study, researchers found that of those reporting cocaine use, African Americans had higher odds of back pain and arthritis compared to Caucasians reporting cocaine use.⁴¹ Nutrition is another relevant Behavioral factor. While the research specific to nutrition is limited, findings indicate nutritional deficiencies (eg, vitamin D) may be significant contributors to pain disparities in diverse ethnic/race groups.^{58,126,133,136}

There is robust evidence that physical activity reduces chronic musculoskeletal pain.^{44,59} Studies have shown educational interventions targeting exercise and behavioral changes decreased pain and improved function across multiple ethnic and/or race groups.^{15,86,122,167} Further, lower body mass index was associated with lower odds of low back pain across ethnic and/or race groups.¹²⁴ Despite the recognized benefits of physical activity for chronic

musculoskeletal pain, disparities in the ability to meet recommended physical activity guidelines¹⁴³ likely contribute toward pain outcomes among differing ethnic and/or race groups.⁶⁰ Environmental and structural factors including accessibility, safety, and finances influence the ability to engage in physical activity.^{92,102,148,160} Data specific to anger and/or violence and alcohol/drug use are limited and warrant further investigation. Research in the areas of smoking, nutrition and physical activity provide an important foundation to extend research efforts in the identification of factors to target both from an interventional perspective and with integrative investigations across differing levels of analysis.

Biological Level

The Biological level of analysis includes the following priority areas:

1) physiological indicators; 2) genetic stability and 3) cellular function and communication.⁷⁷ Biological processes play a critical role in the pathogenesis of diseases that lead to health disparities.^{8,77,87} Ethnic/race groups represent a multilevel social construct rather than a biological construct.¹⁶⁹ The biological consequences of social inequalities are often reported as ethnic/race group differences. Including the Biological level of analyses in research studies can help inform understanding of the biological interface of environmental, sociocultural and behavioral determinants of health. A review of the literature on biological factors, health disparities, and chronic musculoskeletal pain unearthed a dearth of research investigation in this area, signaling a critical gap in the understanding of health disparities from a biological perspective (Table 5).

Physiological indicators are the first priority area under the Biological level of analysis and encompass health factors listed as comorbidities, cardiovascular functioning, sympathetic nervous system, hypothalamic-pituitary-adrenal axis, and inflammation.⁷⁷ A literature search for research on health factor terms representing physiological indicators, underrepresented ethnic/race groups, and chronic musculoskeletal pain resulted in no studies meeting the inclusion criteria. There are some studies that include physiological indicators outside the identified health factor search terms (eg, Herbert et al, 2017; Table 4) which provide an example of where more multilevel research is needed.

Genetic stability is the second priority area under the Biological level of analysis with health factors to include telomere attrition, epigenetic alteration, and loss of proteostasis, protein-related cellular functioning.⁷⁷ No studies were found specific to identified health factors, chronic musculoskeletal pain, and ethnic/race group populations. Studies with specific consideration for genetic stability are needed to better understand the biological interface of chronic musculoskeletal pain disparities.

Cellular function and communication are the third priority area under the Biological level of analysis with health factors identified as deregulated nutrient sensing, mitochondrial dysfunction, cellular senescence, cellular stress response, stem cell exhaustion, and intercellular communication. Studies specific to cellular function and communication health factors in chronic musculoskeletal pain with consideration for underrepresented ethnic/race groups were not found. Extending research to include factors at different levels of analyses

specific to cellular communication and mechanisms of pain may inform understanding of chronic musculoskeletal pain disparities.

Discussion

To better understand what is known and what is needed to advance the science of specific to disparities in the experience of chronic musculoskeletal pain, we applied the *NIA's Health Disparities Research Framework* in the evaluation of studies specific to adults with chronic musculoskeletal pain in underrepresented ethnic/race groups. Search criteria resulted in the identification of a total of 52 publications across Environmental, Sociocultural, Behavioral, and Biological levels of analysis. There were limited publications specific to ethnic/race groups with chronic musculoskeletal pain across all levels of analyses with particular gaps in Sociocultural and Biological levels. A summary of what is known and what is needed for each level of analysis follows.

The Environmental level of analysis is organized under 3 priority areas: geographical and political factors, socioeconomic factors, and health care. No studies specific to chronic musculoskeletal pain and geographical and political factors area were found. However, research shows underrepresented ethnic/race group communities have fewer adequately stocked pharmacies,^{64,128} less access to non-pharmacological pain interventions,³² and that prescription opioid poisoning, that is, opioid abuse, may be more common in rural areas.³⁰ State and local policies often exacerbate health disparities by contributing to inequities by citizen status, ethnicity/race, and other social hierarchies.³⁷ Further, studies specific to evaluating residential segregation, toxin exposure, criminalization, immigration, structural bias, education, income, and occupation would be informative as most studies classify these subtopics broadly into socioeconomic status. Additionally, investigations are needed evaluating language fluency, health literacy, and numeracy as these factors may contribute to a limited understanding of chronic musculoskeletal pain conditions and reduce involvement in and compliance with treatment. While there is a growing recognition of the relevance of Environmental level health factors, there remains a considerable knowledge gap specific to disparities in chronic musculoskeletal pain.^{9,110}

Studies encompassing the Sociocultural level of analysis are minimal. Although the biopsychosocial model of pain is touted as the premier model for understanding and treating pain, sociocultural aspects of chronic musculoskeletal pain have not been adequately investigated. The available evidence indicates that sociocultural factors play a highly influential role in ethnicity/race group chronic musculoskeletal pain disparities. Although not specific to chronic musculoskeletal pain, the relevance of sociocultural factors in influencing behaviors such as seeking medical care, taking medication, health care and pain attitudes, coping strategies, and health outcomes are significant.^{63,115,127,158,144,149,159,168,119,144} Research within the Sociocultural level of analysis specific to underrepresented ethnic/race groups and chronic musculoskeletal pain are needed.

A number of studies were identified at the Behavioral level of analysis representing the 3 priority areas of coping responses, psychosocial risk and resilience factors, and

health behaviors. In regard to risk factors, studies have consistently found that non-Hispanic Black individuals report higher levels of discrimination than non-Hispanic White individuals.^{47,61,76,105,108} Importantly, in a study of pain-free adults, Losin et al reported that areas of the brain associated with discrimination differ from recognized pain activation areas and were associated with higher experimental pain report in African American participants.⁹⁶ Research is now needed to understand how experiences of discrimination influence chronic musculoskeletal pain. Additionally, there is a strong body of evidence showing that protective psychosocial and behavioral factors are beneficial in mitigating the negative impact of stress on health and are associated with lower levels of chronic musculoskeletal pain.^{91,95} However, culturally-tailored interventions have been modestly beneficial. Further investigations are necessary to better understand how the relationships with protective factors may differ by ethnic/race group, identify clinically relevant targets, and how to engage vulnerable populations into implementing and sustaining interventions.^{12,54,84,112,123,157}

Publications specific to the Biological level of analysis as it relates to chronic musculoskeletal pain and health disparities were not found. Chronic musculoskeletal pain is associated with an increased incidence of comorbidities.^{65,118,132} A few studies considered co-morbidities and ethnicity/race related to chronic musculoskeletal pain conditions.^{41,71,93,97,101,117,145,165} Importantly, relationships between chronic pain and the hypothalamic-pituitary-adrenal axis and inflammation are well established.^{38,129,138,139} There are also other physiological indicators warranting inclusion in future health disparities research including brain imaging and allostatic load.^{130,138,141,154} A recent publication indicated sociodemographic groups with consideration for chronic knee pain stage show differences in gray matter thickness in the temporal lobe area of the brain.¹⁵² While there is a growing body of evidence regarding the relationships between chronic musculoskeletal pain and physiological measures, investigations specific to better understanding factors contributing to chronic musculoskeletal pain disparities are needed.

Although ethnic/race group considerations are not included, a number of publications have addressed relationships between measures of psychological stress, chronic pain, resilience, and telomere length.^{70,85,135,137,140,147} Furthermore, epigenetic changes due to higher levels of childhood stress, racial discrimination, and low-economic status have been purported to contribute toward pain disparities in African American adults compared to non-Hispanic White adults.¹¹ While research specific to genetic stability and chronic musculoskeletal pain are increasing, further investigation on determinants across multiple levels of analyses are needed to better appreciate determinates of chronic musculoskeletal pain disparities in disproportionately affected ethnic/race groups.

Lastly, there is a plethora of investigations on cellular function and communication. Investigations exploring the mechanisms of sensory processing of pain in peripheral neuropathies and peripheral injuries and the role of mitochondria and gap junctions in cellular communication at the basic science level are well explored,^{14,53,68,82,166} Extending these research efforts to include consideration for disparities in chronic musculoskeletal pain is an area of opportunity.

Limitations and Future Directions

There are a number of limitations to consider in the evaluation of findings. First, completing the review based on the terms from the *NIA Health Disparities Research Framework* provided the structure specific to levels of analysis, priority focus areas, and health factors. However, a broader array or alternative terms and/or concepts may result in the identification of studies not captured in the current review. The *National Institute on Minority Health and Health Disparity Research Framework* was published in 2019 which is comprised of components of the *NIA Health Disparities Research Framework* and the socioecological model which may further inform efforts moving forward.¹⁰ Second, the current review was limited to the timeframe, location (United States), and search databases described in the Methods. Additional studies aligning with key criteria may be outside the set parameters. Third, many studies on chronic musculoskeletal pain focused on low back pain and osteoarthritis, additional studies specific to other conditions are needed, for example, fibromyalgia and rheumatoid arthritis. Fourth, there are inconsistent terms to characterize ethnic/race groups, aligning with a consistent approach, such as required NIH reported phrasing, will improve comparisons across studies.

The research opportunities for future directions are broad and numerous. First, research incorporating measures across multiple levels of analyses should be prioritized. Second, studies frequently are not powered to compare or stratify by ethnic/race groups. Recruiting based on population representation is not sufficient to provide an evidence-based perspective of factors contributing to chronic musculoskeletal pain disparities.⁵⁶ Thus, strategies to increase participation of underrepresented groups in studies are needed.⁵⁶ Third, the benefit of a common language among all facets of research is apparent. Consistent identification of ethnic/race groups and utilizing key pain and functional outcome measures would allow for clearer interpretation of findings and the ability to replicate across studies.^{45,81,116} Fourth, research focusing on buffering and protective factors would also be beneficial in the identification of clinical targets.^{21,31,164} Further, considerations for similarities between ethnic and/or race groups is also important and will help identify areas that would promote alignment and collaboration. Fifth, input from stake holders such as practicing physicians, individuals with chronic pain, families, health equity advocates, and individuals with cultural diversity expertise to inform and enhance research efforts is needed. Sixth, the *NIA Health Disparities Research Framework* provides the infrastructure to extend collaborative efforts between funders and researchers allowing for progress tracking, needs identification, and continual process improvement. Seventh, current efforts are to promote improved research designs to better understand the complex array of factor contributing to health disparities. The long-term goals of these efforts would be to identify and develop clear modifiable targets across all levels of analysis (environmental, sociocultural, behavioral, and biological) to reduce health disparities and promote improved health outcomes for all people. Finally, with the strong and consistent evidence of sociodemographic and environmental factors accounting for disparities in health outcomes, relevant factors need to be addressed in advance of interpreting ethnic/race group differences.

Conclusion

Investigations of environmental, sociocultural, behavioral, and biological health factors contributing to underrepresented ethnic/race group disparities in the experience of chronic musculoskeletal pain are in the early stages of development. Current limitations in evidence specific to “chronic musculoskeletal pain” are supplemented by a foundation of findings in the over-arching areas of “pain” and “chronic pain” which provide guidance for future research efforts.^{27,78,83} Study designs including a focus on protective factors and combined levels of analysis would be particularly meritorious.

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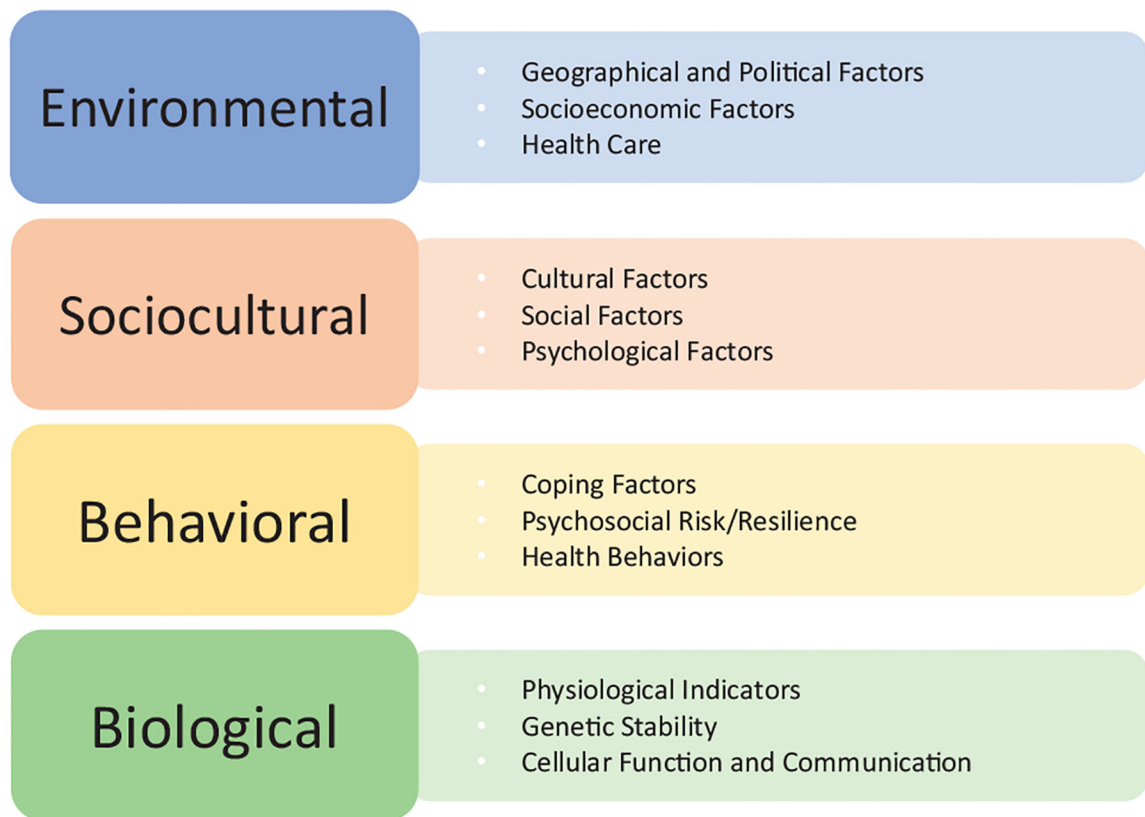


Figure 1.
The Levels of Analyses and Priority Focus Areas in the NIA Health Disparities Research Framework. Adapted from the National Institute on Aging Health Disparities Research Framework (Hill et. al, 2015).

Table 1. Health Factor Search Terms for Each Level of Analysis in the NIA Health Disparities Research Framework

Environmental	Sociocultural	Behavioral	Biological
Structural Bias	Values	Active Coping	Comorbidities
Immigration and/or Documentation	Prejudice	Problem Solving	Cardiovascular
Criminalization	Norms	Stress Management	Sympathetic Nervous System
Residential Segregation	Traditions	Cognitive Reframing	HPA Axis
Urban and/or Rural	Religion	Emotional Regulation	Inflammation
Toxins and/or Exposures	Collective Responses	Social Support	Telomere Attrition
Education	Institutional Racism	Discrimination	Epigenetic Alteration
Income and/or Wealth	Family Stress	Pessimism	Loss of Proteostasis
Occupation	Financial Stress	Optimism	Deregulated Nutrient Sensing
Limited English	Occupational Stress	Control	Mitochondrial Dysfunction
Health Care Access	Residential Stress	Smoking	Cellular Senescence
Insurance	Social Mobility	Anger and/or Violence	Cellular Stress Response
Quality	Social Network	Alcohol and/or Drug	Stem Cell Exhaustion
Literacy	Self-Concepts	Nutrition	Intercellular Communication
Numeracy	Stigma	Physical Activity	
	Bias		
	Loneliness		
	Stereotypes		

Table 2.

Articles That Met Inclusion Criteria Under the Environmental Level of Analysis

Author(s)	Year	Study Location	Study Type	Study Population	Health Factor(s)	Outcome Measure(s)
Geographical and Political Factors						
No articles met inclusion criteria						
Socioeconomic Factors						
Gansky et al	2007	Berkeley, California, Cincinnati, Ohio	Cross-sectional	n = 1,334 young (21–26 years old) women (684 African American and 650 Caucasian individuals)	Income/wealth	Distribution of widespread pain, tender points and fibromyalgia
Thompson et al	2019	Birmingham, Alabama Gainesville, Florida	Cross-sectional	n = 191 adults with knee osteoarthritis	Income/wealth	Poverty status, knee pain
Health Care						
Albert et al	2008	United States	Cross-sectional	n = 551 Medicare beneficiaries with osteoarthritis	Health care access	Self-management behaviors
Burgess et al	2008	United States	Factorial design	n = 382 primary care physicians randomly selected from the American Medical Association Physician Masterfile	Health care quality	Physician’s decision to switch patient to a higher dose or stronger type of opioid in chronic pain patients
Burgess et al	2014	United States	Retrospective	n = 99,903 veterans with diagnoses of chronic low back, neck, or joint pain selected to participate in the Veterans Affairs Survey of the Healthcare Experiences of Patients in fiscal year 2006	Health care quality	Prescription of opioids in the year following the first pain diagnosis
Burgess et al	2016	United States	Retrospective	n = 3,505 Black and n = 46,203 non-Hispanic White patients with diagnoses of chronic musculoskeletal pain who responded to the 2007 Veterans Affairs Survey of Healthcare Experiences of Patients	Health care quality	Pain treatments, pain outcomes
Carey et al	2010	North Carolina	Cross-sectional	n = 837 respondents (620 White, 183 African American, 34 Latino) with chronic back or neck pain	Health care access	Pain 1–10 scale, Roland-Morris back-specific disability scale, health care utilization, opioid use
Dominick et al	2004	Durham, North Carolina	Retrospective	n = 3,061 patients with osteoarthritis treated at a federal Veterans Affairs Medical Center between October 1998 and September 1999	Health care quality	Opioid variables
Dominick et al	2004	United States	Retrospective cohort	n = 6,038 veterans with osteoarthritis	Health care quality	Non-steroidal anti-inflammatory prescribed, amount and time to discontinuation of index non-steroidal anti-inflammatory
Evans et al	2018	United States	Retrospective	n = 79,537 women and n = 389,269 men veterans age 18–54 with chronic musculoskeletal pain who received Veteran Affairs-provided care between 2010 and 2013	Health care quality	Predictors of complementary and integrative health therapies as non-pharmacological approaches for chronic pain
Hausmann et al	2013	United States	Retrospective Cohort	n = 253 African American patients who filled opioid prescriptions for non-cancer pain (predominately musculoskeletal) for 90 consecutive days at the Veterans	Health care quality, Health care access	Opioid monitoring and treatment practices

Author(s)	Year	Study Location	Study Type	Study Population	Health Factor(s)	Outcome Measure(s)
Hausmann et al	2017	United States	Retrospective cohort	Affairs Pitsburgh Healthcare System pharmacy in fiscal years 2007 and 2008 n = 473,170 White, n = 50,172 African American and n = 16,499 Hispanic veterans age 50 years or older with an osteoarthritis diagnosis from 2001 to 2011	Health care quality	Total knee arthroplasty
Heins et al	2006	Mobile, Alabama	Retrospective	n = 868 Emergency Department patients 18 years and older who presented with musculoskeletal pain and were treated by core Emergency Department faculty	Health care access	Prescription of Emergency Department opioids and discharge analgesics
Ibrahim et al	2002	United States	Cross-sectional	n = 596 elderly, male, African American or White patients with moderate-to-severe symptomatic knee or hip osteoarthritis who were receiving primary care at the Department of Veterans Affairs outpatient clinics	Health care access	Willingness to undergo a total knee arthroplasty
Katz et al	2011	Boston, Massachusetts	Qualitative study	n = 39 Hispanic and non-Hispanic White patients with chronic back or knee pain	Health care quality	Decision management of their conditions and roles they preferred in medical decision-making
Parker et al	2011	New York City, New York	Prospective cohort	n = 112 (37 African American, 38 Hispanic, and 37 non-Hispanic White adults) 60-years-old and older with non-cancer pain	Health care quality	Impact of the Arthritis Foundation Self-Help Program
Tait et al	2006	Missouri	Cross-sectional	n = 580 African American and n = 892 White workers' compensation claimants with occupational low back pain	Health care access; Health care insurance	Disability ratings, diagnosis, surgery, medical costs
Taylor et al	2005	United States	Retrospective	n = 5,690 patients with degenerative lumbosacral pathologies	Health care access	Lumbosacral pathologies

Table 3.

Articles that Met Inclusion Criteria Under the Sociocultural Level of Analysis

Author(s)	Year	Study Location	Study Type	Study Population	Health Factor(s)	Outcome Measure(s)
<u>Cultural Factors</u>						
Katz et al	2011	Boston, Massachusetts	Qualitative study	n = 234 Hispanic and non-Hispanic White individuals with chronic back or knee pain from urban medical center	Religion	Areas important in medical decision-making
Ibrahim et al	2004	Cleveland, Ohio	Qualitative Study	n = 75 African Americans with hip and knee pain	Religion	African American's perceptions and preferences for care
Mingo	2013	Tampa, Florida, Atlanta, Georgia	Qualitative Study	n = 198 (85 White individuals, 113 African American individuals)	Values	Willingness to help family member with Osteoarthritis
<u>Social Factors</u>						
Blake et al	2002	New Hyde Park, New York	Cross-sectional	n = 515 Black and n = 455 White Medicare beneficiaries	Social Network	Social network experience with surgery and perceptions of benefit
Ibrahim et al	2002	United States	Cross-sectional	n = 596 elderly, male, African American and White patients with knee/hip osteoarthritis receiving primary care at the Department of Veterans Affairs clinics	Social Network	Willingness to undergo a total knee arthroplasty
McIlvane et al	2008	Florida	Cross-sectional	n = 175 African American and White women aged 45–90	Financial Stress	Arthritis-related stress, discrimination, chronic life and financial stress, and well-being
<u>Psychological Factors</u>						
No articles met inclusion criteria						

Table 4.

Articles that Met Inclusion Criteria Under the Behavioral Level of Analysis

Author(s)	Year	Study Location	Study Type	Study Population	Health Factor(s)	Outcome Measure(s)
Coping Factors						
Allen et al	2006	Durham, North Carolina	Daily diary analysis	n = 36 patients with osteoarthritis (13 non-White, 23 White patients)	Emotional regulation	30-day diaries of pain and coping
Allen et al	2010	North Carolina	Interventional	n = 491 African-Americans and Caucasian individuals enrolled in telephone-based osteoarthritis self-management	Emotional regulation	Arthritis self-efficacy, affect, and use of emotion-focused coping
Allen et al	2019	North Carolina	Randomized Control	n = 284 African-American individuals with osteoarthritis pain	Cognitive Reframing	Pain, disability, general health, coping, pain catastrophizing, depressive symptoms after pain coping skills training program
Booker et al	2019	Gainesville, Florida	Cross-sectional	n = 162 non-Hispanic Black and non-Hispanic White older adults with knee pain	Active Coping	Identify ethnic/race group differences on movement evoked pain, physical performance and perceived stress
Edwards, RR	2005	United States	Cross-sectional	n = 1,800 individuals with chronic musculoskeletal (14.9% African American, 79.2% White, 5.9% Hispanic)	Coping	Pain, emotional distress, pain-related disability, and pain coping
Hausmann et al	2018	Pittsburgh, Philadelphia, Pennsylvania	Randomized controlled	n = 360 non-Hispanic White, n = 180 non-Hispanic African American patients aged >50, diagnosis of osteoarthritis	Cognitive Reframing	Self-reported pain and functional difficulty in response to positive psychological intervention compared to neutral control intervention.
Lumley et al	2005	Michigan	Cross-sectional	n = 155 patients with rheumatoid arthritis, n = 160 migraine headaches, n = 123 systemic lupus	Emotional regulation	Toronto Alexithymia Scale, pain severity, functional disability, symptoms
McIlvane, JM	2007	Florida	Cross-sectional	n = 175 individuals (77 African American, 98 White individuals) with arthritis	Active Coping	Arthritis related symptoms, coping and well-being
Psychological Risk/Resilience						
Bartley et al	2019	Gainesville, Florida	Cross-sectional	n = 201 individuals with knee osteoarthritis (105 African American, 96 White)	Optimism	Resilience, clinical pain and functioning performance
Edwards, RR	2008	United States	Cross-sectional	N > 3,000 from the National Survey of Midlife Development	Discrimination	Perceived discriminatory events and back pain frequency
Goodin et al	2013	Birmingham, Alabama, Gainesville, Florida	Cross-sectional	n = 130 older adults with knee osteoarthritis; (67 African American, 63 White adults)	Discrimination	Racial discrimination, response to noxious thermal stimuli
Groeneveld et al	2008	Pittsburgh, Pennsylvania, Philadelphia, Pennsylvania	Cross-sectional	n = 909 male patients with osteoarthritis; (450 African American, 459 White patients)	Social support	Patients expectations of joint replacement
Herbert et al	2017	Birmingham, Alabama, Gainesville, Florida	Cross-sectional	n = 91 individuals with knee osteoarthritis; (56 African American, 35 White individuals)	Discrimination	Cortisol, pain responses during cold pressor task, racial discrimination

Author(s)	Year	Study Location	Study Type	Study Population	Health Factor(s)	Outcome Measure(s)
McIlvane, JM	2007	Florida	Cross-sectional	n = 175 individuals with arthritis (77 African American, 98 White individuals)	Social Support	Arthritis related symptoms, coping and well-being
McIlvane et al	2008	Florida	Cross-sectional	n = 175 African American and White women aged 45–90	Discrimination	Arthritis-related stress, discrimination, chronic life and financial stress, and well-being
Tan et al	2005	Texas	Cross-sectional	n = 482 individuals with chronic pain at multiple body sites (128 African American, White individuals)	Control	Pain appraisal, beliefs about pain, ways of coping with pain
Health Behaviors						
Bessiner et al	2012	New York City, NY	Interventional	n = 69 seniors with chronic back pain (24 African American, 25 Hispanic, and 20 non-Hispanic White individuals)	Physical Activity	Impact of self-management program combines cognitive-behavioral strategies and exercise
Dodani et al	2016	St. Louis, Missouri, Gainesville, Florida, and Jacksonville, Florida	Cross-sectional	n = 6,145 African and Caucasian reporting cocaine use	Alcohol/Drug	Differences in clinical characterizes and musculoskeletal conditions by cocaine use
Eberly et al	2018	New Mexico	Retrospective	n = 355 new patients with knee osteoarthritis	Alcohol/Drug Smoking	Knee pain scores, psychosocial, sociodemographic, disease and treatment
Foley et al	2015	North Carolina	Cohort study	n = 1,422 individuals with hip osteoarthritis	Smoking	Pain, stiffness, radiographic features
Glover et al	2012	Gainesville, Florida	Cross-sectional	n = 94 individuals with symptomatic knee osteoarthritis, 45–71 y old	Nutrition	Vitamin D levels, osteoarthritis pain
Goepfinger et al.	2007	North Carolina	Randomized Controlled	n = 416 older adults with arthritis (365 African American adults)	Physical Activity	Health care use, health related quality of life health behaviors and arthritis self-efficacy between Arthritis-Self-Help Course and Chronic Disease Self-Management Program
Golightly et al	2005	North Carolina	Cross-sectional	n = 202 African American and Caucasian veterans with osteoarthritis	Physical Activity	Osteoarthritis symptom severity
Jones et al	2018	Chicago, Illinois	Interventional	n = 62, 40–75 years old adults with non-traumatic knee pain and BMI > 30 (32 African American, 30 Hispanic/Latino adults), 40–75 years old with nontraumatic knee pain and BMI > 30	Physical Activity	Efficacy of a community-base, culturally sensitive program to stimulate behavioral changes in activity level
Parker et al	2011	New York City, New York	Prospective cohort	n = 112 (37 African American, 38 Hispanic, and 37 non-Hispanic White adults) 60-years-old and older with noncancer pain	Physical Activity	Impact of the Arthritis Foundation Self-Help Program
Peng et al.	2018	United States	Cross sectional	n = 32,060 adult respondents to 2015 National Health Interview Survey	Physical Activity	Association between obesity and low back pain
Plotnikoff et al	2003	Minnesota	Cross sectional	n = 150 African American, East African, Hispanic & American Indian patients w/musculoskeletal pain, aged 10 to 65 y old	Nutrition	Prevalence of hypovitaminosis D in outpatients with musculoskeletal pain
Rundell et al	2017	California, Detroit, Boston	Cohort Study	n = 5,239 older adults greater than equal to 65, presenting to primary care for back pain 2011–2013	Smoking	Disability and pain intensity

Author(s)	Year	Study Location	Study Type	Study Population	Health Factor(s)	Outcome Measure(s)
Shmigel et al	2018	United States	Cohort Study	n = 2,548 patients with radiographic knee osteoarthritis recruited between 2006 and 2010	Nutrition	Magnesium intake and the association with knee pain and function
Sibille et al	2018	Birmingham, Alabama, Gainesville, Florida	Cross-sectional	n = 167 individuals positive for knee osteoarthritis aged 45–85 y	Nutrition	Clinical and experimental pain, physical and psychosocial functioning, plasma omega 6-omega 3 ratio
Song et al	2013	Illinois	Cross-sectional	n = 1,142 individuals with radiographic knee osteoarthritis and n = 747 at risk of radiographic knee osteoarthritis	Physical Activity	Aerobic component (150 moderate-to-vigorous (MV) min/wk in bouts 10 minutes) of the States Department of Health and Human Services Physical Activity Guidelines
Turner et al	2017	United States	Cross-sectional	n = 516 Hispanic individuals completed survey; n = 102 Hispanic chronic non-cancer pain	Physical Activity	Exercising and using prescription medications for pain control
Wolfe and Michaud	2007	United States	Longitudinal observational	n = 12,090 patients with rheumatoid arthritis from the National Data Bank for Rheumatic Diseases	Smoking	Comparing visual analog pain scale and Medical Outcomes Study Short Form-36 Health Survey pain measures
Wyatt et al	2014	North Carolina	Interventional	n = 117 African American individuals with self-reported arthritis participating in self-directed (n = 68) or group (n = 49) 6-wk WWE program	Physical Activity	Effectiveness of Arthritis foundation 's Walk with Ease Program

Table 5.

Articles that Met Inclusion Criteria Under the Biological Level of Analysis

<u>Physiological Indicators</u>
No articles met inclusion criteria
<u>Genetic Stability</u>
No articles met inclusion criteria
Cellular Function and Communication
No articles met inclusion criteria
