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THE INFLUENCE OF PHYSICAL HEALTH, EMOTIONAL HEALTH, AND SOCIOECONOMIC FACTORS ON THE MUSCULOSKELETAL PAIN EXPERIENCE IN PATIENTS ATTENDING A PRO BONO PHYSICAL THERAPY CLINIC

Garrett Naze
University of Kentucky, garrettnaze@gmail.com
Author ORCID Identifier:
https://orcid.org/0000-0003-3497-0411
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Garrett Naze, Student

Dr. Anne L. Harrison, Major Professor

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DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Health Sciences at the University of Kentucky

By

Garrett Scott Naze

Lexington, Kentucky

Co- Directors: Dr. Anne L. Harrison, Emeritus Faculty of Physical Therapy

and Dr. Joseph C. Stemple, Professor of Communication Sciences and Disorders

Lexington, Kentucky

2021

https://orcid.org/0000-0003-3497-0411

ABSTRACT OF DISSERTATION

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Non-communicable, chronic diseases are highly prevalent in the United States, reducing the quality of life for those affected and contributing to the majority of the nation's healthcare expenditure. These conditions include, among others, cardiovascular disease, diabetes, and musculoskeletal disease. Musculoskeletal disease is particularly of interest for the field of physical therapy as the vast majority of patients seeking care in the outpatient setting present with musculoskeletal pain complaints, resulting in limitations in function, participation, and quality of life for the patient.

The factors influencing health outcomes are diverse and include a person's physical environment, social and economic factors, access to quality clinical care, and health behaviors. Thus, managing chronic disease requires intervention at the level of the patient, provider, healthcare organization, community, and the local, state, and federal governments. Implementing multilevel intervention and advocacy can reduce the impact of chronic disease and allow people to more meaningfully engage in their lives. The purpose of this dissertation was to first describe a population attending a pro bono physical therapy clinic for musculoskeletal pain complaints in the southeastern United States in regards to measures of physical health, emotional health, socioeconomic status, and pain presentation. These measures were then assessed to discover their usefulness in identifying chronic disease as well as their ability to identify clinically-important patient subgroups that may require a more tailored treatment approach. By understanding the patient population more completely, future directions for addressing patient needs through clinical intervention, clinical programming, and advocacy endeavors can be implemented to produce more positive health outcomes.

Theoretical foundation for the management of chronic disease was informed by the Innovative Care for Chronic Conditions framework (World Health Organization, 2002). The County Health Ratings Model (University of Wisconsin Population Health Institute, 2019) and the Tool for Health & Resilience in Vulnerable Environments (Prevention Institute, 2004) were used as guides in determining the important factors influencing health outcomes and routes of intervention to improve health equity. Models of the pathophysiology of metabolic syndrome (Eckel et al, 2005), a precursor to cardiovascular disease and diabetes, and their impact on musculoskeletal disease (Collins et al, 2018) were also considered to identify clinical measures in the physical therapy setting that can better inform the clinician of the patient's condition.

A clinically-based, standardized intake process was created and implemented at a pro bono physical therapy clinic to capture measures of physical health, emotional health, health behaviors, and social and economic variables. The measures chosen fall within the scope of physical therapy practice and were selected to bolster the treating clinician's clinical decision making to provide patient-centered care. A retrospective chart review was performed over a two-year period (December 2017 to December 2019) to collect these data from the initial patient evaluation. Descriptive statistics were used to define the population attending the clinic and their potential healthcare needs. Regression analysis was then performed to determine which measures best inform the clinician regarding metabolic disease status in this population and whether those at risk of metabolic disease presented differently from those without. Finally, a latent class analysis was performed to identify unique patient subgroups within those presenting to the clinic and the distinguishing features of these subgroups.

KEYWORDS: Pro Bono Care, Chronic Disease, Chronic Pain, Physical Health, Emotional Health, Socioeconomic Variables

Garrett Scott Naze

(Name of Student)

04/05/2021

Date

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By
Garrett Scott Naze

Anne Harrison, PT, PhD
Co-Director of Dissertation

Joseph Stemple, PhD, CCC-SLP, ASHAF
Co-Director of Dissertation

Esther Dupont-Versteegden, PhD
Director of Graduate Studies

04/05/2021
Date

DEDICATION

To all of the faculty, staff, patients, and students who have been, or will be, a part of building our clinic into a welcoming community for health and wellness.

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CHAPTER 1. CHRONIC DISEASE, METABOLIC SYNDROME, AND PERSISTENT MUSCULOSKELETAL PAIN

1.1 Introduction

In the United States, many people are affected by non-communicable diseases such as cardiovascular disease, diabetes, mental health conditions, and musculoskeletal disease.[1] Often considered to be diseases related to lifestyle, these conditions are commonly and often incorrectly stigmatized as a result of health choices by the individual while the role of the larger, societal issues driving health outcomes go unacknowledged.[2,3] While personal behaviors are an important factor in the development of chronic disease, there are many external variables that impact a person's ability to engage with a healthier lifestyle.[4]

In Chapter One, these external factors will be presented, demonstrating that management of chronic disease requires a systems-based approach.[2] Health outcomes are influenced not only at the level of the patient and provider, but also within the organizational, community, and political environments.[2] Thus, to create significant and long-term health outcomes in those suffering from chronic disease and also those at risk of developing chronic disease, intervention is needed at all levels influencing health-related outcomes.[3,4] No single provider has the resources necessary to prevent and/or manage chronic disease.[5] Proper management requires an interdisciplinary team with each member providing expertise in their domain, and physical therapists are well-positioned to be a contributing member of this interdisciplinary team.[6] In the outpatient setting, the majority of patients present to physical therapy with musculoskeletal complaints.[7,8] However, many of the same patients present with comorbid, chronic

disease or are at risk of developing chronic disease.[9] Therefore, as an interdisciplinary team member, physical therapists must be aware of the importance of screening for chronic disease, not only as it relates to morbidity and mortality, but also the impact comorbid chronic diseases can have on the rehabilitation of diseases of the musculoskeletal system.[10] While physical therapists specialize in human movement,[11] a whole-person, patient-centered approach must be considered to optimize not only outcomes related to the musculoskeletal system, but also improve the overall quality of life of this patient population.

Chapter Two will discuss the risk factors for developing chronic disease and the overlap with the risk factors for developing musculoskeletal diseases. As an appreciation for the biopsychosocial variables impacting musculoskeletal disease has grown within the physical therapy profession, classification systems to guide clinical reasoning and patient management have evolved to consider not only impairments related to movement, but also underlying pain mechanisms, psychosocial variables, and the impact of physical health.[12] However, there continues to be a lack of consensus regarding which measures are most effective in capturing these domains. Many instruments are available to screen for and capture domains related to socioeconomic health, emotional health, and physical health variables, with many of the physical health measures demonstrating relationships with overall risk of morbidity and mortality. Further investigation of these measures are warranted to determine the needs of specific populations as well as to discover which measures best inform management strategies for patients with musculoskeletal disease. A better understanding of the key variables impacting the patient presentation will lead to more precise prescription of intervention at the patient and provider level as well as

identify key issues related to advocacy that can be used to create change at organizational, community, and political levels to promote long-term improvements in health and quality of life for those most at risk for chronic health issues.

Managing chronic disease, including chronic musculoskeletal pain, can be a difficult task.[13] The content presented in Chapters One and Two will support the need for further research in specific clinical populations with chronic disease and musculoskeletal pain, which is the purpose of this study. First, this study will be assessing the physical, emotional, and socioeconomic health of a population attending a pro bono physical therapy clinic to identify the specific needs of the population to inform interdisciplinary care strategies, healthcare programming, and advocacy endeavors that can address these needs. Next, the ability to clinically identify the presence of chronic disease, specifically metabolic syndrome, will be investigated to determine if additional measures of physical, emotional, and socioeconomic health can help practitioners recognize those patients at-risk of having metabolic syndrome. Being at-risk or not-at-risk for metabolic syndrome will then be used as a sub-classification of the clinical population to determine between group differences exist in the domains of physical health, emotional health, socioeconomic health, and the pain experience. Should such differences be discovered, consideration of interventions to improve the risk factors associated with metabolic syndrome may be important to improving clinical outcomes for those at-risk of metabolic syndrome. Last, using measures of pain, physical health, and emotional health, novel subgroup discovery will be performed to determine if unique presentations exist within the population attending a pro bono physical therapy clinic which ultimately could inform

a more targeted management strategy to meet the specific needs of the individual sub-groups.

1.2 Chronic Disease and Management

Non-communicable diseases are often chronic conditions that reduce quality of life for those affected as well as burden the systems managing those impacted by these conditions. In the United States, non-communicable diseases are responsible for 89% of deaths and 85% of disability-adjusted life years (DALY), which are years lost to illness, disability, or death.[1] Chronic physical and mental health conditions also accounted for 90% of the $3.5 trillion in healthcare expenditure in the United States in 2017.[14-16] The prevalence of chronic disease is high, as 60% of Americans have one chronic disease and approximately 40% of the population have two or more.[14,15] The five leading non-communicable diseases in the United States include cardiovascular disease, cancer, chronic respiratory disease, diabetes, and mental health conditions.[1] Other non-communicable diseases include liver disease, digestive disease, urogenital disease, blood disease, endocrine disease, and musculoskeletal disease. It is estimated that non-communicable diseases will create a total economic loss of $94.9 trillion in the United States over the time range of 2015-2050.[1] Only 39% of this estimate is related to treatment cost, with the remainder related to the economic impact of morbidity and mortality of the disease.[1] It is therefore important for healthcare infrastructure in the United States to develop efficient and effective systems to improve outcomes and quality of life for patients with chronic diseases.

Currently, the healthcare system in the United States is not well-structured for managing chronic conditions.[13] Healthcare services have been designed around an acute care, communicable disease model and change is needed to increase patient engagement through provider interactions, community resources, and incentives in reimbursement to manage chronic conditions.[2] Most patients with chronic conditions are managed by a primary care physician.[13] However, there is a growing shortage of primary care physicians in light of the aging population.[5] A projected shortage of between 21,100 and 55,200 primary care physicians is expected by 2033.[17] On average, primary care physicians spend 17% of their time on preventive clinic visits, 37% managing chronic complaints, and 46% assessing acute complaints.[18] Thus, there is a need for an interdisciplinary team that can reduce the burden on primary care physicians to help manage those with chronic conditions.

Recognizing the challenge of managing chronic conditions, the World Health Organization (WHO) expanded the Chronic Care Model developed by Wagner et al[19] to become the Innovative Care for Chronic Conditions framework.[2] This model describes "eight essential elements for taking action" in chronic disease management which include, (1) supporting a paradigm shift, (2) managing the political environment, (3), building integrative health care, (4) aligning sectoral policies for health, (5) using health care personnel more effectively, (6) centering care on the patient and family, (7) supporting patients in their communities, and (8) emphasizing prevention.[2] The goal of this framework is to create an integrated triad between the patient/family, health care teams, and community supporters that all play an important role in management of chronic conditions. Organizational, community, and political environments impact how

each part of the team can engage with their role and thus leadership and advocacy is needed to support policies that maximize health outcomes. Managing chronic conditions requires the proper training and support at many different levels. The WHO continues to use this model to manage chronic diseases to improve health-related outcomes and demonstrate return on investment through savings in healthcare spending and reducing the economic impact of morbidity and mortality.

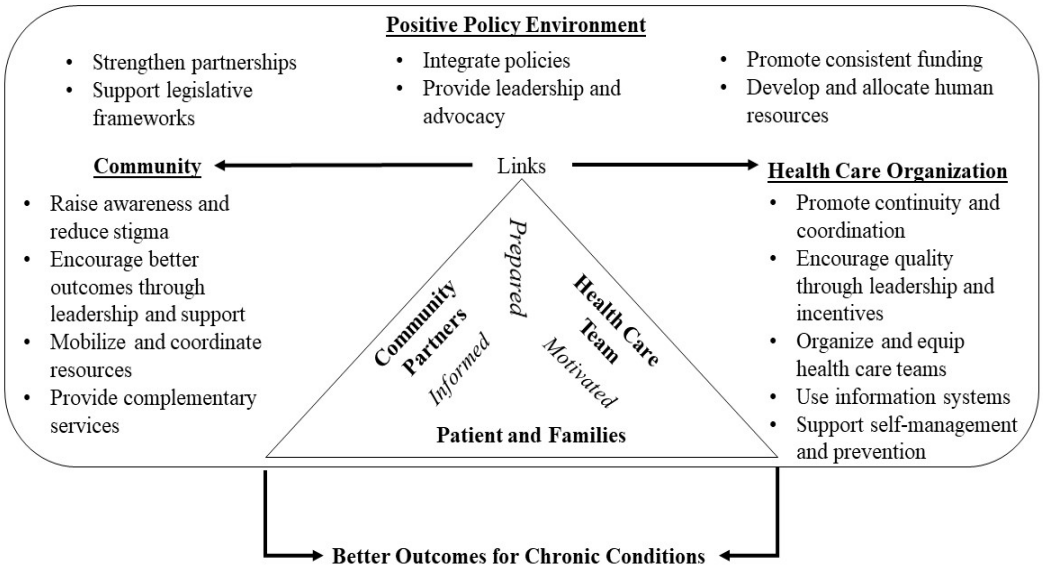


Figure 1.1: Innovative Care for Chronic Conditions Framework[2]

1.3 Case Example: Guilford County, North Carolina, and Pro Bono Physical Therapy Care

A systems-based approach to managing chronic conditions is necessary as health outcomes are impacted by many different variables. The County Health Rankings and Roadmaps program is a collaboration between the Robert Wood Johnson Foundation and

the University of Wisconsin Population Health Institute. Having identified key factors in health outcomes, a weighting analysis was performed to create the County Health Ratings Model.[4]

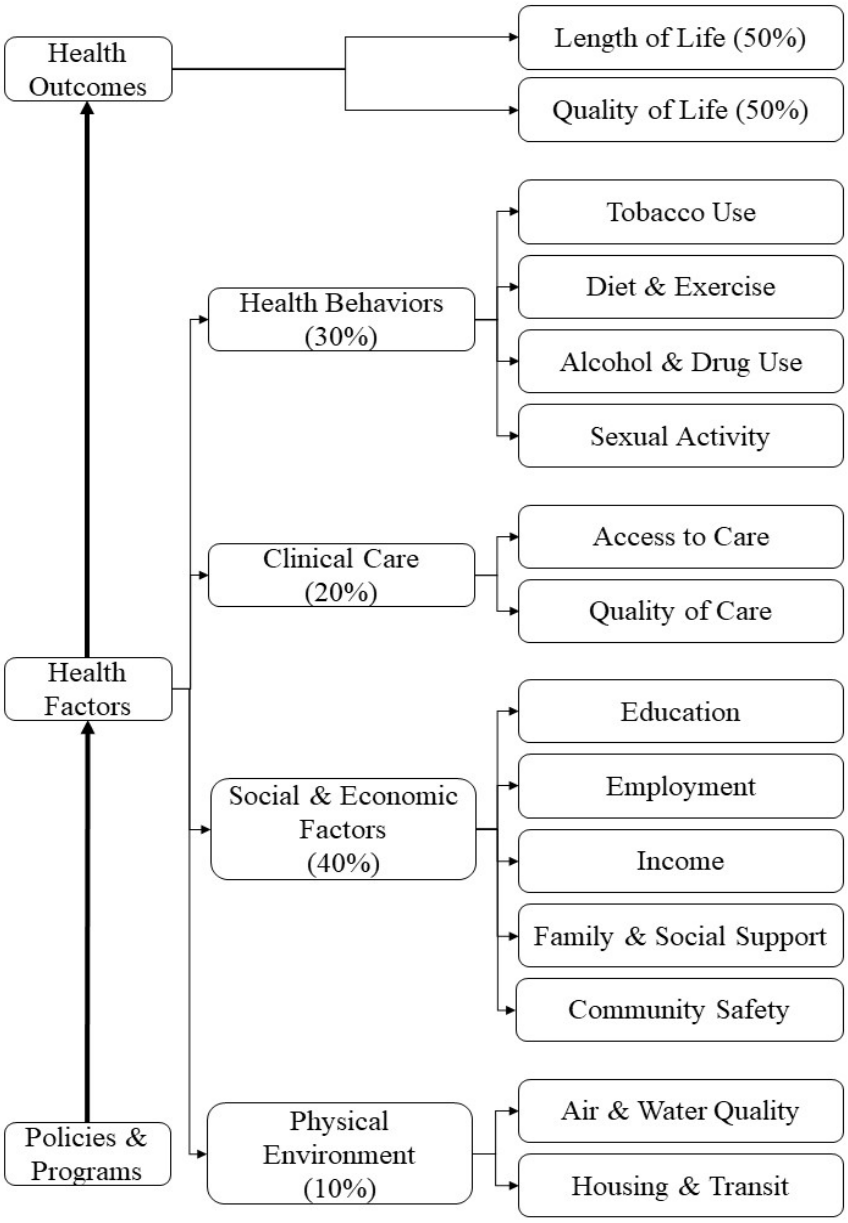


Figure 1.2: The County Health Rankings and Roadmaps Program[20]

As is presented, health outcomes are determined by more than just the patient's health behaviors. Physical environment, social and economic factors, and access to quality care account for 70% of health outcomes. These are important considerations not only for advocacy and structural change but also for boosting understanding and empathy in patient-provider interactions. Another Robert Wood Johnson Foundation commissioned group, the Prevention Institute, recognizes the multifaceted determinates of health.[3] which includes structural drivers, community determinants, and quality healthcare in moving toward health equity. Making the structural drivers, community determinants, and quality healthcare more equitable in the population, negative health behaviors and exposures can be reduced, ultimately decreasing the prevalence of certain health conditions and raising the health and quality of life for the population as a whole.

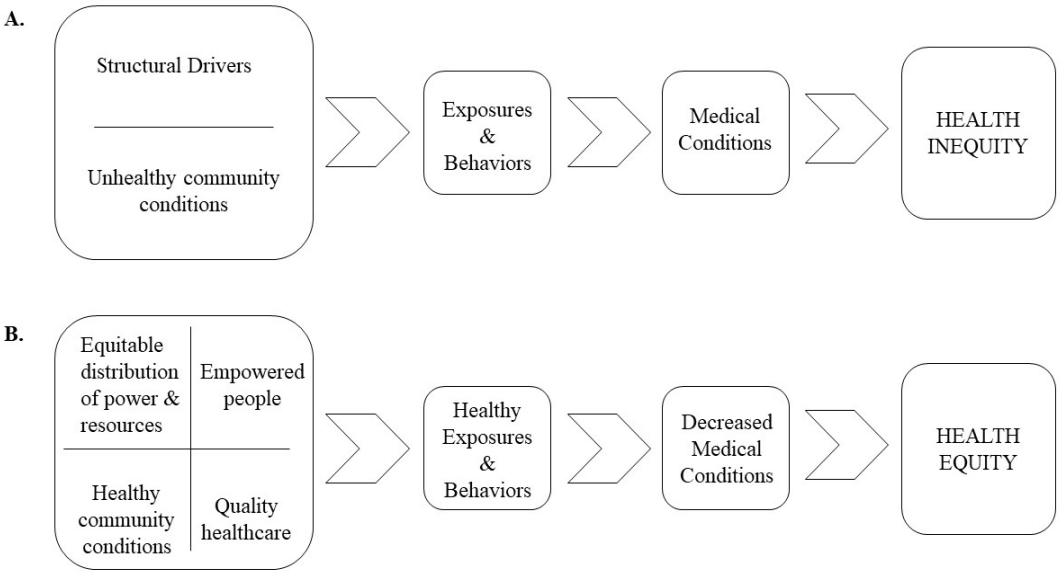


Figure 1.3: Trajectory from Health Inequity (A) to Health Equity (B)[3]

Table 1.1: The Interaction Between Determinates of Health, Behaviors and Exposures, and Medical Conditions[3]

Determinates of Health →	Behaviors & Exposures →	Medical Conditions
Structural Drivers ▪ Inequitable distribution of power, money, opportunity, and resources ▪ Disempowered people **Community Determinants** *Social-cultural environment* ▪ Social networks & trust ▪ Participation & willingness to act for the common good ▪ Norms & culture *Physical/built environment* ▪ What's sold & how it's promoted ▪ Look, feel, & safety ▪ Parks & open spaces ▪ Getting around ▪ Housing ▪ Air, water, & soil ▪ Arts & cultural expression *Economic environment* ▪ Education ▪ Living wages & local wealth **Quality Healthcare**	Tobacco/smoking Excessive alcohol Diet/nutrition Physical activity Chemical exposures Air pollution Sexual behaviors Infections Pollens & dust Automobiles Falls Poisoning Weapons Violence Drug use & abuse Trauma and adverse experiences	Heart disease Cerebrovascular Diabetes mellitus Malignant neoplasms Chronic lower respiratory disease Unintentional Injury Suicide Homicide HIV Infant mortality Liver disease Nephritis Mental health conditions and trauma Occupational exposures Drug/substance use & abuse

Improving the distribution of power and resources and providing access to healthy community conditions and quality healthcare will create a more empowered community to engage in healthier behaviors, decreasing the presence of medical conditions and improving the gap in health inequities between populations with different socioeconomic

backgrounds.[3] Again, the importance of change at the level above health exposures and behaviors is highlighted.

In order to make sustainable health impacts in a community, it is important to understand the community itself. Guilford County is located in the Piedmont region of North Carolina. Each year, the Guilford County Department of Health and Human Services, along with partners within local healthcare systems and other community organizations, publish a Community Health Assessment.[21] to capture the current status and future needs to improve health in Guilford County. This assessment compiles and analyzes data from local to national sources, ranging from community surveys, local public health research, state databases, and national databases. The North Carolina Department of Health and Human Services, and its divisions of Public Health and the State Center for Health Statistics, release county specific data via the County Health Data Book[22] and the North Carolina Electronic Disease Surveillance System.[23] County information was also gathered from the American Community Survey performed by the United States Census Bureau[24] and the Behavioral Risk Factor Surveillance System from the County Health Rankings.[25] Local perspective of health and wellness was captured through on-line and in-person surveys of "key informants" in the community carried out by the Community Health Assessment team members.[21] Together, this information provides important information about the current health of the county as a whole, as well as key targets for intervention to raise the health and quality of life for every demographic within the community.

Health outcomes have been found to be inequitable for different demographics of Guilford County. Estimates describe 55.8% of the population as White, 33.8%

Black/African American, 4.9% Asian, and 6.5% of another race.[21] Regardless of race, those identifying as Hispanic or Latino make up an estimated 7.8% of the population.[21] In 2017, chronic diseases such as cardiovascular disease and cancer accounted for over 50% of deaths in the county.[21] Disparities in mortality related to chronic diseases were noted, with Black/African American residents having higher age-adjusted mortality rates for most chronic diseases compared to White residents.[21] Life expectancy is lower within the county in census tracts with higher percentages of Black/African American residents, higher rates of poverty, and low rates of educational achievement, with some census tracts demonstrating as much as a 20-year shorter life expectancy.[21] Thus, while chronic diseases can affect all residents of Guilford County, particular demographics of the population are much more severely affected by these conditions.

As noted in both the County Health Ratings Model and the Prevention Institute diagrams, health outcomes are driven by more than just health behaviors alone.[3,4] Access to quality healthcare can account for 20% of health-related outcomes.[4] In Guilford County, 11.3% of the population have no form of health insurance.[21] Again, disparities are seen between demographics, with 8.5% of Whites, 13.5% of Black/African Americans, and 30.5% of Hispanics having no form of health insurance.[21] Residents in census tracts with a higher percentage of racial minorities, higher rates of poverty, and lower educational attainment were less likely to have health insurance.[21] Lack of healthcare access is an issue for both physical and emotional health in the community. In a survey of community members, the most commonly identified barrier to receiving proper mental healthcare in the county was limited access to mental health services due to a lack of resources, a lack of funding for mental health programs, a lack of providers,

limited services for the uninsured population, and expensive co-pays in the insured populations.[21] Therefore, improving access to quality healthcare is a necessary component to improving health outcomes in Guilford County, particularly in lower socioeconomic populations.

Nutrition and exercise are important factors in the development of chronic diseases and engagement with healthy eating and physical activity guidelines are dependent on much more than individual behavioral choices.[26] The percentage of adults with obesity in Guilford County is 31% and those experiencing food insecurity is at 19%.[21] Twenty-six of the 119 census tracts are food deserts, meaning that 20% of residents live below the poverty level and one-third of residents live more than one mile away from a full-service supermarket.[21] These areas also overlap with the mapped areas having higher rates of mortality due to heart disease.[21] Additionally, as many as 38% of the households in food desert areas in the county have no access to a personal vehicle, increasing the difficulty of obtaining healthy food options.[21] In a survey of residents of the county, the most commonly reported barriers to healthy eating were the cost of healthy food and the lack of access to healthy food outlets.[21] Therefore, improving access to healthy foods that are not cost prohibitive may improve community health outcomes. Similarly, societal barriers are also seen with physical activity. Of adults in Guilford County, 22% report no leisure time physical activity.[21] Safety issues, including crime and traffic, were the most commonly reported barriers to physical activity.[21] With residents feeling safer exercising indoors, cost of exercise facilities was also a commonly cited barrier to exercise, and, for those unaccustomed to exercise or those starting from a place of being out of shape or overweight, not knowing how to start a physical activity program

was commonly described.[21] Improving access to structured physical activity opportunities for those with limited environmental options or those uncertain of how to begin exercising can change health behaviors.

Education and economic health are also important considerations for improving health outcomes.[4] In Guilford County, 34.9% of adults have completed a Bachelor's degree or higher and the per capita income is $28,582.[21] In lower income areas of Greensboro and High Point, a much higher density of substandard housing is present which increases environmental health risks.[21] For example, areas of with higher densities of substandard housing demonstrate higher rates of hospital admissions for asthma complaints.[21] A lack of safe, affordable housing was cited as the largest barrier to improving housing conditions in a survey of county residents.[21] More generally, surveyed residents reported that the largest challenges to improving education and economic health were found within inequalities of economic and political power as well as public policies at the state or national level.[21] Thus, leadership and advocacy are needed at the local, state, and national levels of government to address disparities in the distribution of power and resources to improve outcomes in chronic disease management.

Aware of the inequities in access to healthcare in the community, a physical therapy pro bono clinic (PTPBC) was established in the region to provide full-time clinical care to patients without medical insurance or those whose physical therapy benefits have been exhausted. This endeavor was supported through community grant funding and a clinical position was endowed through private donation. While the initial goal of the clinic is to provide an access point to physical therapy for underserved members of the community, long-term ambitions include engagement of the community

beyond the office visit and advocating at professional and government levels to improve access to healthcare, community conditions, and distribution of power and resources to increase health equity. Over time, the clinic endeavors to create a sustainable model of pro bono care and advocacy that can be adopted by organizations to improve health equity in their own local communities. Also, the clinic offers opportunity for students interested in healthcare fields to participate in experiences related to clinical care, increasing the awareness of health inequities within the future practitioners and leaders in healthcare. In order to progress on these goals, it will be important to assess the needs of the patients utilizing the PTPBC as a healthcare resource to recognize opportunities to improve interdisciplinary care, community engagement, and to support advocacy initiatives.

1.4 The Role of Physical Therapy in Chronic Disease Management

Physical therapists can be an important ally in the management of patients with chronic disease. Indeed, the American Physical Therapy Association (APTA) states in their most recent vision statement:

> Movement is a key to optimal living and quality of life for all people that extends beyond health to every person's ability to participate in and contribute to society. The complex needs of society, such as those resulting from a sedentary lifestyle, beckon for the physical therapy profession to engage with consumers to reduce preventable health care costs and overcome barriers to participation in society to ensure the successful existence of society far into the future.[11]

Through expertise in exercise prescription, health behavior change strategies, and health education, physical therapists can promote patient engagement in self-management of their condition.[6] They can also provide information and referrals to community resources designed to assist community members in engaging in healthier behaviors and/or management of chronic disease. Thus, physical therapists can be an important member of the interdisciplinary team managing patients with chronic disease, reducing burden on primary care physicians and increasing access to healthcare for patients as the shortage in primary care physician grows.

Physical therapists can also provide an access point into the healthcare system for patients with complaints of musculoskeletal disease. The APTA continues to work toward unrestricted direct access to physical therapy in the United States. While states such as Nebraska have had unrestricted direct assess as early as 1954, currently 20 states have unrestricted direct access.[27] Of the remaining states, 27 have direct access with provisions, and three states have limited direct access.[27] Having direct access allows patients to seek care from a physical therapist without the need of physician referral. Through an initial evaluation, the physical therapist determines whether the patient is appropriate for physical therapy care or whether referral for medical care is indicated. Early research is indicating that patients utilizing physical therapy through direct access demonstrated equivocal clinical outcomes with lower healthcare consumption which ultimately reduced primary care physician burden.[28] Related, a systematic review analyzing the most common complaints of patients presenting to primary care physicians in developed and developing countries found that back pain was the fourth most common presentation, with arthritis being the sixth most common complaint.[29] Therefore, physical

therapists can be an ally in the management of chronic diseases and an access point for patients with musculoskeletal pain complaints, decreasing the strain on primary care physicians.

In the outpatient setting in the United States, the majority of patients seeking physical therapy care present with musculoskeletal disorders. Using the data from the Medical Expenditure Panel Survey from 1996 to 2000, it was found that 79.2% of patients presented with non-traumatic joint disorders, sprains and strains, spondylosis, intervertebral disk disorder, or other back problems.[7] A study of Medicare beneficiaries from 2006 to 2008 reported 71.3% of patients presented with disorders of the lumbar spine, shoulder, and knee.[8] Therefore, it is important for outpatient physical therapists to have the skill and knowledge to manage musculoskeletal pain complaints. However, many patients with musculoskeletal complaints in the United States are not presenting to physical therapy with musculoskeletal pain alone. A study observing outpatient physical therapy clinics across 22 states from 2005 to 2009 reported that of 2,375 patients, 9.2% presented with diabetes, 15.7% with depression, 25.4% with headache, 30% with hypertension, and 34.4% with obesity.[9] Thus, whether physical therapists are managing musculoskeletal pain in a direct access setting or as part of an interdisciplinary team, it is important to screen and triage patients at risk of chronic disease, morbidity, and mortality to provide patient centered care.

1.5 Metabolic Syndrome and Musculoskeletal Disease

As a part of management of the whole patient, it is essential to identify those at risk of having or developing chronic disease. Metabolic syndrome (MetS) is a cluster of

findings that increase a person's risk of developing cardiovascular disease, diabetes, and certain cancers. The diagnostic criteria for MetS includes measures of waist circumference, blood pressure, serum triglyceride level, high-density lipoprotein level, and blood glucose levels. While organizations have established different cut-off points used for diagnosis, current guidelines include:[30] (1) waistline of equal to or greater than 89 cm for women and 102 cm for men,[31] (2) blood pressure of equal to or greater than 120/80 mmHg,[32,33] (3) fasting triglyceride level equal to or greater than 150 mg/dL,[31] (4) high-density lipoprotein levels equal to or less than 50 mg/dL of women and 40mg/dL for men,[31] and/or (5) a fasting blood glucose level of 100 mg/dL or greater and HbA1c greater than 5.7%.[34,35] Using various cut-off points in these areas of risk, it has been found that only 12.2-19.9% of Americans are metabolically healthy.[30] This is significant as it demonstrates that the vast majority of adults in the United States are at risk for developing chronic disease.

The pathophysiology of MetS is not yet fully understood and is still being extensively researched as it reaches across many different organ systems and human biomes.[10] However, a good starting point of reference is the development of an abundance of adipose tissue, particularly abdominal adipose tissue.[36] This results in an increased release of free fatty acids which increase glucose production at the liver[36,37] and results in triglyceride accumulation and decreased glucose uptake in skeletal muscle.[36,38-40] Along with increases in hepatic glucose production, triglycerides and very low density lipoproteins are also produced while a reduction in high-density lipoproteins occurs.[36,41,42] In response, the pancreas secretes more insulin, eventually creating insulin resistance.[36,43-45] These processes, along with an observed sodium reabsorption and

increased sympathetic nervous system activity contribute to hypertension.[36,46-50] Compounding these factors is the production of a pro-inflammatory state as adipose tissue releases inflammatory cytokines, such as interlukein-6 and tumor necrosis factor α,[36,51,52] which further promote free fatty acid release,[36,53] insulin resistance,[36,53] and a prothrombic state via the release of fibrinogen and plasminogen activator inhibitor-1 from the liver.[36,54] Thus, insulin resistance, hypertension, and a prothrombic state set the stage for the development of type II diabetes and cardiovascular disease.

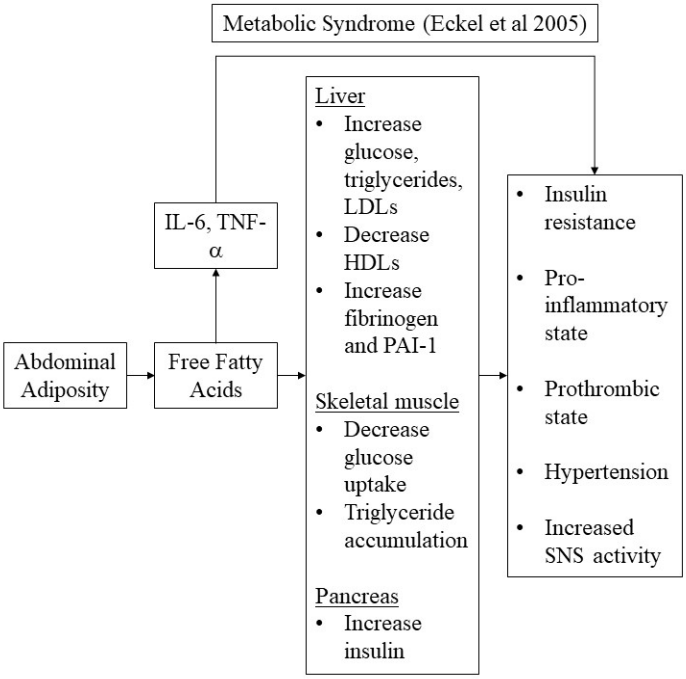


Figure 1.4: Metabolic Syndrome

It is important for physical therapists to recognize MetS risk in an outpatient population so that proper interdisciplinary management strategies can be initiated to improve health and quality of life for the patient. However, a finding of MetS is also significant to the patient presentation as it relates to musculoskeletal pain complaints. In a

recent review, Collins et al outline the very detailed mechanisms in which the pathophysiology of MetS also contributes to musculoskeletal disease.[10] The metabolic changes seen with an increase in free fatty acids, triglycerides, insulin resistance, cardiovascular regulation, and a pro-inflammatory state can lead to impaired tissue regeneration and structural adaptations in both muscle and bone,[10,55-62] leading to a reduction in integrity of these tissues that become pathoanatomical diagnoses such as tendinopathy[63] and osteoarthritis.[64]

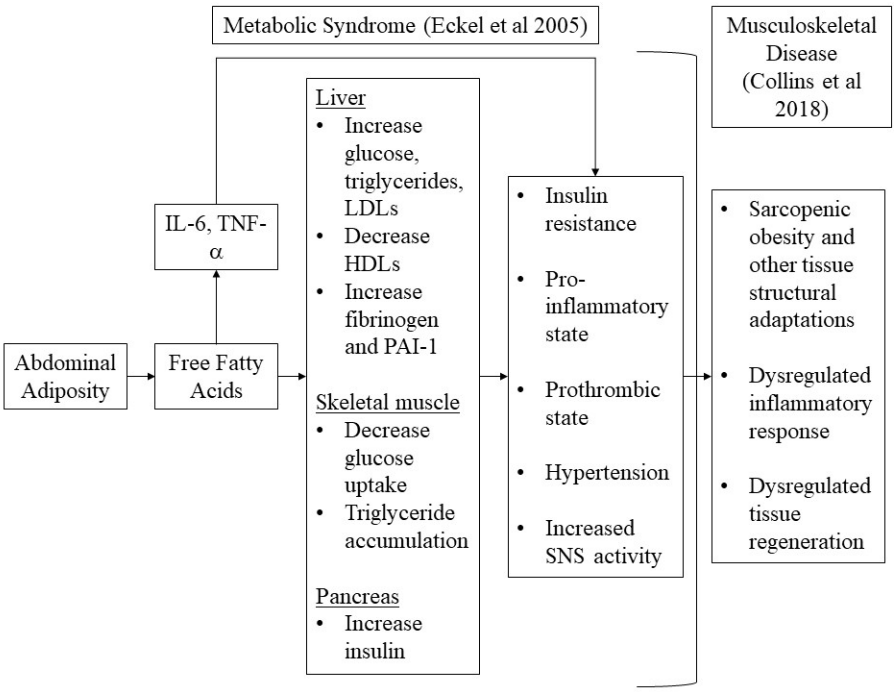


Figure 1.5: Metabolic Syndrome and Musculoskeletal Disease

These musculoskeletal conditions can activate nocioceptive pathways secondary to mechanical tissue irritation or inflammation and can result in changes in the peripheral and central nervous systems that promote a pro-algesic state and subsequent increases in

pain, loss of function, and further sedentariness.[65-68] In turn, sedentariness can promote even more metabolic distress,[69] as sedentariness is a risk factor for metabolic disorder.[70] Thus, in order to thoroughly manage a patient with both musculoskeletal and metabolic disease, consideration of health behaviors, socioeconomic influences, and interdisciplinary care strategies have to be incorporated. However, in a recently published study surveying physical therapists on the APTA Orthopaedic Section email list regarding cardiovascular disease screening, only 14.8% reported measuring blood pressure and heart rate for each patient at the initial examination.[71] Lack of time and lack of perceived importance were cited as the main barriers to screening for cardiovascular disease.[71] Therefore, in order to change clinical behaviors to align with best practice strategies to improve outcomes for patients with metabolic disease and musculoskeletal pain, screening procedures must not be over-burdensome and their importance must be highlighted for practicing clinicians.

Improving the provider's ability to understand and screen for chronic disease and its socioeconomic and psychosocial underpinnings is particularly important when managing patients with persistent musculoskeletal pain (PMP) which affects more than 100-million Americans.[72] This number equates to approximately one in every three people in the United States. In other terms, more people in the United States are experiencing PMP compared to those with heart disease, cancer, and diabetes combined.[72] It is estimated at 20.4% of the population in the United States suffers from chronic pain, with 8.0% suffering from chronic pain that limits life or work activities most days.[73] Because of this, annual economic costs related to PMP are exorbitant. Estimates from the early 2010s placed this burden at $560 to $635 billion dollars

annually.[74] and therefore current costs likely exceed this amount. Practitioners searching to ease the suffering of this patient population have often resorted to improper management, such as the use of opioid medication, leading to even more harmful sequelae. Opioid medication was previously considered to be an effective and safe intervention for PMP.[75] However, more recent research has identified the danger of prescription opioid use. Addiction to prescription opioids with long-term use occurs in as many as one in four patients.[76] In 2015, of the 52,404 deaths in the United States from drug overdose, 33,091 involved an opioid.[77] To date, the cost of the opioid epidemic to the United States has been estimated to be at least $631 billion, with the 2019 costs projecting at $172 to $214 billion.[78] Thus, given the vast prevalence of PMP and the associated inordinate costs, it is imperative to identify meaningful, cost-effective, and non-opioid interventions to reduce the suffering in this patient population.

1.6 Summary

Chronic disease management is impacted by much more than individual health choices. Models for managing chronic diseases must incorporate intervention strategies at all levels impacting health outcomes, from patient/provider interactions to the larger socioeconomic barriers preventing health equity. Management of chronic disease requires an interdisciplinary team, of which physical therapists can play an important role. However, in order to be more effective in this role, physical therapists must understand the models of chronic disease management and their influence on musculoskeletal disease in order to be able to provide whole person, patient-centered care.

CHAPTER 2. RISK FACTORS, CLASSIFICATION SYSTEMS, AND CLINICAL MEASURES

Metabolic syndrome is a risk factor for developing cardiovascular disease, diabetes, and musculoskeletal disease. Chapter Two will discuss the risk factors for MetS that have been investigated in the literature and demonstrate how these risk factors mirror those that predict the development of musculoskeletal disease. Identification of these risk factors has created a greater appreciation for the biopsychosocial variables influencing musculoskeletal disease, causing a shift in physical therapy classification systems to include not only movement impairments, but also underlying neurophysiological pain mechanisms and psychosocial variables. Thus, further investigation into measures of socioeconomic status, emotional health, and physical health are needed to develop best practice guidelines for the evaluation of patients with musculoskeletal disease and chronic disease to inform more tailored intervention strategies.

2.1 Modifiable Risk Factors for Metabolic Syndrome

Aside from the physiologic measures of waist circumference, blood pressure, triglyceride levels, high-density lipoprotein levels, and blood glucose levels, many modifiable risk factors for the development of MetS have been investigated through meta-analysis. Smoking has been found to increase the risk of developing MetS (RR=1.26; 95% CI: 1.10-1.44) with male heavy smokers demonstrating even greater a risk (RR=1.44; 95% CI: 1.27-1.59).[79] Smoking cessation decreases the risk of MetS for male smokers as former male smokers were found to have less risk (RR=1.19; 95% CI: 1.00-1.42) than actively smoking males (RR=1.34; 95% CI: 1.20-1.50).[79] Therefore,

engaging patients with smoking cessation programs and resources can reduce the risk of developing chronic disease.

Sedentariness also increases risk of developing MetS. Those reporting greater amounts of sedentary behavior had increased odds of MetS (OR=1.73; 95% CI: 1.55 to 1.94).[70] Similarly, those demonstrating high levels of leisure time physical activity were found to have less risk of MetS[80] (RR=0.80; 95% CI: 0.75-0.85) and those meeting the physical activity guidelines of 150 minutes of moderate physical activity per week reduced their risk of MetS by 10% (RR=0.90, 95% CI: 0.86-0.94).[81] Even greater risk reduction was seen in those engaging in moderate physical activity at twice (RR=0.80; 95% CI 0.74-0.88) and seven times (RR=0.47; 95% CI: 0.34-0.64) the physical activity guidelines.[81] Therefore, increasing physical activity participation based on patient preference and tolerance can be a target for reducing metabolic distress.

Emotional health is also an important consideration in the development of MetS. When adjusting for demographic factors, smoking, physical activity, functional capacity, and beta blocker use, those scoring 10-points or greater on the Beck Depression Inventory or having a previous diagnosis of depression had higher odds of developing MetS (OR=1.67; 95% CI: 1.15-2.44).[82] However, those scoring 10-points or greater on the Beck Depression Inventory and with a previous diagnosis of depression did not demonstrate higher odds as the confidence interval for the odds ratio crossed 1.0 (OR=1.59; 95% CI: 0.94-2.67).[82] Two meta-analysis studies investigated the risk of post-traumatic stress disorder (PTSD) for developing MetS. Compared to the general population, those with PTSD had a higher risk[83] (RR=1.82; 95% CI: 1.72-1.92) and higher odds[84] (OR=1.37; 95% CI: 1.03-1.82) of developing MetS. In investigating levels

of perceived stress, those with higher perceived stress demonstrated greater odds of developing MetS compared to those with lower perceived stress (OR=1.45; 95% CI: 1.21-1.74).[85] Occupational stress demonstrated the highest odds (OR=1.69; 95% CI: 1.18-2.42) while general perceived stress demonstrated the lowest (OR=1.22, 95% CI: 1.02-1.46).[85] Anxiety has been found to increase the odds of developing MetS, however, only marginally (OR=1.07; 95% CI=1.01-1.12).[86] Ensuring patients are connected with the proper providers to manage emotional health is an important consideration managing a patient's metabolic risk.

Sleep has also been demonstrated as a risk factor for the development of MetS. In analyzing 12 cross-sectional studies, a short sleep duration (< 5 to 6 hours) increased odds of MetS development (OR=1.27; 95% CI: 1.10-1.48). However, three pooled cohort studies did not demonstrate greater odds as the confidence interval for the odds ratio crossed 1.0 (OR=1.62; 95% CI: 0.74-3.55).[87] Long sleep duration also was found to increase the odds of developing MetS in 11 pooled cross-sectional studies (OR=1.23; 95% CI: 1.02-1.49). Yet again, two pooled cohort studies did not demonstrate greater odds as the confidence interval for the odds ratio crossed 1.0 (OR=1.62; 95% CI: 0.86-3.04).[87] Patients with obstructive sleep apnea (OSA) have also been demonstrated to have higher odds of developing MetS with those with mild OSA (OR=2.39; 95% CI: 1.65-3.46) having lower odds than those with moderate-to-severe OSA (OR=3.45; 95% CI: 2.33-5.12).[88] The odds of developing MetS in the presence of OSA remains significant even when controlling for obesity (OR=1.96; 95% CI: 1.73-2.22).[89] Therefore, properly identifying and managing sleep dysfunction should be a focus in evaluating a patient's metabolic risk.

Dietary habits also can influence a patient's metabolic risk. Those consuming a healthy diet pattern had lower odds for developing MetS compared to those with less healthy eating habits in pooled cross-sectional studies (OR=0.83; 95% CI: 0.76-0.90) while pooled cohort studies (OR=0.91; 95% CI: 0.68-1.21) did not demonstrate greater odds as the confidence interval for the odds ratio crossed 1.0.[90] Those following a Western dietary patterns had higher odds in pooled cross-sectional studies (OR=1.28; CI: 1.17-1.40) but not pooled cohort studies (OR=0.96; 95% CI: 0.53-1.73) of developing MetS.[90] Individuals in the highest quantile of sugar sweetened beverage consumption had a 20% greater risk of developing MetS (RR=1.20; 95% CI: 1.12-1.41).[91] Drinking coffee (RR=0.87; 95% CI: 0.79-0.96) and tea (RR=0.83; 95% CI: 0.73-0.95) were associated with lower risk of developing MetS.[92] Therefore, dietary interventions can play an important role in the management of chronic disease, highlighting the importance of nutritional specialists as a part of the multidisciplinary team.

Interestingly, meta-analysis investigation of the risk factors for MetS have found that they are also risk factors for the other risk factors themselves. Poor sleep increases the risk of obesity,[93,94] anxiety,[95] depression,[95-97] and hypertension.[98,99] Physical activity positively influences anxiety,[100-104] depression,[103,105-107] sleep,[108] and obesity.[109] Depression[110] and anxiety[111] increase risk of hypertension. Thus, the influence of the risk factors of MetS, and the interplay between those risk factors, must be a consideration in the development of MetS and its influence on musculoskeletal disease.

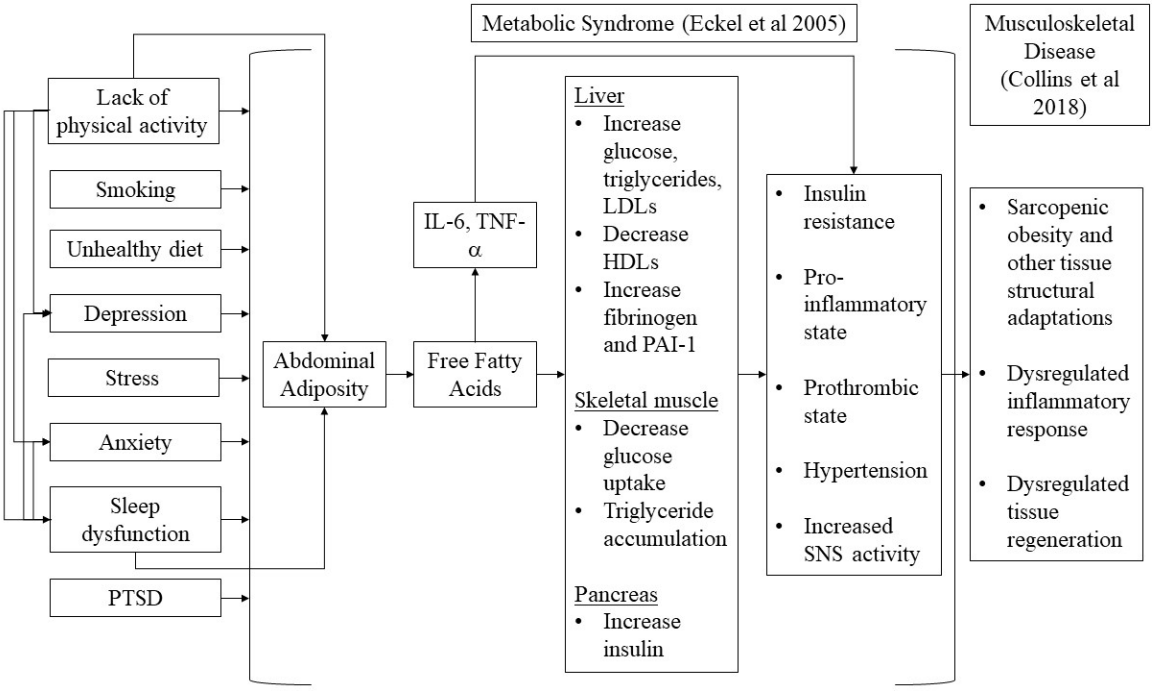


Figure 2.1: Metabolic Syndrome, Musculoskeletal Disease, and Health Behaviors

Additionally, having previously discussed the impact of structural drivers, community conditions, and access to quality healthcare on health behaviors and overall health outcomes,[3,4] socioeconomic considerations must be taken into account on the pathway from health behaviors, to MetS, to PMP conditions.

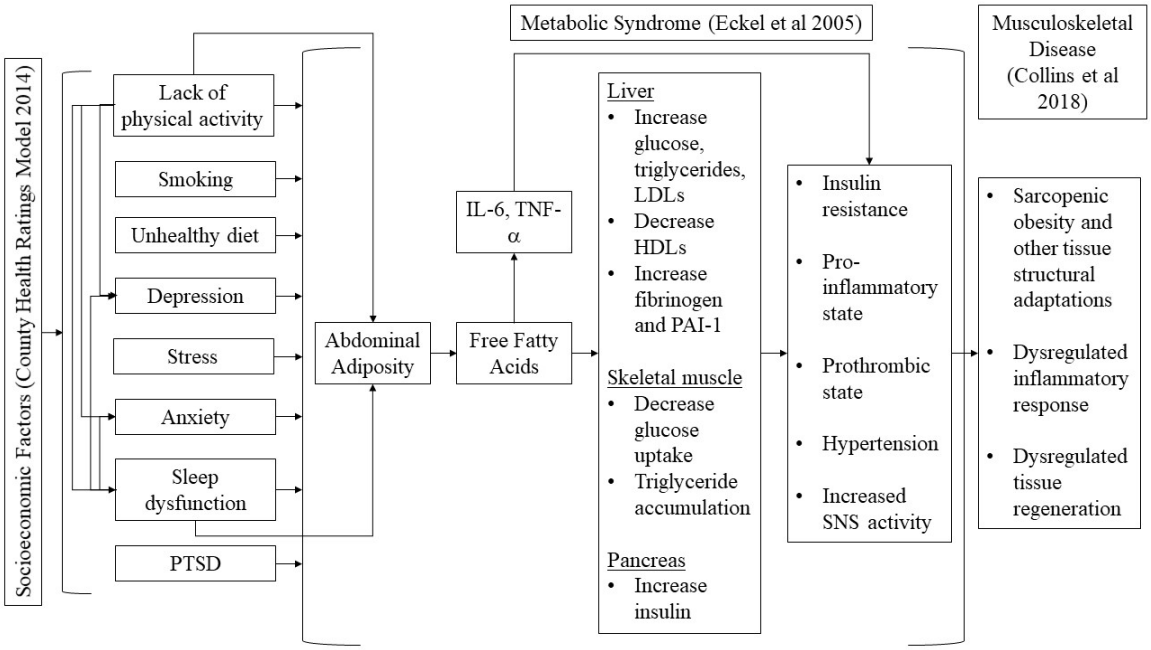


Figure 2.2: Metabolic Syndrome, Musculoskeletal Disease, Health Behaviors, and Socioeconomic Variables

2.2 Modifiable Risk Factors of Persistent Musculoskeletal Pain

The risk factors for developing MetS are also found in PMP conditions per meta-analysis. Smoking increases the odds of developing chronic low back pain (OR=1.78; 95% CI: 1.27-2.50) and disabling low back pain (OR=2.14; 95% CI: 1.11-4.13).[112] Participation in leisure time physical activity was protective against frequent/chronic low back pain in moderately active (RR=0.86; 95% CI: 0.79-0.94) and highly active (RR=0.84; 95% CI: 0.75-0.93).[113] Those who are overweight (RR=1.59; 95% CI: 1.34-1.89) or obese (RR=2.81; 95% CI=2.27-3.48) are at higher risk for developing chronic back pain.[114] Therefore, there is pooled evidence that smoking and being overweight/obese are risk factors for chronic low back pain, with leisure time physical activity protecting against the development of frequent/chronic low back pain.

While not yet analyzed through meta-analysis, multiple prospective studies have investigated the risk factors for PMP conditions including chronic neck and shoulder pain,[115] chronic low back pain,[116] chronic musculoskeletal pain,[117,118] chronic widespread pain,[119,120] and chronic arm pain.[121] Similar risk factors were identified across these conditions such as poor physical health,[116,119] emotional distress,[115,116,120] poor sleep,[118-120] and high body mass index.[121 119,120] Exercise was also an important variable with adequate exercise being protective against chronic arm and chronic musculoskeletal pain.[118,121] Therefore, there appears to be overlap between the risk factors for MetS and PMP conditions which helps support the pathway between metabolic distress and musculoskeletal disease.

2.3 The Need for Diagnostic Guidance for Intervention and Triage

Clinical diagnosis should impact management strategies, and diagnostic classification systems have been introduced in attempts to guide clinical management of patients with musculoskeletal pain complaints.[12] Over time, a greater understanding of the impact of socioeconomic factors and health behaviors on musculoskeletal disease has resulted in the evolution of diagnostic classification systems in physical therapy.

Historically, diagnosis and classification of musculoskeletal pain attributed the patient presentation exclusively to tissue damage. Patients often share this theoretical framework, given that the beliefs of the healthcare provider strongly shapes the beliefs of the patient.[122,123] Patients often want to identify the problematic structure as evidence of a legitimate medical problem as they experience difficulty communicating the magnitude of their complaint to the provider in the absence of these findings.[124-126] However,

evidence now demonstrates that structural pathology does not always correlate with the clinical presentation.[127-130] Similarly, symptomatic improvement can occur in spite of findings of structural pathology on diagnostic imaging remaining unchanged.[131] In a meta-analysis investigating outcomes following rotator cuff repair, it was determined that "rotator cuff repair may not alter natural history" of the disease compared to non-operative management[132] and of the randomized control trials comparing sham surgery to actual surgery, outcomes in pain and disability were found to be equivocal.[133] Therefore, while it is important to consider the underlying structural pathoanatomy in regards to the patient presentation, the tissues are not the only factor to contemplate when managing patients with PMP.

In physical therapy, new classification systems have been introduced, beginning with movement impairments and treatment based approaches, and progressing to neurophysiological and biopsychosocial classification systems to pain to better capture the patient's experience. Movement-based classification systems[12] were developed to guide treatment based on impairments observed in patient movement. Examples include Mechanical Diagnosis Therapy[12,134] and Movement Impairment Syndromes.[12,135] Mechanical Diagnosis Therapy uses repeated motions to determine a directional preference of movement that improves clinical signs and/or symptoms of the patient's chief complaint.[134] Movement Impairment Syndromes are based in kinesiology and biomechanics, identifying movement dysfunctions in the musculoskeletal system that may be contributing to the clinical presentation.[135] However, movement-based classifications have also been found not to fully explain the pain experience. In a cohort of 723 subjects with low back pain, adding Mechanical Diagnosis Therapy to a risk-

adjusted model to predict functional outcomes did not have a significant impact.[136] At one-year follow up, Mechanical Diagnosis Therapy was found to have equivocal outcomes in pain and disability when compared to motor control exercises in patients with chronic low back pain.[137] When compared to a group Back School program, Mechanical Diagnosis Therapy was found to be more effective in improving disability, but effect sizes were small.[138] Similar findings have been noted in movement impairment based classifications. Two meta-analyses have investigated biomechanical contributions to patellofemoral joint pain. No association was found between isometric hip strength and the development of patellofemoral joint pain.[139] Lower knee extension strength was predictive of patellofemoral joint pain, but a set of other measures, including height, weight, leanness, Q-angle, number of sit-ups performed, and peak knee valgus during landing were non-predictive.[140] Meta-analysis found that a pronated foot posture was predictive of developing medial tibial stress syndrome and patellofemoral pain, but effect sizes were small.[141] Pronated foot posture did not predict any other lower extremity injury. Specifically regarding Movement Impairment Syndromes, when compared to non-specific treatment, no differences between groups were noted.[12,142] Thus, while movement-based and biomechanical variables should be a part of clinical reasoning to guide musculoskeletal interventions, a wider lens must be used when considering the patient presentation.

Treatment-Based Classification systems were also introduced to help guide clinical reasoning in managing patients with pain complaints. These systems use clinical findings to categorize patients into groups based on the intervention to which they are most likely to respond.[12,143,144] In acute and subacute low back pain, Treatment-Based

Classification systems out performed non-matched treatments in improving patient outcomes.[145] However, when applied in a population with persistent low back pain, Treatment-Based Classification systems did not impact outcomes any greater than standard guideline-based care.[12,146] In attempts to improve efficacy of Treatment-Based Classification systems, psychosocial variables have been incorporated, particularly the domain of fear-avoidance.[12,147] Thus, pathoanatomy, movement-based classifications, and treatment-based classifications can add value in matching the patient to the proper intervention strategy, however, the clinician must also take into account non-musculoskeletal findings.

In place of structural identification, classification systems have been developed instead to identify pain by the underlying neurophysiological mechanisms.[12] Smart et al introduced a checklist to categorize patients into groups based on mechanisms of pain mediation, including nociceptive, peripheral neuropathic, nociplastic (central sensitization), or mixed presentations thereof.[148,149] Along with pain mechanisms, psychosocial contributions to the pain experience are also considered. While the reliability and validity of this classification system has been studied,[149-153] management strategies and outcomes based on this subgrouping are yet to be evaluated. However, given that the nervous systems of patients in each subgroup can be processing nociceptive information in different ways, consideration of the neurophysiological mechanisms of the pain experience is an important consideration for clinical reasoning.

Classification systems based on psychosocial variables have also been presented.[12] The STartBack Screening Tool[154] uses a questionnaire capturing pain, function, distress, fear, anxiety, catastrophizing, depression, and bothersomeness to

stratify patients into low-, medium-, and high-risk subgroups. General management recommendations are made based on these groupings, ranging from education and reassurance, to a course of physical therapy with emphasis on cognitive, emotional, and behavioral strategies.[154] Evaluation of outcomes using this patient stratification and management guidelines are currently being studied,[155] however, meta-analysis of five studies using the STartBack Tool has found the classification system to be "non-informative" for discriminating outcomes related to low back pain and "acceptable" for low back disability outcomes at follow-up.[156] Indeed, identification and incorporation of musculoskeletal, neurophysiological, and psychosocial factors influencing the pain experience can be a demanding task for the clinician.

In attempts to consolidate many different systems into one, O'Sullivan proposed a classification system incorporating elements of the above mentioned classifications which considers triage, time course of the disorder, neurophysiological factors, cognitive factors, social and cultural factors, work-related factors, lifestyle factors, health and pain comorbidities, individual factors, deconditioning, and pain communicative behaviors.[12,157,158] Based on these variables, Cognitive Functional Therapy is recommended as management, tailoring the interventions based on the individual patient needs. The goals of Cognitive Functional Therapy are to "provide a person-centered, biopsychosocial understanding of pain, enhance pain coping strategies through cognitive restructuring, stress and threat reduction, and pain control via targeted functional training and lifestyle change."[158] Initial evaluation of Cognitive Functional Therapy in patients with chronic low back pain found it more effective than a group-based exercise and education intervention in reducing disability at 6- and 12-months, but no differences

between groups for pain outcomes were found.[12,159] Thus, a move towards a more complete, systems-based approach for evaluation and management of PMP has evolved in the profession. However, further refinement is needed to better capture the clinical presentation to guide management of these patient populations. To be complete, musculoskeletal impairments (movement-based and treatment-based classifications), neural processing of pain (neurophysiological mechanism classifications), and biopsychosocial variables (STartBack tool and O'Sullivan) should all be included in the patient work up and subsequent management. Further research is needed to determine the best clinical technologies to capture the domains and develop consensus in regards to these measures so that an individualized, yet standardized, approach can be used by the clinician to guide clinicians to improve outcomes in patients with PMP.

Similarly, in physical therapy settings working with patients with limited access to healthcare, further guidance is needed in regards to medical triage in patients at risk for chronic disease. Revisiting the diagnostic criteria for MetS, only blood pressure and waist circumference are clinical measures that can be taken by the physical therapist. The remaining criteria require blood work, which is outside the scope of practice of physical therapy and potentially costly examinations for the uninsured populations. Thus, identifying additional non-invasive clinical measures that can further inform the clinician about the health status of the patient is necessary to ensure proper referrals to additional members of the healthcare team can be made.

In summary, classification systems have moved to encompass a whole-person, patient-centered approach by not only capturing movement impairments, but also socioeconomic, emotional health, and physical health variables. However, while many

instruments are available to screen for and capture these domains, further investigation of these measures is warranted to determine which measures best inform management strategies for patients with musculoskeletal disease.

2.4 Clinical Measurement of Risk Factors for Chronic Disease

Based on the risk factors for chronic disease, a literature search was performed to identify impactful, clinically efficient measures to capture these risk factors of chronic disease, morbidity, and mortality of a patient population attending a PTPBC. A standardized physical and emotional health battery was then created to assist clinicians and student clinicians with clinical decision making incorporating important domains identified in the diagnostic classification systems presented above.

2.4.1 Metabolic Syndrome

As mentioned, the diagnostic criteria for MetS requires the patient to undergo blood work to assess triglyceride, blood glucose, and high-density lipoprotein levels.[30] However, non-invasive models have been developed to assess metabolic risk. Investigating a working population, Romero-Saldaña et al found that by using a cutoff of waist-to-height ratio (WtHR) of greater than or equal to 0.55 and a cutoff greater than or equal to 128/85 mmHg for blood pressure was able to identify those with MetS with a sensitivity of 91.6% and specificity of 95.7%.[160] A validation of this study was performed which updated the cutoff values to greater than or equal to 0.56 for WtHR and greater than or equal to 128/80 mmHg for blood pressure, resulting in a sensitivity of 54.7%, a specificity of 94.9%.[161] The same author found that WtHR was the best predictor of MetS

in a population attending a nursing practice, with a cutoff of greater than or equal to 0.54 resulting in a sensitivity of 70% and a specificity of 77%. More recently, a nomogram was developed by Wang et al using measures of age, smoking status, body fat percentage, waist circumference, and systolic and diastolic blood pressure to estimate the probability of having MetS.[162] Thus, researchers have begun to investigate non-invasive strategies to capture metabolic status. However, these models still rely on physiologic measures and may be improved by considering measures of physical function or emotional health.

2.4.2 Cardiovascular and Pulmonary Function

Along with hypertension, measures of cardiovascular and pulmonary function can provide insight into the patient's physical health status. Peak expiratory flow (PEF) finrate is the measure of maximal flow rate, or speed, of a patient's forceful expiration measured through the use of a peak flow meter in units of liters per minute.[163] Predicted normative values can be calculated using the patient's height, age, and race/ethnicity.[164,165] The relationship between peak expiratory flow rate and mortality has been studied, with lower values predicting higher mortality.[166-168] Another cardiovascular indicator, aerobic capacity, or maximal oxygen uptake (VO_2 max), is the measurement of the maximum rate of oxygen consumption a patient can use during maximal exercise, and is reflective of cardiovascular fitness.[169] The American Heart Association published a statement paper recommending that aerobic capacity be adopted as a clinical vital sign given that lower values are associated with cardiovascular disease and all-cause mortality,[170-172] even when adjusted for potential confounders. Measuring cardiovascular fitness in a population with persistent pain can be difficult as musculoskeletal pain often precludes participation in more vigorous maximal or submaximal aerobic capacity

testing. Fortunately, a non-exercise model to predict aerobic fitness has been developed. This equation estimates VO_2max using the patient's age, waist circumference, resting heart rate, and physical activity index.[173] This model has been shown to explain 61% and 56% of the variance in measured VO_2max in men and women, respectively.[173] Thus, measuring peak expiratory flow using a peak flow meter and calculating predicted aerobic capacity using a non-exercise model are accessible tests for the patient and clinician to better inform health status.

2.4.3 Musculoskeletal Function

Measures of musculoskeletal function have also been associated with chronic disease, morbidity, and mortality. Grip strength using hand dynamometry has been associated with all-cause, cardiovascular, and non-cardiovascular mortality and was a stronger predictor than systolic blood pressure in both all-cause and cardiovascular mortality.[174,175] In older adults, men with lower grip strength had mortality rates 64-74% higher at 10-years and women with lower grip strength had 48% higher mortality rates.[174,176] The Center for Disease Control and Prevention recommends the use of the 30-second sit-to-stand test, measured in number of reps performed in 30-seconds, as a screen for fall risk.[177] In adults aged 60-64, a score less than 14 repetitions for males and 12 repetitions for females increases fall risk.[178] While normative values for the 30-second sit-to-stand in adults under the age 60 are limited, it is logical to assume that these populations should function at least as well as the older cohort. Falls are an important consideration for mortality, as 29,668 residents in the United States over the age of 65 died as a result of a fall in 2016.[179] Last, walk tests, measuring distance completed in a set time frame, have been studied in relationship to morbidity and mortality. Low scores on

the six-minute walk test have been associated with all-cause mortality, coronary heart disease specific mortality, and incident coronary heart disease.[180] Compared to the six-minute walk test, the two-minute walk test has been demonstrated to be as reliable and valid [181], making it a more efficient clinical test. Thus, grip strength, the 30-second sit-to-stand test, and the two-minute walk test can be important and efficient measures in capturing disease.

2.4.4 Sleep

As previously discussed, sleep is a risk factor for both MetS and musculoskeletal pain conditions. Clinically, questionnaires can be used to screen a patient's sleep quality. The Pittsburgh Sleep Quality Index (PSQI) is a 19-item questionnaire which is further broken down into seven component scores that are totaled.[182] Scoring higher than five on the PSQI was found to be fairly good at identifying patients with a sleep disorder, demonstrating a sensitivity of 89.6% and specificity of 86.5%.[182] Another validated instrument for assessing sleep is the Insomnia Severity Scale (ISS).[183] This scale totals the responses to seven items and a cutoff score of 10 identified patients with a sleep disorder at a sensitivity of 86.1% and a specificity of 87.7%.[183] Both questionnaires appear to be valid for screening purposes, however, there is some evidence to support the ISS as a better option to track improvement in sleep quality.[184] Additionally, not all sleep quality is related to insomnia. The STOP BANG is an eight-item screening tool that uses subjective questions about snoring, feeling tired, observation of dysfunctional breathing during sleep, and having hypertension, along with body mass index, age, neck circumference, and gender variables to determine risk of obstructive sleep apnea (OSA).[185,186] This screening tool has demonstrated validity, with predicted probability of

OSA increasing from 0.36 to 0.60 when comparing a score of three to a score of seven or eight.[185,186] Thus, relatively short questionnaires and tools can be used to screen for sleep dysfunction in a patient population.

2.4.5 Emotional Health Measures

As described previously, depression, PTSD, perceived stress, and to a lesser extent, anxiety are important risk factors to consider for chronic disease and pain. The Patient Health Questionnaire (PHQ-4) is a four-item, brief screening tool validated to identify patients with anxiety and depression.[187] A score of three or more on the depression or anxiety subscales suggest the presence of a disorder and referral to a mental health professional should be considered.[187] The Posttraumatic Stress Disorder (PTSD) Checklist for DSM-5 (PCL-5) has been psychometrically validated to measure symptoms of PTSD.[188] A score of 33 or greater on this 20-item questionnaire would warrant referral to a mental health provider for further diagnosis and management of PTSD.[189] The Primary Care PTSD Screen for DSM-5 (PC-PTSD-5) has also been developed and validated to identify patients with signs and symptoms consistent with PTSD.[190] This questionnaire was developed to be only five items to increase clinical efficiency, with a score of three or higher indication potential PTSD.[190] Perceived stress can be captured through use of the Perceived Stress Scale-4 (PSS-4).[191] This validated measure has patients rate four questions regarding the frequency of feelings and thoughts related to stress on a 5-point Likert scale ranging from “0” (Never) to “4” (Very often). Higher scores are correlated to higher levels of perceived stress.[191] Therefore, the PHQ-4, PC-PTSD-5, and the PSS-4 can be used to capture multiple emotional health domains without significant administrative burden.

2.4.6 Socioeconomic Measures

As noted previously, factors such as race/ethnicity, income, proximity to food sources, and education levels influence health outcomes. Along with demographic questions regarding these variables, the construct of self-efficacy can be a helpful indicator of health outcomes in chronic disease.[192,193] Perceived self-efficacy is representative of an "individual's beliefs in their capabilities to exercise control over a particular task and their own functioning, and…optimistic beliefs about one's capability to cope with barriers that arise during the period of behavioral maintenance."[194,195] General self-efficacy can also be captured through questionnaire format. A six-item short form of the General Self-Efficacy Scale (GSES-6) has been validated for use.[196,197] This questionnaire has the patient rate statements about self-efficacy on a four-point Likert scale ranging from "1" (not at all true) to "4" (exactly true). Higher scores are reflective of higher self-efficacy. In patients with PMP, meta-analysis has found self-efficacy to be an extremely important predictor of outcome, with low levels of self-efficacy predicting poorer outcomes.[198] Specific to pain, a two-item Pain Self-Efficacy Questionnaire (PSEQ-2) has been validated.[199] This questionnaire has the patient rate their confidence in performing certain tasks despite their pain on a 7-point Likert scale ranging from "0" (not at all confident) to "6" (extremely confident). Higher scores represent higher pain self-efficacy.[199] In subjects with persistent pain, improving pain self-efficacy has been demonstrated to be associated with a reduction in disability, independent of changes in pain levels.[200] Along with demographic variables related to socioeconomic status, capturing measures of perceived self-efficacy can improve the clinician's understanding of the patient presentation.

2.5 Summary

In summary, chronic disease and PMP conditions are significant issues affecting a large portion of the population resulting in immense societal costs. While diagnostic classification systems have been developed for musculoskeletal pain, further research is needed to better identify the measures that should be used to capture this population so that results are meaningful for the clinician. These measures should not only capture musculoskeletal function, but also emotional health and socioeconomic variables know to contribute to health outcomes, as minority populations with lower income and education levels are more greatly impacted by chronic disease. Similarly, it will be important for the identified measures to be clinically efficient so that the burden of incorporating these tests does not prohibit their use in the clinical setting. Also, given the interplay between the risk factors for chronic disease and PMP conditions, it is important to study the relationships between these variables to determine which moderate outcomes and which ones mediate outcomes. Similarly, it is important to identify novel patient subgroups based on these risk factors to allow for more targeted assessment of the patient population, allowing for more effective and efficient intervention strategies.

The purpose of this study is to assess a clinical population of patients presenting to a pro bono physical therapy clinic with complaints of musculoskeletal pain. The primary aims of this study are:

1) To describe the population based on physical health, emotional health, and socioeconomic variables.
    a. This will determine the needs of this population to inform future interdisciplinary care and advocacy endeavors.

2) To investigate the association between physical health (BMI, systolic blood pressure, diastolic blood pressure, mean arterial pressure, resting heart rate, waist circumference, WtHR, peak expiratory flow rate, predicted VO_2max, grip strength, 30-second sit-to-stand, fall risk, 2-minute walk test, gait speed, smoking status), emotional health (PHQ-4 anxiety, PHQ-4 depression, PSS-4, ISS, GSES-6, PSEQ-2), and socioeconomic (age, sex, employment status, highest level of education, race/ethnicity, food insecurity) variables to group membership of those at risk of MetS versus those without.
    a. This will inform potential targets for clinical measures that can be incorporated into a non-invasive testing battery to diagnose patients with MetS.
3) To investigate differences between those "at-risk" of MetS and those not at risk of MetS in the domains of pain (chronicity, severity, number of descriptors chosen), socioeconomic (level of education, employment status, race/ethnicity, smoking status, food insecurity), psychosocial (PSS-4, PHQ-4 anxiety, PHQ-4 depression, ISS, GSES-6), and physical health performance (number of medications taken, predicted VO_2max, two-minute walk test, 30-second sit-to-stand test, peak expiratory flow rate, grip strength).
    a. This will help determine if those with MetS have a uniquely different clinical presentation that may inform modification to clinical management strategies
4) To identify novel subgroups of patients based on measures of the pain experience, physical health, and emotional health variables.

a. This will inform a more targeted approach in measurement and treatment of these patient populations.

CHAPTER 3. METHODS

3.1 Study Design

Based on the extensive background literature presented in Chapter Two, the author developed a standardized intake packet and physical health testing battery to be completed by all patients a PTPBC at initial visit. The tests and measures were chosen based on perceived clinically usefulness, ability to provide insight into the patient's pain experience, and the opportunity for discussion about the role of health behaviors with this patient population; thus, shifting the belief model from pathoanatomy to a whole-systems approach. Given the clinical nature and standard of care of the intake and physical health batteries, all information regarding these measures were documented in the initial evaluation through electronic medical records. At the initial sessions, patients were to arrive 30-minutes prior to their scheduled visit to complete the intake packet in the waiting room administered by the front desk staff. The intake paperwork contained questions relating to demographics, the reason for the visit, pain description and nature, associated symptoms, history of care, food insecurity, exercise participation, medical history, current medications, pain self-efficacy, stress, anxiety, depression, suicidal ideation, post-traumatic stress, sleep, general self-efficacy, health literacy, and fall risk. Physical measures of health were captured during the initial evaluation, performed by the treating physical therapist or Doctor of Physical Therapy students under the observation of a licensed physical therapist. Thus, the data used in this study were accessed through retrospective chart review. The PTPBC initial intake packet and data collection sheet can be found in the Appendix.

3.2 Sample

Data from the initial evaluation of all patients attending the PTPBC was retrospectively reviewed and collected from a two-year period representing December 2017 through December 2019. Patients under the age of 18 years and those missing a substantial amount of information collected at the initial evaluation were excluded from the data collection. Given the clinical nature of this study, reasons for missing information included language barriers preventing completion of intake paperwork, patients not thoroughly completing initial paperwork, error/omission of tests and measures when training entry level students in the clinical setting, and/or late patient arrival to the initial visit precluding the ability to perform certain tests and measures during the first session. In total, data were collected from 504 patient charts.

3.3 Data Collection

Prior to the data collection process, approval for the study was obtained from the High Point University Internal Review Board (IRB). The following describes the information and measures collected during the retrospective chart review:

3.3.1 Metabolic Syndrome Risk

Using the model described by Romero-Saldaña et al[161], risk of MetS was determined using a cut-off for WtHR greater than or equal to 0.56 and blood pressure greater than or equal to 128/80 mmHg. Those exceeding these cut-off scores were classified as at risk for MetS while those falling below the cut-off were classified as not at risk. Thus, this information was inputted dichotomously.

Table 3.1: Criteria for MetS Risk

Blood pressure ≥ 128/80 mmHg	Yes to both: _____ (positive for risk)
Waist-to-height ratio ≥ 0.56	Yes to ≤ 1: _____ (negative for risk)

3.3.2 Cardiovascular and Pulmonary Function

Blood pressure readings were captured as continuous data for systolic (SBP) and diastolic (DBP) values which were then used to calculate mean arterial pressure (MAP).[201] Blood pressure values were also categorized for each patient into "normal", "prehypertensive", "stage I hypertension", "stage II hypertension", and "hypertensive crisis" as outlined by the American Heart Association.[202] Categorization of MAP was performed using a cut-off of greater than 100 mmHg to identify dichotomous groups of those with hypertension versus those without.[201,203,204]

Table 3.2: Blood Pressure Categories

Category	Systolic	Diastolic
Normal	< 120	< 80
Prehypertension	120 – 129	< 80
Stage I hypertension	130 – 139	80 – 90
Stage II hypertension	> 140	> 90
Hypertensive crisis	> 180	> 120

Cardiovascular and pulmonary function was additionally assessed using values recorded from peak expiratory flow rate testing and prediction of maximal oxygen update (VO_2max). Raw scores for peak expiratory flow rate were captured as continuous data in L/min. To categorize peak expiratory flow rate results, predicted values based age,

height, and race/ethnicity were calculated and those scoring 80% or greater of the predicted score were classified as normal, 50-79.9% were classified as low, and 0-49.9% were classified as very low.[164,165,205]

Table 3.3: Peak Expiratory Flow (L/min) Equations

Age	Sex	Race/ethnicity	Equation
≥ 18 years	Female	Black/African-American	60 [1.3597 + 0.03458 (age) – 0.000847 (age)^2 + 0.00019746 (height, cm)^2]
		White/non-Hispanic	60 [0.9267 + 0.06929 (age) – 0.001031 (age)^2 + 0.00018623 (height, cm)^2]
		Latino/Latinx	60 [0.2401 + 0.06174 (age) – 0.001023 (age)^2 + 0.00022203 (height, cm)^2]
		Other	{[(height, m × 3.72) + 2.24] - [Age × 0.03]} × 60
≥ 20 years	Male	Black/African-American	60 [2.2257 – 0.04082 (age) + 0.00027333 (height, cm)^2]
		White/non-Hispanic	60 [1.0523 + 0.08272 (age) – 0.001301 (age)^2 + 0.00024962 (height, cm)^2]
		Latino/Latinx	60 [0.0870 + 0.06580 (age) – 0.001195 (age)^2 + 0.00030243 (height, cm)^2]
		Other	{[(height, m × 5.48) + 1.58] - [age × 0.041]} × 60
Peak flow variability			
(measured PEF / estimated PEF) x 100		> 80%	Green (normal)
		50-80%	Yellow (low)
		< 50%	Red (very low)

Predicted maximal oxygen uptake (VO_2max) was calculated using the non-exercise model described by Nes at al.[173]

Table 3.4: Non-exercise Model to Predict VO2max

Sex	Predicted VO_2max equation		
Female	74.74 – (0.0.247 x age) – (0.259 x waist circumference) – (0.114 x resting heart rate) + (0.198 x physical activity index)		
Male	100.27 – (0.296 x age) – (0.369 x waist circumference) – (0.155 x resting heart rate) + (0.226 x physical activity index)		
Physical activity index		Responses	Index value
"How frequently do you exercise?"		Never/less than once a week	0
		Once a week	1
		Two to three times a week	2
		Almost every day	3
"How hard do you push yourself?"		Take it easy	0
		Heavy breath and sweat	5
		Push near exhaustion	10
"How long does each session last?"		Less than 30 minutes	1
		Greater than 30 minutes	1.5

Raw scores were captured as continuous data in ml/kg/min. Once the predicted value was determined, it was categorized as "very poor", "poor", "fair", "good", "excellent", or "superior" based on the values described by the Cooper Institute of Aerobics Research for each category based on age and sex of the participant.[169]

Table 3.5: VO2max Categories for Females (values in ml/kg/min)

Age	Very poor	Poor	Fair	Good	Excellent	Superior
13 – 19	< 25.0	25.0 - 30.9	31.0 - 34.9	35.0 - 38.9	39.0 - 41.9	> 41.9
20 – 29	< 23.6	23.6 - 28.9	29.0 - 32.9	33.0 - 36.9	37.0 - 41.0	> 41.0
30 – 39	< 22.8	22.8 - 26.9	27.0 - 31.4	31.5 - 35.6	35.7 - 40.0	> 40.0
40 – 49	< 21.0	21.0 - 24.4	24.5 - 28.9	29.0 - 32.8	32.9 - 36.9	> 36.9
50 – 59	< 20.2	20.2 - 22.7	22.8 - 26.9	27.0 - 31.4	31.5 - 35.7	> 35.7
60 +	< 17.5	17.5 - 20.1	20.2 - 24.4	24.5 - 30.2	30.3 - 31.4	> 31.4

Table 3.6: VO2max Categories for Males (values in ml/kg/min)

Age	Very poor	Poor	Fair	Good	Excellent	Superior
13 – 19	< 35.0	35.0 - 38.3	38.4 - 45.1	45.2 - 50.9	51.0 - 55.9	> 55.9
20 – 29	< 33.0	33.0 - 36.4	36.5 - 42.4	42.5 - 46.4	46.5 - 52.4	> 52.4
30 – 39	< 31.5	31.5 - 35.4	35.5 - 40.9	41.0 - 44.9	45.0 - 49.4	> 49.4
40 – 49	< 30.2	30.2 - 33.5	33.6 - 38.9	39.0 - 43.7	43.8 - 48.0	> 48.0
50 – 59	< 26.1	26.1 - 30.9	31.0 - 35.7	35.8 - 40.9	41.0 - 45.3	> 45.3
60 +	< 20.5	20.5 - 26.0	26.1 - 32.2	32.3 - 36.4	36.5 - 44.2	> 44.2

3.3.3 Musculoskeletal Function

Measures of musculoskeletal function included grip strength, the 30-second sit-to-stand test, and the two-minute walk test. Grip strength was tested on both right and left sides using a JAMAR hand dynamometer (Patterson Medical, Warrensville, IL). Testing was completed in a sitting position with the tested arm at the patient's side, elbow bent to 90 degrees, and cueing to give a maximal effort throughout the test, using the second handle position to be consistent with procedures used during development of normative values.[206-208] Raw scores were captured as continuous data in kilograms. Results were categorized based on normative values by age and sex, with "normal" values representing a score within one standard deviation above or below the mean, "low" falling greater than one standard deviation below the mean, and "high" falling greater than one standard deviation above the mean.

Table 3.7: Normative Values for Grip Strength (in kg)

Men					Women		
Low	Normal	High	Age	Hand	Low	Normal	High
< 48.2	48.2 – 65.45	> 65.45	20-24	R	< 26.45	26.45 – 37.6	> 37.6
< 39.9	39.9 – 57.85	> 57.85		L	< 21.35	21.35 – 33.85	> 33.85
< 45.2	45.2 – 63.35	> 63.35	25-29	R	< 27.85	27.85 – 39.0	> 39.0
< 42.6	42.6 – 56.7	> 56.7		L	< 25.35	25.35 – 36.5	> 36.5
< 43.6	43.6 – 66.35	> 66.35	30-34	R	< 28.35	28.35 – 49.05	> 49.05
< 39.65	39.65 – 58.05	> 58.05		L	< 23.65	23.65 – 41.6	> 41.6
< 44.45	44.45 – 67.2	> 67.2	35-39	R	< 28.2	28.2 – 39.35	> 39.35
< 42.25	42.25 – 61.35	> 61.35		L	< 26.2	26.2 – 35.75	> 35.75
< 45.65	45.65 – 64.05	> 64.05	40-44	R	< 24.65	24.65 – 39.4	> 39.4
< 42.25	42.25 – 61.35	> 61.35		L	< 22.1	22.1 – 35.5	> 35.5
< 39.75	39.75 – 60.25	> 60.25	45-49	R	< 23.0	23.0 – 36.9	> 36.9
< 35.85	35.85 – 59.25	> 59.25		L	< 21.15	21.15 – 31.6	> 31.6
< 43.75	43.75 – 60.1	> 60.1	50-54	R	< 23.6	23.6 – 34.7	> 34.7
< 39.05	39.05 – 55.65	> 55.65		L	< 20.95	20.95 – 30.25	> 30.25
< 36.4	36.4 – 58.0	> 58.0	55-59	R	< 20.5	20.5 – 32.55	> 32.55
< 28.65	28.65 – 48.3	> 48.3		L	< 17.8	17.8 – 28.0	> 28.0
< 32.0	32.0 – 51.55	> 51.55	60-64	R	< 20.9	20.9 – 30.0	> 30.0
< 23.6	23.6 – 43.8	> 43.8		L	< 17.0	17.0 – 25.4	> 25.4
< 33.45	33.45 – 50.45	> 50.45	65-69	R	< 19.2	19.2 – 28.05	> 28.05
< 27.2	27.2 – 44.05	> 44.05		L	< 15.9	15.9 – 23.6	> 23.6

Table 3.7 (continued): Normative Values for Grip Strength (in kg)

Men					Women		
Low	Normal	High	Age	Hand	Low	Normal	High
< 24.35	24.35 – 41.65	> 41.65	70-74	R	< 18.75	18.75 – 29.0	> 29.0
< 22.0	22.0 – 35.9	> 35.9		L	< 14.7	14.7 – 24.7	> 24.7
< 24.05	24.05 – 45.65	> 45.65	75+	R	< 15.4	15.4 – 24.45	> 24.45
< 19.55	19.55 – 39.55	> 39.55		L	< 14.0	14.0 – 22.4	> 22.4

The 30-second sit-to-stand test requires the patient to stand from a seat 17-inches in height as many times as possible in 30-seconds without use of the upper extremities. A repetition is counted each time the patient stands from the chair and if the patient is halfway to a standing position when 30-seconds expire, this repetition is also counted.[177] This this has been used to identify fall risk in older populations, with a cut-off of less than 14 repetitions for males and 12 repetitions for females aged 60-64 representing increased fall risk.[178] Thus, if a patient below the age of 60-64 scored below these cut-off values, they were also categorized as a fall risk. Those patients aged over 60-years were categorized based on the established cut-off scores for their sex and age group. This data was inputted dichotomously as positive for fall risk or negative for fall risk. Raw scores were also captured as continuous data as number of repetitions completed.

Table 3.8: 30-second Sit-to-Stand Test Cut-off Values for Fall Risk

Age	Female	Male
60 – 64	< 12	< 14
65 – 69	< 11	< 12
70 – 74	< 10	< 12
75 – 79	< 10	< 11
80 – 84	< 9	< 10
85 – 89	< 8	< 8
90 – 94	< 4	< 7

Additionally, fall risk was determined using the three screening questions recommended by the Center for Disease Control and Prevention Stopping Elderly Accidents, Deaths, and Injuries (STEADI) program which includes, (1) "Do you feel unsteady when standing or walking?", (2) "Do you worry about falling?", and (3) Have you fallen in the past year?"[177] A positive response to any of the three questions indicates fall risk and this data was inputted dichotomously as positive or negative for fall risk.

Table 3.9: Screening Questions for Fall Risk

"Do you feel unsteady when standing or walking?"	Yes to any item: ____ (positive fall risk)
"Do you worry about falling?"	
"Have you fallen in the past year?"	No to all items: ____ (negative fall risk)

The two-minute walk test measures the distance a patient can ambulate over the course of two-minutes using a self-selected walking speed. Pooled data has been analyzed to report normative values based on age and sex for this test.[209] Raw scores

were captured as continuous data in meters completed in two-minutes as well as gait speed in m/second. Using these values, patients were categorized as "normal" if they scored within the 95% confidence interval for the mean score in their age/sex group. "Low" scores represented those falling below this confidence interval and "high" represented those falling above the confidence interval. Gait speed was calculated by taking the distance walked in meters and dividing by the time in seconds. This raw score was inputted as continuous data. A cut-off score of 0.8 m/sec[210,211] was used to dichotomously group the population as having the gait speed necessary to ambulate in the community compared to those with gait speeds below community ambulation.

Table 3.10: Normative Values for Two-Minute Walk Test (m)

Men				Women		
Normal	Low	High	Age	Normal	Low	High
207.2 – 228.6	< 207.2	> 228.6	20 – 29	177.7 – 210.5	< 177.7	> 210.5
196.3 – 207.9	< 196.3	> 207.9	30 – 39	178.1 – 184.8	< 178.1	> 184.8
186.8 – 197.5	< 186.8	> 197.5	40 – 49	160.3 – 201.0	< 160.3	> 201.0
184.7 – 194.9	< 184.7	> 194.9	50 – 59	149.6 – 188.7	< 149.6	> 188.7
169.3 – 196.8	< 169.3	> 196.8	60 – 69	150.0 – 177.3	< 150.0	> 177.3
152.7 – 173.5	< 152.7	> 173.5	70 – 79	147.7 – 152.9	< 147.7	> 152.9

3.3.4 Sleep and Emotional Health

Sleep quality was quantified using the ISS.[183] This seven-item questionnaire uses a five-point Likert scale (0 to 4) for each item with the responses indicating poor sleep quality representing the higher scores.[183] Thus, the overall score ranges from 0 to 28 points with higher scores reflecting poor sleep quality. This raw score was inputted as continuous data. A cut-off of 10 points or greater was used to dichotomously group those with potential sleep disturbance versus those without.[183]

Table 3.11: Insomnia Severity Scale

Please rate your current (i.e. last two weeks) quality of sleep	None	Mild	Moderate	Severe	Very severe
Difficulty falling asleep	[ ]	[ ]	[ ]	[ ]	[ ]
Difficulty staying asleep	[ ]	[ ]	[ ]	[ ]	[ ]
Problems waking up too early	[ ]	[ ]	[ ]	[ ]	[ ]
	Very satisfied	Satisfied	Moderately satisfied	Dissatisfied	Very dissatisfied
How satisfied/dissatisfied are you with your current sleep pattern?	[ ]	[ ]	[ ]	[ ]	[ ]
	Not at all noticeable	A little	Somewhat	Much	Very much noticeable
How noticeable to others do you think your sleep problem is in terms of impairing your quality of life?	[ ]	[ ]	[ ]	[ ]	[ ]

Table 3.11 (continued): Insomnia Severity Scale

	Not at all worried	A little	Somewhat	Much	Very much worried
How worried/distressed are you about your current sleep problem?	[ ]	[ ]	[ ]	[ ]	[ ]
	Not at all interfering	A little	Somewhat	Much	Very much interfering
To what extent do you consider your sleep problem to interfere with your daily functioning (i.e. daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, etc.)?	[ ]	[ ]	[ ]	[ ]	[ ]

Obstructive sleep apnea risk was assessed using the STOP BANG questionnaire.[185] This eight-item screening tool uses subjective questions about snoring, feeling tired, observation of dysfunctional breathing during sleep, and having hypertension, along with body mass index, age, neck circumference, and sex to determine risk of OSA.[185] [186] Results are categorized into "low" (0-2), "intermediate" (3-4), and "high" (≥ 5) risk for OSA.

Table 3.12: STOP BANG Questionnaire

Criteria	Risk scoring	
[ ] Snore loudly (heard through a closed door [ ] Feel tired, fatigued, or sleepy during the day [ ] Observed stopped breathing during sleep [ ] Have high blood pressure [ ] Body mass index ≥ 35 [ ] 50 years or older [ ] Neck circumference ≥ 41 cm [ ] Male	High Intermediate Low	≥ 5 3 – 4 0 – 2

Presence of potential anxiety or depression was captured using the PHQ-4.[187] This four-item tool contains two-items related to anxiety and two-items related to depression. Each item is scored on a four-point Likert scale (0 to 3), and a score of three or greater on the anxiety or depression subscale suggests the potential of a diagnosis of anxiety or depression.[187] Raw scores for each subscale were captured as continuous data. This data was also inputted dichotomously for both anxiety and depression as positive or negative for the potential presence of these emotional health conditions.

Table 3.13: Patient Health Questionnaire – 4

Over the past 2 weeks, have you been bothered by these problems?	Never	Almost never	Sometimes	Fairly often	Nearly every day
Feeling nervous, anxious, or on the edge	[ ]	[ ]	[ ]	[ ]	[ ]
Not being able to stop/control worrying	[ ]	[ ]	[ ]	[ ]	[ ]
Feeling down, depressed, or hopeless	[ ]	[ ]	[ ]	[ ]	[ ]
Little interest or pleasure in doing things	[ ]	[ ]	[ ]	[ ]	[ ]

Perceived stress was collected using the PSS-4.[191] This validated measure has patients rate four questions regarding the frequency of feelings and thoughts related to stress on a 5-point Likert scale ranging from "0" (Never) to "4" (Very often). Higher scores are correlated to higher levels of perceived stress.[191] This data was entered continuously. Dichotomous grouping was performed after determining the median value of the sample, with those scoring higher than the median being categorized as high stress.

Table 3.14: Perceived Stress Scale – 4

Please choose the best answer – In the past month:	Never	Almost never	Sometimes	Fairly often	Very often
How often have you felt that you were unable to control the important things in your life?	[ ]	[ ]	[ ]	[ ]	[ ]
*How often have you felt confident about your ability to handle your personal problems?	[ ]	[ ]	[ ]	[ ]	[ ]
*How often have you felt that things were going your way?	[ ]	[ ]	[ ]	[ ]	[ ]
How often have you felt difficulties were piling up so high that you could not overcome them?	[ ]	[ ]	[ ]	[ ]	[ ]

* items are reversed scored

Presence of potential PTSD was captured using the PC-PTSD-5. Of the five items, a score of three or higher was recorded as positive for the potential presence of PTSD.[190]

Table 3.15: The Primary Care PTSD Screen for DSM-5

Have you experienced a traumatic event (serious accident; fire; disaster such as hurricane, tornado, or earthquake; physical or sexual abuse; war; homicide; or suicide)?	Yes [ ]	No [ ]
If yes, in the past month, have you:		
Have had nightmares about it or thought about it when you did not want to?	Yes [ ]	No [ ]
Tried hard not to think about it or went out of your way to avoid situations that reminded you of it?	Yes [ ]	No [ ]
Were constantly on guard, watchful, or easily startled?	Yes [ ]	No [ ]
Felt numb or detached from others, activities, or your surroundings?	Yes [ ]	No [ ]
Felt guilty or unable to stop blaming yourself or others for the event(s) or any problems the event(s) may have caused?	Yes [ ]	No [ ]

3.3.5 Self-Efficacy

Pain self-efficacy was captured using the PSEQ-2.[199] Using a seven-point Likert scale (0 to 6) for each item a total score of 0 to 12 is calculated with lower scores representing lower pain self-efficacy.[199]

Table 3.16: Pain Self-Efficacy Questionnaire 2-Item

Please rate how confident you are that you can do the following things at present:	Not at all confident 0	1	2	3	4	5	Confident 6
I can do some form of work, despite the pain ("work" includes housework and paid/unpaid work).	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
I can live a normal lifestyle, despite the pain.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Similarly, general self-efficacy was captured using the GSES-6 which uses a four-point Likert scale (1 to 4) for each item to calculate a total score of 4 to 24, with lower

scores representing lower general self-efficacy.[196,197] Both PSEQ-4 and GSES-6 measures were inputted as continuous data. Dichotomous grouping was performed after determining the median value of the sample. Those scoring lower than the median value on the PSEQ-4 were categorized as low pain self-efficacy, and those scoring lower than the median value on the GSES-6 were categorized as low general self-efficacy.

Table 3.17: General Self-Efficacy Scale 6-Item

Please select the best answer:	Not at all true	Hardly true	Moderately true	Exactly true
- If someone opposes me, I can find means and ways to get what I want.	[ ]	[ ]	[ ]	[ ]
- It is easy for me to stick to my aims and accomplish my goals.	[ ]	[ ]	[ ]	[ ]
- I am confident that I could deal efficiently with unexpected events.	[ ]	[ ]	[ ]	[ ]
- Thanks to my resourcefulness, I know how to handle unforeseen situations.	[ ]	[ ]	[ ]	[ ]
- I can remain calm when facing difficulties because I can rely on my coping abilities.	[ ]	[ ]	[ ]	[ ]
- No matter what comes my way, I'm usually able to handle it.	[ ]	[ ]	[ ]	[ ]

3.3.6 Socioeconomic Variables

The intake paperwork at the PTBPC captured variables related to socioeconomic status including age, sex, employment status, highest level of education achieved, race/ethnicity, and food insecurity. Age was inputted as continuous data. Sex and food insecurity were dichotomous variables entered as male or female, or, reporting yes or no for presence of food insecurity. Food insecurity was assessed using a 1-item screening

tool, "Have there been times in the last 12 months when you and your family did not have the food you needed or the resources necessary to purchase food?", modified from the 2-item screening tool for food insecurity.[212] Employment status (yes/full-time, yes/part-time, no/unemployed, no/disabled, no/retired), highest level of education (did not complete high school, high school/GED, some college, Bachelor's or technical degree, some post-graduate, Master's degree, advanced academic or clinical graduate degree), smoking (yes, no) and race/ethnicity (Black/African-American, White/non-Hispanic, Latino/Latinx, Asian, Black/African, Native American/Indigenous, Black/Latin American/Caribbean, Middle Eastern, Pacific Island, Multiracial/Other, Refused to answer) were entered categorically.

Table 3.18: Socioeconomic Variables

Age	Response:	
Sex	[ ] Female [ ] Male [ ] Other	
Food insecurity	Have there been times in the last 12 months when you and your family did not have the food you needed or the resources necessary to purchase food? [ ] Yes	[ ] No
Are you presently employed?	[ ] Yes [ ] No	[ ] Full-time [ ] Part-time [ ] Unemployed [ ] Disabled [ ] Retired
Highest level of education	[ ] Did not complete high school [ ] High school/GED [ ] Some college	[ ] Bachelor's or technical degree [ ] Some postgraduate [ ] Advanced academic or clinical graduate degree
What do you consider your race? What do you consider your ethnicity?	Response: Response:	
Do you currently smoke?	[ ] Yes	[ ] No

3.3.7 Pain Measures

Various domains of the pain experience were captured. Usual pain intensity was measured using a numerical pain rating scale from 0 to 20.[213] Pain chronicity was reported in number of years. Usual pain intensity and chronicity in years was inputted as continuous data. If the patient reported constant pain, this was inputted dichotomously as a yes or no response.

Table 3.19: Pain Intensity, Chronicity, and Constancy

What is the usual severity of your pain? (Circle the appropriate number)																				
No pain																				Extreme pain
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

When did this problem begin?	How long does the pain typically last?	
Response:	[ ] Less than 1-minute	[ ] 6-12 hours
	[ ] 1-10 minutes	[ ] 13-24 hours
	[ ] Less than 1-hour	[ ] Several days
	[ ] 1-5 hours	[ ] Constant

Pain location was quantified in two manners. As patients often presented with more than one area of pain complaint, region of complaint was broken up into quadrants for the extremities and the axial skeleton/head. Thus, 18 different categories for pain location were created ranging from no specific pain complaint to pain in all four quadrants and the axial skeleton. This data was inputted categorically. Generalized/widespread pain versus regional pain was determined by the report of pain in four of these five body regions.[214,215] and was inputted dichotomously as yes or no for the presence of generalized/widespread pain.

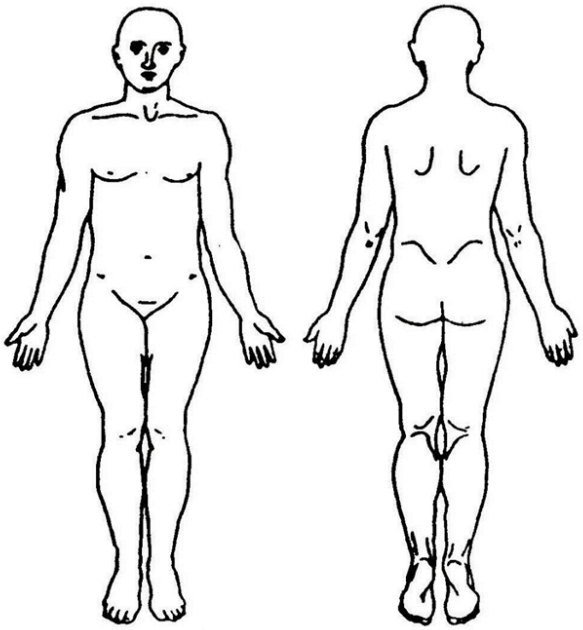


Figure 3.1: Body Diagram
Table 3.20: Pain Location

Regional	One area of complaint	[ ] Axial [ ] One LE	[ ] One UE
	Two areas of complaint	[ ] Both LE [ ] Axial + One LE [ ] One UE + One LE	[ ] Both UE [ ] Axial + One UE
	Three areas of complaint	[ ] Axial + Both LE [ ] One LE + Both UE [ ]Axial + One LE + One UE	[ ] Axial + Both UE [ ] One UE + Both LE
Wide-spread	Four areas of complaint	[ ] Axial + One LE + Both UE [ ]Axial + One UE + Both LE	[ ] Both LE + Both UE
	Five areas of complaint	[ ] Axial + Both LE + Both UE	

The validated Short-Form McGill Pain Questionnaire has the patient select from 15 pain descriptors that best represents their pain experience.[216,217] Of these, 11 words

relate to sensory description of pain (throbbing, shooting, stabbing, sharp, cramping, gnawing, hot/burning, aching, heavy, tender, splitting), and four words capture the emotional-affective component of pain (tiring/exhausting, sickening, fearful, punishing/cruel).[216,217] The emotional-affective descriptors, along with total number of words chosen, are of particular interest as they represent a greater pain experience.[216 217] Data was inputted dichotomously to demonstrate whether the patient did or did not select one or more of the emotional-affective descriptor. Total number of words chosen was inputted as continuous data. Dichotomous grouping was performed after determining the median value of the sample, with those scoring higher than the median value being categorized as selecting more pain descriptors.

Table 3.21: Short-Form McGill Pain Questionnaire Descriptors

Describe the way your pain typically feels: (please select all that apply)			
[ ] Throbbing	[ ] Gnawing	[ ] Splitting	[ ] Shooting
[ ] Hot/burning	[ ] Tiring/exhausting*	[ ] Stabbing	[ ] Aching
[ ] Sickening*	[ ] Sharp	[ ] Heavy	[ ] Fearful*
[ ] Cramping	[ ] Tender	[ ] Punishing/cruel*	[ ] Other:

* Indicates emotional-affective descriptors

3.4 Data Analysis

Descriptive information (frequencies, means, and standard deviations) were used to determine the MetS risk, cardiovascular and pulmonary function, musculoskeletal function, sleep, emotional health, self-efficacy, and socioeconomic profile of the sample.

For regression analysis, approximately 500 adult outpatients ranging from 18-86 years of age were studied at the PTPBC. Out of these 500 subjects, 421 subjects had their

sex, height, weight, age, and BMI reported. These 421 subjects were the initial data set that was used for further analyses. Ultimately a data set of 412 subjects were used to answer the main research questions.

Binary logistic regression was conducted to determine which independent continuous variables [sex, age, weight, height, BMI, waist circumference, blood pressure (SBP, DBP, MAP) hand grip strength, peak expiratory flow rate (L/min), predicted VO_2max (mL/kg/min), number of sit-to-stand-reps in 30-seconds, distance walked in two-minutes, fall risk status, PHQ-4 anxiety score, PHQ-4 depression score, PSS-4 score, ISS score, and GSES-6 score] were predictors of MetS risk (dichotomous variable). The forward stepwise selection method enters predictors based on the score statistic and then assess removal based on the likelihood-ratio statistic (based on the maximum partial likelihood estimates) was used. The elimination of outliers was performed through a graphical examination of Cook's Distance (any value that was $\geq 4/n$) and through the elimination of any standardized residual ≥ 3.0 SD units.

In order to determine whether those that were classified as being "at-risk" for MetS were any different compared to those who were not "at-risk" for being classified for MetS, associations between MetS risk (yes, no) and five other categorical variables (level of education, employment status, race/ethnicity, current smoker, food insecurity) were examined.

Mann-Whitney U tests were used to compare questionnaire scores between groups. Pain chronicity (number of years), pain severity (0 to 20), number of pain descriptors (0 to 15), the total number of medications taken (0 to 21), perceived stressed score (0 to 16), PHQ-4 anxiety score (0 to 6), PHQ-4 depression score (0 to 6), ISS score

(0 to 28), and the GSES-6 score (6 to 24) between those who were classified as being "at-risk" for MetS compared to those who were not classified as being "at-risk" for MetS.

Several tests of covariance analyses (ANCOVA) were performed to determine whether one or more physical performance characteristics were different between those classified as being "at-risk" for MetS compared to those that were not. The covariates, sex, and age were controlled for, and physical performance measures for aerobic/functional capacity continuous value (predicted VO_2max, distance walked over two-minutes, peak expiratory flow rate (L/min), number of sit-to-stand reps in 30-seconds) and upper body strength (combined right and left hand grip strength scores) were compared between groups.

Statistical analyses were conducted using SPSS version 27 (IBM® SPSS® Statistics, Chicago, IL) by G.S. Zavorsky, Ph.D. University of California, Davis. An α of 0.05 was set to signify statistical significance.

Latent class analyses were performed using MPlus (Muthen & Muthen, 2005). Variables used in the model included pain severity, reported number of pain regions, selection of affective pain descriptors, number of pain descriptors chosen, pain constancy, pain self-efficacy, general self-efficacy, stress, anxiety, depression, sleep disturbance, metabolic syndrome risk, peak expiratory flow rate, aerobic capacity (VO2max), right grip strength, left grip strength, 30-second sit-to-stand test, and gait speed. Each variable was grouped dichotomously to allow for a “positive”/ “negative” outcome. For the purpose of this analysis, a “positive” outcome was the presence of the less favorable outcome (higher pain severity, more regions of pain, presence of affective pain descriptors, more pain descriptors chosen, presence of constant pain, lower pain self-

efficacy, lower general self-efficacy, higher stress, presence of potential anxiety, presence of potential depression, presence of potential sleep disturbance, presence of metabolic syndrome risk, lower peak expiratory flow rate, lower aerobic capacity, lower grip strength, fewer repetitions on the 30-second sit-to-stand test, slower gait speed). For the variables of anxiety (PHQ-4), depression (PHQ-4), sleep disturbance (ISS), MetS risk, 30-second sit-to-stand, and gait speed, the published cut-off scores described previously in the methods for these measures were used to dichotomously group the sample. For the variables of pain severity, reported number of pain regions, number of pain descriptors chosen, pain self-efficacy (PSEQ-2), general self-efficacy (GSES-6), and stress (PSS-4), the median score of the sample was used as a cut-off to dichotomously group the sample. If affective pain descriptors were chosen or if the subject marked "yes" to having constant pain, then they were considered "positive" for the presence of those items. For the physical measures of peak expiratory flow rate, aerobic capacity, and grip strength, scoring lower than the published normative range previously described in the methods grouped a subject as "positive" for the presence of these items.

Latent class modeling was performed starting with a one-class model and increasing by one class each time modeling was performed. Model fit was assessed using Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample-size adjusted BIC, model entropy, the Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (LRT), the Lo-Mendell-Rubin Adjusted LRT, and the parametric bootstrapped LRT. Lower values of AIC, BIC, and sample-sized adjusted BIC, along with higher model entropy, signify better model fit [214,218] Likelihood ratio tests are used to determine significance ($P < 0.05$) of the model compared to a model with an additional class added

[219,220,221] Therefore, the model with the lowest AIC, BIC, and sample-sized adjusted BIC, and with the highest model entropy, that remained significant across the LRTs was selected as the model of best fit. A minimum sample size of 200-subjects has been recommended to perform a latent class analysis [214,222,223]

CHAPTER 4. RESULTS

4.1 Descriptive Statistics

The mean patient presentation was an age of 46.87 years (SD: 12.10), pain chronicity of 3.82 years (SD: 6.68), usual pain intensity of 11.24 (SD: 5.42) on a scale of 0 to 20, selection of 4.45 (SD: 3.01) pain descriptors out of a total of 14, PSEQ-2 score of 5.65 (SD: 3.60) on a scale of 0 to 12, GSES-6 score of 16.73 (SD: 3.69) on a scale of 6 to 24, PSS-4 score of 7.12 (SD: 3.14) on a scale of 0 to 16, ISS score of 11.27 (SD: 7.58) on a scale of 0 to 28, taking 3.55 (SD: 3.43) medications.

4.1.1 Descriptive statistics: Socioeconomic Variables

Of patients attending the PTPBC, 76.59% were aged between 31 and 60 years of age and 61.81% of patients identified as female. Regarding employment and education, 79.26% of patients reported being employed full- or part-time and 83.53% reported not earning a college or technical school degree. The most common race/ethnicities reported were Black/African-American (34.0%), White/non-Hispanic (31.33%), Latino/Latinx (14.22%), and Asian (4.44%). Food insecurity was present in 24.76% of the sample and 27.5% reported currently smoking.

Table 4.1: Socioeconomic Variables

	Number of patients	Percentage
Age (n = 504; mean: 46.87; SD: 12.10)		
18 to 20	10	1.98
21 to 30	49	9.72
31 to 40	87	17.26
41 to 50	139	27.58
51 to 60	160	31.75
61 to 70	49	9.72
71 to 80	8	1.59
81 to 90	2	0.40
Sex (n =495)		
Female	306	61.81
Male	189	38.18
Employment status (n = 459)		
Full-time employed	143	31.55
Part-time employed	219	47.71
Unemployed	48	10.46
Disabled	49	10.68
Highest level of education (n = 443)		
Did not complete high school	90	20.32
High school/GED completed	130	29.35
Some college or technical school	150	33.86
College or technical school completed	48	10.84
Some postgraduate school	12	2.71
Master's degree	9	2.03
Advanced academic or clinical degree	4	0.90
Race/ethnicity (n = 450)		
Black/African-American	153	34.0
White/non-Hispanic	141	31.33
Latino/Latinx	64	14.22
Asian	20	4.44
Black/African	11	2.44
Native American/Indigenous	5	1.11
Black/Latin American/Caribbean	2	0.44
Middle Eastern	2	0.44
Pacific Island	0	0.0
Multiracial/Other	41	9.11
Refused to answer	11	2.44

Table 4.1 (continued): Socioeconomic Variables

	Number of patients	Percentage
Food insecurity (n = 420)		
Yes	104	24.76
No	316	70.22
Current smoker (n = 440)		
Yes	121	27.5
No	319	72.5

4.1.2 Descriptive Statistics: Pain Characteristics

Pain was reported in one or two body regions by 70.99% of patients and three or more body regions by 18.05%. Forty-two (8.52%) patients met the criteria for having widespread pain. Pain in the upper extremity was reported by 154 patients, pain in the lower extremity by 240 patients, and pain in the axial skeleton (cranial and spinal regions) by 257 patients. The majority of patients met the temporal definition of chronic pain, with 98.78% of patients reporting a pain duration of one-year or greater. Usual pain intensity greater than 10 on a 20-point scale was reported by 62.78% of patients. Over half of patients (51.88%) described their pain as constant. Selection of pain descriptors reflecting an emotional/affective component of the pain experience was present in 39.20% of patients and 23.66% of patients selected a total of seven or more pain descriptors.

Table 4.2: Pain Characteristics

	Number of patients	Percentage
Pain location (n = 493)		
Pain not chief complaint	54	10.95
Axial	103	20.89
One LE	83	16.84
One UE	54	10.95
Both LE	28	5.68
Both UE	4	0.81
Axial + One LE	49	9.94
Axial + One UE	25	5.07
One LE + One UE	4	10.95
Axial + Both LE	22	4.46
Axial + Both UE	13	2.64
One LE + Both UE	1	0.20
One UE + Both LE	1	0.20
Axial + One LE + One UE	10	2.03
Both LE + Both UE	7	1.42
Axial + One LE + Both UE	10	2.03
Axial + One UE + Both LE	2	0.41
Axial + Both LE + Both UE	23	4.67
Regions involved (n = 493)		
Zero	54	10.95
One	240	48.68
Two	110	22.31
Three	47	9.53
Four	19	3.85
Five	23	4.67
Region location (n = 493)		
Axial	257	52.13
UE	154	31.24
LE	240	48.68
Regional versus Widespread (n = 493)		
Regional	451	91.48
Widespread	42	8.52

Table 4.2 (continued): Pain Characteristics

	Number of patients	Percentage
Chronicity (n = 462; mean: 3.82; SD: 6.68)		
< 1 year	6	1.22
1 to 1.99	241	48.88
2 to 2.99	52	10.55
3 to 3.99	38	7.71
4 to 4.99	19	3.85
5 to 5.99	17	3.45
6 to 6.99	4	0.81
7 to 7.99	9	1.83
8 to 8.99	14	2.84
9 to 9.99	4	0.81
> 10 years	58	11.76
Usual pain intensity (n = 446; mean: 11.24; SD: 5.42)		
0 to 4	50	11.21
5 to 8	98	21.97
9 to 12	108	24.21
13 to 16	106	23.77
17 to 20	84	18.83
Emotional/affective descriptor (n = 449)		
Yes	176	39.20
No	273	60.80
Number of descriptors (n = 448; mean: 4.45; SD: 3.01)		
0 to 3	197	43.97
4 to 6	145	32.37
7 to 9	80	17.86
10 to 12	20	4.46
13 to 15	6	1.34
Constant pain (n = 451)		
Yes	234	51.88
No	217	48.11

Using the pain descriptors chosen, a correlation matrix was performed to determine what percentage of subjects selecting one pain descriptor also chose other pain descriptors. The following table lists the pain descriptors that could be selected in the left-most column, the number of subjects selecting that pain descriptor in the next

column, and then the percentage of those subjects that also selected the pain descriptors listed in the following columns. The table is color-coded for ease of interpretation, with percentages 25-49.99% highlighted as green, 50-74.99% highlighted as yellow, and 75-100% highlighted as orange. The five pain descriptors (throbbing, tiring/exhausting, sharp, stabbing, aching) included in this table were those that were selected by at least 75% of the subjects selecting a pain descriptor in the left-most column.

Table 4.3: Pain Descriptors Correlation Matrix

		Percentage				
	Count	Throbbing	Tiring/ Exhausting	Sharp	Stabbing	Aching
Throbbing	220	-	0.41	0.7	0.51	0.76
Hot/Burning	129	0.64	0.43	0.71	0.62	0.74
Sickening	33	0.82	0.76	0.76	0.73	0.88
Cramping	104	0.67	0.55	0.75	0.6	0.74
Gnawing	48	0.58	0.6	0.67	0.56	0.85
Tiring/ Exhausting	140	0.64	-	0.69	0.56	0.78
Sharp	256	0.6	0.38	-	0.58	0.7
Tender	152	0.59	0.49	0.7	0.51	0.78
Splitting	36	0.75	0.53	0.72	0.78	0.78
Stabbing	181	0.62	0.44	0.82	-	0.73
Heavy	111	0.63	0.64	0.71	0.58	0.67
Punishing/ Cruel	63	0.65	0.62	0.86	0.67	0.76
Shooting	179	0.67	0.42	0.78	0.59	0.77
Aching	286	0.59	0.38	0.63	0.46	-
Fearful	38	0.71	0.76	0.82	0.76	0.79

As displayed above, those selecting the affective descriptors of sickening and fearful often chose multiple other pain descriptors. Aching and sharp were most commonly chosen with other pain descriptors.

4.1.3 Descriptive statistics: Emotional Health and Sleep

Patients scoring less than 6 on a 12-point scale for the PSEQ-2 was 62.01% of the sample. Around 28% of the sample reported a score of 15 or less on the GSES-6 which has a possible range of 6 to 24. Scores on the PSS-4 ranged between 5- and 12-points out of a total of 16-points in 76.36% of the sample. Potential anxiety was present in 33.01% of patients, potential depression in 28.64%, and potential PTSD in 19.91%. Using the cut-off score of 10-points on the ISS,[183] 54.63% of patients presented with potential sleep disturbance. Moderate to high risk of OSA was present in 53.76% of patients.

Table 4.4: Emotional Health and Sleep

		Number of patients	Percentage
Pain Self-Efficacy Scale 2-item (n = 408; mean: 5.65; SD: 3.60)			
(Low)	0 to 2	96	23.53
	3 to 4	69	16.91
	5 to 6	88	21.57
	7 to 8	57	13.97
	9 to 10	51	12.50
(High)	11 to 12	47	11.52
General Self-Efficacy Scale 6-item (n = 390; mean: 16.73; SD: 3.69)			
(Low)	6 to 9	21	5.38
	10 to 12	35	8.97
	13 to 15	54	13.85
	16 to 18	175	44.87
	19 to 21	72	18.46
(High)	22 to 24	33	8.46

Table 4.4 (continued): Emotional Health and Sleep

		Number of patients	Percentage
Perceived Stress Scale (n = 406; mean: 7.12; SD: 3.14)			
(Low)	0 to 4	82	20.20
	5 to 8	201	49.51
	9 to 12	109	26.85
(High)	12 to 16	15	3.69
Patient Health Questionnaire – 4: Anxiety (n = 418)			
	Yes	138	33.01
	No	280	62.22
Patient Health Questionnaire – 4: Depression (n = 412)			
	Yes	118	28.64
	No	304	73.79
The Primary Care PTSD Screen for DSM-5 (n = 422)			
	Yes	84	19.91
	No	338	80.10
Insomnia Severity Scale (n = 410; mean: 11.27; SD: 7.58)			
(Low)	0 to 4	100	24.39
	5 to 8	73	17.80
	9 to 12	71	17.31
	13 to 16	53	12.93
	17 to 20	53	12.93
	21 to 24	39	9.51
(High)	25 to 28	21	5.12
STOP BANG OSA risk (n = 452)			
	Low risk	209	46.24
	Intermediate risk	161	35.62
	High risk	82	18.14

4.1.4 Descriptive statistics: Physical health

In regards to blood pressure, 82.96% of patients had readings greater than 120/80 mmHg, with 43.47% of patients with hypertension meeting the criteria for stage II hypertension. Using WtHR, 85.25% of patients had elevated body mass measures, with the majority (58.59%) falling in the morbidly obese range. Similarly, using body mass index, 84.53% of the sample had elevated body mass, with 54.57% falling into obese

categories. Just over half of patients (50.11%) were at risk for metabolic syndrome. Peak expiratory flow rate values were below normal levels in 64.72% of the sample. Predicted VO_2max values were scored "fair", "poor", or "very poor" in 53.28%. Grip strength was measured to be low in 48.16% and 42.42% for the right and left side, respectively. The majority of patients (75.80%) scored below the cut-off values on the 30-second sit-to-stand test and in the total fall risk screening 85.27% were classified as at risk for falls. Gait speed was also found to be low in the majority of the sample (92.06%) as measured by the two-minute walk test. Using a definition of polypharmacy as regular use of five or more medications,[224] 27.89% patients were categorized as under polypharmacy management. Just under half of patients reported some kind of regular exercise with 0 to 1 exercise sessions per week being the most common response (58.19%). Using the physical activity guidelines for an exercise frequency of most days per week,[225] 20.35% of patients met the frequency criteria. When exercising, the majority of patients (82.06%) reported a light intensity level ("take it easy"). Exercise session duration was reported most often to be less than 30 minutes (77.23%).

Table 4.5: Physical Health Measures

	Number of patients	Percentage
Number of medications (n = 459; mean: 3.55; SD: 3.43)		
0 to 2	212	46.19
3 to 4	119	25.93
5 to 6	50	10.89
7 to 8	36	7.84
9 to 10	18	3.92
>10	24	5.23

Table 4.5 (continued): Physical Health Measures

	Number of patients	Percentage
Blood pressure (n = 452)		
Normal	77	17.04
Prehypertensive	111	24.56
Stage I	96	21.24
Stage II	163	36.06
Hypertensive crisis	5	1.11
Body mass index (n = 460)		
Underweight (< 18.5)	7	1.52
Normal (18.5 – 24.9)	78	16.96
Overweight (25 – 29.9)	124	26.96
Obese (30.0 – 39.9)	184	40.0
Extreme Obesity (≥ 40)	67	14.57
Waist-to-height ratio (n = 454)		
Extremely slim	2	0.44
Slim	16	3.52
Healthy	49	10.79
Overweight	57	12.56
Very overweight	64	14.10
Morbidly obese	266	58.59
Metabolic syndrome risk (n = 437)		
Yes	219	50.11
No	218	49.89
Peak expiratory flow rate (n = 445)		
Very low	74	16.63
Low	214	48.09
Normal	157	35.28
Predicted VO_2max (n = 458)		
Very poor	54	11.79
Poor	74	16.16
Fair	116	25.33
Good	128	27.95
Excellent	60	13.10
Superior	26	5.68
Right grip strength (n = 461)		
Low	222	48.16
Normal	217	47.07
High	22	4.77

Table 4.5 (continued): Physical Health Measures

	Number of patients	Percentage
Left grip strength (n = 462)		
Low	196	42.42
Normal	217	46.97
High	48	10.38
30-second sit-to-stand (n = 438)		
Low	332	75.80
Normal	106	24.2
Fall risk (n = 448)		
Yes	382	85.27
No	66	14.73
Two-minute walk test (n = 428)		
Low	394	92.06
Normal	33	7.71
High	1	0.02
"Do you exercise?" (n = 443)		
Yes	215	48.53
No	228	51.47
"How frequently do you exercise?" (n = 452)		
0 to 1 time per week	263	58.19
2 to 3 times per week	97	21.46
4 to 6 times per week	44	9.73
Daily	48	10.62
"How hard do you push yourself?" (n = 457)		
Take it easy	375	82.06
Heavy breath and sweating	9	1.97
Push near exhaustion	73	15.97
"How long does each session last?" (n = 448)		
Less than 30 minutes	346	77.23
Greater than 30 minutes	102	22.77

4.2 Regression Analysis

4.2.1 Predictors of MetS Risk

Binary logistic regression was conducted to determine which independent variables were predictors of MetS risk. Data screening eliminated nine outliers (2% of the data). Regression results indicated that the overall model fit of two predictors (systolic blood pressure and waist circumference) was statistically reliable in distinguishing predicted MetS risk [-2 Log-Likelihood = 211, $\chi 2$ (2) = 360, $p < 0.001$]. The model correctly classified 87% of the cases. Approximately 58% to 78% of the variance in predicting MetS risk was accounted for by systolic blood pressure and waist circumference. For each one mmHg increase in systolic blood pressure, the likelihood of being classified as being "at-risk" for metabolic syndrome increases by about 16 to 27% (OR=1.21; 95% CI: 1.16-1.27). That is to say, if a subject's systolic blood pressure were to increase one mmHg from their original measurement, then the likelihood of being classified as "at-risk" for MetS would increase, at the lower end, 16%. Similarly, for every one cm increase in waist circumference from a subject's original value, the likelihood of being classified as being "at-risk" for metabolic syndrome increases by about 14 to 24% (OR=1.19; 95% CI: 1.14-1.24). Thus, an increase in systolic blood pressure by 5 mmHg and an increase in waist circumference of 5 mmHg would increase the relative risk of being classified as "at risk" of MetS approximately 2-fold. However, absolute risk would be lower for a subject, for example, increasing in systolic blood pressure from 110 mmHg to 120 mmHg and waist circumference from 70 cm to 75 cm compared to a subject increasing in these measures from 145 mmHg to 150 mmHg and 120 cm to 125 cm.

4.2.2 Associations Between MetS Risk and Social Determinants of Health

In order to determine whether those that were classified as being “at-risk" for MetS were any different in social determinants of health compared to those who were not "at-risk" for being classified for MetS, associations between MetS classification risk (yes, no) and five other categorical variables were examined. Only race/ethnicity (Phi Coefficient = 0.20 to 0.39, $p = 0.018$, $n = 296$) and not smoking (Phi Coefficient = -0.24 to -0.01, $p = 0.04$, $n = 296$) were statistically associated with being classified as “at-risk” for MetS; however, these associations were weak. Nonetheless, the data demonstrate that if racial/ethnic differences were examined between patients identifying as White/non-Hispanic and patients identifying as Black/African Americans, patients identifying as Black/African Americans were 1.2 to 3.6 times more likely to be classified as "at-risk" for MetS compared to those identifying as White/non-Hispanic ($p = 0.009$, $n = 224$). Furthermore, smoking tends to elicit a protective effect against MetS as smoking tended to reduce the likelihood of being classified as being "at-risk" for MetS by 10 to 70% ($p = 0.02$, $n = 224$). Yet, again, it must be stressed that caution is warranted since the percentage of shared variance between the classification of MetS risk versus race/ethnicity and smoking was small (less than 7% shared variance).

4.2.3 Differences Between Groups in Pain, Medications, Perceived Stress, Anxiety, Depression, Insomnia, and General Self-Efficacy

Mann-Whitney U tests determined that only the number of medications taken were significant between the two groups ($p < 0.01$). Those who were classified as "at-risk" for MetS took more than one more medication (median number of medications = 3)

compared to the group that was not classified as being at risk for metabolic syndrome (median number of medications = 2). No other non-parametric variable (pain chronicity, pain severity, number of pain descriptors chosen, perceived stress, anxiety, depression, insomnia, general self-efficacy) was different between those "at-risk" for MetS versus those not at risk for MetS.

4.2.3 Differences Between Groups in Physical Performance

There were physical performance differences between those who were classified as "at risk" for MetS compared to those who were not, even after controlling for sex and age. An analysis of covariance in over 350 subjects determined that estimated peak oxygen uptake (VO_2max) was 6 mL/kg/min (~20%) lower, two-minute walk test distance was 11 m (~9%) less, number of sit-to-stand reps in 30-seconds was 1.3 reps fewer (~14%), and summed right and left hand grip strength was 5 kg (~8%) higher in those that were classified as "at-risk" for MetS compared to those that were not classified as at risk, when controlling for age and sex, (all $p < 0.05$). Peak expiratory flow rate was not different between groups when controlling for sex and age. Sex and age significantly influenced most of these physical performance variables.

4.3 Latent Class Analysis

Latent class analysis uses cross-sectional latent variable mixture modeling to assess the individual profiles of the included subjects in regards to the measures included in the model.[218,226] Individuals are then assigned to a class based on the probability that their measures are most similar to other members of the class.[226] This ultimately creates subgroups where members are most similar to those in their class while at the same time

most distinct from the individuals belonging to the other classes.[226,227] Model fit statistics for latent class models (1 to 5) demonstrated that a 3-class model was most appropriate. The 3-class model had the highest entropy and lowest AIC, BIC, and sample-size adjusted BIC while maintaining statistical significance across the Vuong-Lo-Mendell-Rubin LRT, the Lo-Mendell-Rubin Adjusted LRT, and the parametric bootstrapped LRT.

Table 4.6: Model Fit Statistics

# of Latent Classes	AIC	BIC	Adjusted BIC	Entropy	LMR LRT	LMR Adjusted LRT	Boot-strap LRT
1	10123.5	10199.5	10142.3				
2	9583.5	9739.7	9622.3	0.7	577.7*	573.1*	577.7
3	**9446.6**	**9683.1**	**9505.3**	**0.7**	**174.9***	**173.4***	**174.9***
4	9365.7	9682.3	9444.3	0.7	119.0	118.0	119.0*
5	9299.1	9696.0	9397.7	0.7	105.4	104.5	105.4

* $p < 0.05$

The following figure displays the grouping of the latent class analysis with each variable included in the model listed on the X-axis and the percentage likelihood of a member within each class that a subject would be classified as "positive" for each variable.

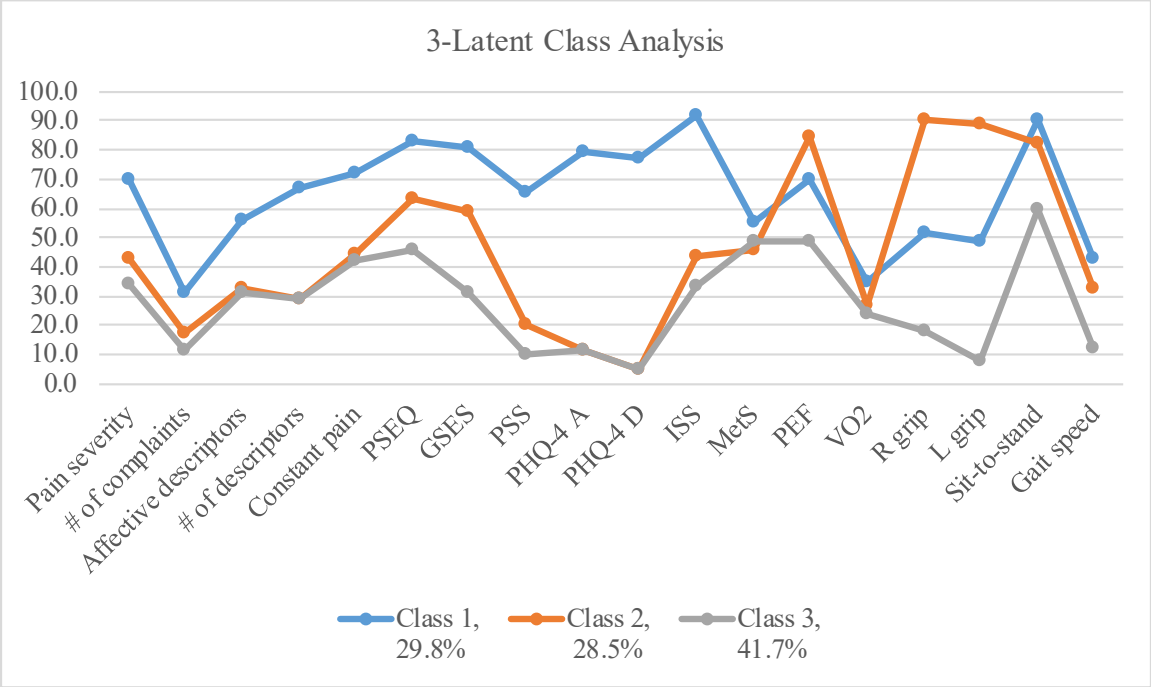


Figure 4.1: 3-Latent Class Analysis

Class-one represented 29.8% of the sample, Class-two 28.5% of the sample, and Class-three 41.7% of the sample. Looking at the defining characteristics for each class, members of Class-one were more likely to have higher pain severity, use more pain descriptors, report constant pain, have low pain self-efficacy, low general self-efficacy, high stress, anxiety, depression, and sleep disturbance. Thus, Class-one can be defined by having a greater pain experience and greater psychosocial involvement than the other two classes. Both Class-two and Class-three were less likely to report a greater pain experience and were less likely to display high psychosocial involvement compared to

Class-one. Separating Class-two and Class-three were mainly the measures of peak expiratory flow rate and both right and left grip strength. Therefore, if Class-one is characterized by higher pain/psychosocial involvement, Class-two is characterized by lower pain/psychosocial involvement with poorer physical health measures, and Class-three is characterized by lower pain/psychosocial involvement with better physical health measures.

The following table again lists the included variables along the left-most column and the percentage likelihood a member of each class would classify as "positive" for each variable. The table is color-coded for ease of interpretation, with percentages 0-24.99% highlighted as blue, 25-49.99% highlighted as green, 50-74.99% highlighted as yellow, and 75- 100% highlighted as orange.

Table 4.7: 3-Latent Class Analysis

	Class 1, 29.8%	Class 2, 28.5%	Class 3, 41.7%
Pain severity	70.2	43.1	34.3
# of complaints	31.3	17.3	11.1
Affective descriptors	56.1	32.9	30.9
# of descriptors	67.3	28.7	29.3
Constant pain	72.4	44.4	41.9
PSEQ	83.0	63.5	45.5
GSES	80.5	58.6	31.2
PSS	65.6	19.9	10.2
PHQ-4 A	79.6	11.3	11.5
PHQ-4 D	77.2	5.2	4.7
ISS	91.9	43.5	33.6
MetS	55.6	45.7	49.0
PEF	69.6	84.4	48.7
VO2	34.6	27.0	23.8
R grip	51.9	90.6	18.0
L grip	48.6	89.1	7.9
Sit-to-stand	90.4	82.0	60.0
Gait speed	42.6	32.7	12.2

Again, Class-one demonstrates a greater likelihood of group members to have high pain severity, use affective pain descriptors, use more pain descriptors, and have constant pain, and are much more likely to have poorer scores as they relate to pain self-efficacy, general self-efficacy, anxiety, depression, and sleep disturbance. Class-two

particularly stands out in measures of low peak expiratory flow rate and right and left grip strength. Class-three does not stand out across all pain, psychosocial, and physical health domains compared to the other two classes.

For ease of interpretation, the latent class analyses were also re-run removing three variables from the model that did not show much differentiation between classes. These variables were number of pain regions reported (# of complaints), risk of metabolic syndrome (MetS), and aerobic capacity (VO2). Removing these variables did change the model fit statistics and percentage of the sample belonging to each class, however, the 3-class model again was identified as having the best fit using the previously described criteria. The following figure shows the model with these variables removed to better demonstrate the differentiation between classes.

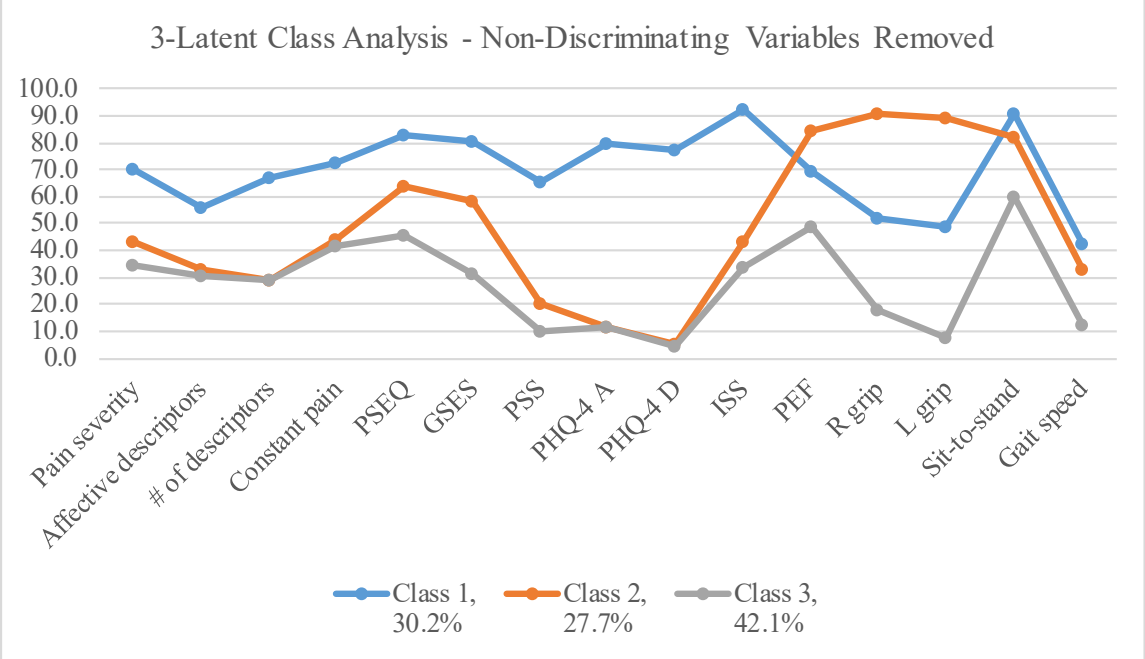


Figure 4.2: 3-Latent Class Analysis with Non-Discriminating Variables Removed

CHAPTER 5. DISCUSSION OF RESULTS

5.1 Descriptive Findings

5.1.1 Demographics and Social Determinants of Health

Differences between the clinical population of the PTPBC and the surrounding community were identified along the social determinants of health. The population of Guilford County, North Carolina, is estimated to be 50.5-55.8% White, 33.8-34.8% Black/African American, and 7.8-9.1% Latino/Latinx.[21,228] The clinical population at the PTPBC was found to be more diverse, with 68.67% of patients reporting racial/ethnic backgrounds other than White. The rate of college graduation was lower than that of Guilford County (34.9%)[228] with only 16.48% of patients attending the PTPBC reporting having finished a college or technical degree. Guilford County unemployment is estimated at 4.8%[228] of the population which is 5.88% less than the percentage of patients reporting unemployment at the PTPBC (10.48%). Rates of food insecurity were higher in the clinical population (24.76%) compared to rates in Guilford County (17.8-19%).[21, 228] Current smoking status was also more common in the clinical population, with 27.5% reporting currently smoking compared to 19.0% in Guilford County.[228] Given the diversity of the clinical population of PTPBC, it will be important to consider differences in cultural beliefs as it relates to physical and emotional health as this can impact the provider/patient relationship as well as health outcomes.[229-231] It will also be beneficial to identify community partners to help guide patients who are unemployed or under-skilled in finding gainful employment or training opportunities to improve financial stability and quality of life. However, employment is also a larger societal issue as respondents to the

Guilford County Community Health Assessment identified a lack employment opportunities offering benefits and livable wages as well as a paucity of train-to-work or training-for-advancement opportunities by community employers to be barriers to career development.[21] While patients with food insecurity are able to use the PTPBC food pantry during their time at their clinic, part of discharge planning for this patient population will require that these patients be aware of other food pantry locations in the community for more sustainable access to food. Last, identification of local no-cost or low-cost smoking cessation programs within the community, particularly those taking into account the barriers of smoking cessation in lower socioeconomic groups,[232] is a priority to lower smoking rates of the PTPBC clinical population. In summary, improving access to health and wellness opportunities through pro bono services and referral to community partners can help reduce health inequities, however, advocacy at local, state, and national levels needs to occur to ensure that those resources exist for marginalized populations.

5.1.2 Measures of Emotional Health and Sleep

The prevalence of depression in the Piedmont region of North Carolina was estimated at 20.9% in 2019 using a survey asking respondents if they have been given the diagnosis of depression by a healthcare provider.[233] A recent survey of North Carolina by the National Center for Health Statistics asking about active symptoms of depression or anxiety estimated that the prevalence of depressive symptoms at 24.1% of the population and symptoms of anxiety at 32.1%.[234] Using the PHQ-4, potential depression was present in 28.64% of the clinical population at the PTPBC while potential anxiety was present in 33.01%. Therefore, prevalence of these mental health conditions was fairly similar

between these two populations using these measures. Still, given the association of emotional distress to pain,[115],[116,120] along with the barriers to mental health support in Guilford County,[21] identifying or establishing access to mental health care for those without resources is an important consideration for the PTPBC in improving quality of life for the patient population. Similarly, the lifetime prevalence of PTSD in the Piedmont region of North Carolina was estimated to be 1.30% of the population in the early 1990s,[235] while estimates nationally for lifetime prevalence are reported at 6.8%.[236] With nearly 20% of patients potentially having PTSD using the PC-PTSD-5 screening questionnaire, the prevalence of PTSD within the clinical population at the PTPBC may be much higher than the rest of the state. This is an interesting consideration for future lines of research given the potential discrepancy in PTSD prevalence between this population and the general population. Regarding perceived stress, the PSS-4 has been studied across a general sample of 1568 English subjects and a mean score of 6.11 (SD: 3.14) was identified.[237] The clinical sample at the PTPBC demonstrated a similar mean of 7.12 (SD: 3.14), demonstrating that the sample as a whole did not demonstrate higher levels of stress compared to a more general population.

Sleep disturbance has also been associated with the development and maintenance of pain.[118-120] In North Carolina, it is estimated that 32.5% of the population experience short sleep (< 7 hours).[238] In the PTPBC clinical population, 54.63% were identified as having potential sleep disturbance using a cut-off score of 10 or greater on the ISS.[183] Therefore, specific interventions to improve sleep quality and quantity is an important consideration in improving the health and wellbeing of the patients attending the clinic. Similarly, moderate to high risk of OSA was present in 53.76% of patients

attending the PTPBC. A 2007 study through the North Carolina Family Practice Research Network identified that 13-33% of 1935 patients reported symptoms of sleep apnea.[239] The potentially higher rates of OSA in the PTPBC, which is related to the higher rates of obesity, is of note not only due to the higher risk of development of other chronic diseases associated with OSA,[240,241] but also due to the potential barriers of being evaluated by a sleep specialist and the high cost of the equipment used to manage OSA for a patient population with lower socioeconomic status and lack of health insurance.

The GSES and the PSEQ have been studied in patients with chronic conditions and pain conditions. The full version of the GSES is 10-items with total scores ranging from 10- to 40-points,[197] with higher scores implying higher general self-efficacy. Mean scores for the GSES for patients with arthritis have been reported to range from 28.71(SD: 5.1) to 30.23 (SD: 4.8).[242] Other populations have been studied including those without impairment (28.77; SD: 5.37), college students (30.35; SD: 4.00), professional swimmers (30.45l SD: 4.98), patients with coronary heart disease (32.11; SD: 0.52), and patients with gastrointestinal diseases (28.61; SD 5.33).[243] Thus, mean scores on a 40-point scale ranged from approximately 28- to 32-points. Considering a score of 30-points, this would represent a patient selecting 20-points of the 30-points possible on the 10- to 40-point scale, or 66.67%. Using the short-form GSES, the 6-item tool scored from 6- to 24-points, revealed a mean score of 16.73 (SD: 3.69) for the patients attending the PTPBC. Rounding to 17-points, this would represent a patient selecting 11-points of the 18-points possible on the 6- to 24-point scale, or 61.11%, which is only slightly lower than the other populations. Similarly, the full version of the PSEQ has also been studied in populations with pain.[244,245] The full version of the PSEQ is a 10-item questionnaire

with a total score ranging from 0- to 60-points,[244] with higher scores implying higher pain self-efficacy. In two studies in populations with pain, Nicholas et al identified a mean score of 25.8 (SD: 12.4) and 20.7 (SD: 13.3).[244,245] Thus, of the available points, the mean subject selected approximately 43.33% and 35.0% of the available 60-points. Using the two-item PSEQ, the mean score of the patient population at the PTPBC was found to be 5.65 (SD: 3.60), or 47% of the available 12-points, demonstrating potentially higher pain self-efficacy compared to the Nicholas et al trials.

5.1.3 Physical Measures of Health

In the clinical population, obesity was present in 54.57% using BMI and 58.59% using WtHR, both of which are higher than the county estimates (30.6%) for obesity.[21] Regional estimates of the percentage of adults participating in at least 150 minutes of physical activity per week is 52.5% of the population.[21] Only 20.35% of the clinical population attending the PTPBC reported exercising 4-7 days per week. In North Carolina, it is estimated that 32.2-34.7% of the population has been diagnosed with hypertension.[246] The clinical population at the PTPBC demonstrated much higher rates with 58.41% presenting with stage I hypertension or higher and 24.56% being prehypertensive. A study performed of 217,056 individuals attending the Carolinas HealthCare System's facilities in North Carolina in 2014 found that 22.5% of this population was diagnosed with MetS using the National Cholesterol Education Program Adult Treatment Panel III criteria.[247] While laboratory confirmed MetS was not captured in the clinical population at the PTPBC, 50.11% were at risk of MetS based on the non-invasive model reported by Romero-Saldaña et al[161] potentially demonstrating a higher rate of MetS. Compared to published normative values, much of the clinical population

also scored below normative values on the measures of physical health. In regards to cardiovascular and pulmonary health, peak expiratory flow rate was measured below normal in 64.72%[164,165,205] of the sample and aerobic capacity was estimate to be fair or worse in 53.25%.[169] Functional musculoskeletal measures included grip strength, the 30-second sit-to-stand test, and the two-minute walk test. Right grip strength was below normative values in 48.16% of the sample and left grip strength was low in 42.42%.[206-208] Approximately 75% of the sample did not meet the expected repetitions on the 30-second sit-to-stand test[178] and nearly all subjects (92.06%) were measured to have lower than expected scores on the two-minute walk test.[209] Between measures of blood pressure, body mass, cardiovascular and pulmonary function, and musculoskeletal functional measures, there appears to be a large need for health and wellness opportunities for this patient population. Remembering the perceived barriers to regular exercise for Guilford counties include not having safe and affordable facilities along with not knowing how to begin exercising,[21] initiatives for the PTPBC to develop exercise and wellness options for the community to engage with beyond the physical therapy plan of care can be an area to make a significant impact on improving health disparities.

5.1.4 Comparison to Other Pro Bono Physical Therapy Clinics

Creps et al assessed the demographics and chronic health conditions of a sample of 29 patients aged 18-years and older attending a student-run pro bono physical therapy clinic in Michigan, United States.[248] Ten subjects reported their sex to be female (34.5%) and 48.2% of the sample were between the ages of 45- and 64-years.[248] Measured blood pressures found that 82.8% of the sample registered readings greater than 120/80 mmHg, with 31.0% fulfilling the criteria for stage I hypertension and 6.9% meeting the criteria

for stage II hypertension.[248] Depression was self-reported by 20.7% and difficulty sleeping by 75.9%.[248] Measures of BMI found that 24.1% of the sample was overweight and 37.9% had a BMI of 30-39.9 (obese).[248] No patients were measured to have a BMI greater than or equal to 40.[248] Comparatively, the population sampled at the PTPBC had a higher representation of the female sex (61.8%), higher prevalence of stage II hypertension (36.1%), lower prevalence of depression as determined by the PHQ-4 (28.6%) and sleep difficulties as measured by the ISS (54.6%). Regarding BMI, approximately 27.0% of the sample was overweight, 40.0% obese (BMI 30.0 -39.9), and 14.6% with a BMI greater than or equal to 40.

Stickler et al similarly assessed a sample of 28 patients aged 20-69 years attending a student-run pro bono physical therapy clinic in Kansas, United States.[249] Over half (53.6%) of patients reported belonging to the female sex with 53.5% of patients falling within the age range of 40- to 59-years.[249] Unemployment was reported by 75% of the sample,[249] a much higher percentage than those at the PTPBC (10.5% unemployed; 10.7% disabled). Outcome measures collected included a numeric pain rating scale (0-10), a visual analog scale for quality of life (0-100), the Short Form-8 (SF-8) questionnaire mental and physical health subscales, and systolic and diastolic blood pressure.[249] At baseline, mean pain severity of the sample was rated at 7.8 and mean blood pressure was calculated to be approximately 135/85 mmHg,[249] which were similar to the higher pain severity reports and measured blood pressures at the PTPBC. After an average of three visits, significant differences ($p<0.05$) were found in follow up pain severity scores (7.8 to 3.7) and SF-8 physical health scores (32.71 to 36.88).[249] No significant differences were found in the visual analog scale for quality of life (58.13 to

61.31), SF-8 mental health (38.29 to 42.24), or blood pressure (approximately 135/85 mmHg to 134/85 mmHg).[249]

In summary, along with complaints in pain and function, many patients attending pro bono physical therapy clinics are also presenting with unmet needs in regards to physical, mental, and socioeconomic health. Therefore, as pro bono care grows in physical therapy settings, consideration must be placed on how to connect these patients to opportunities to address these domains of health and wellness to improve not just pain and function, but also quality and longevity of life.

5.1.5 Comparison to Other Pain Clinics

May et al assessed a clinical population of 935 patients attending a community-based multidisciplinary chronic pain clinic in British Columbia, Canada.[250] Regarding the demographics and social determinants of health for this group, the mean age was 49.5 (SD: 14.9), 69.1% reported sex as female, 27.9% were non-white, 56.3% were not employed full- or part-time, and 60.2% had not earned higher than a high school degree.[250] Mean age and sex were similar to the population at the PTPBC, however, fewer patients in the PTPBC were not working (21.2%), a greater number of patients were non-white (68.67%) and had not earned higher than a high school degree (83.5%).

Regarding pain characteristics, 93.5% of the sample attending the multidisciplinary chronic pain clinic reported a pain duration of greater than one year, with 51.1% describing pain in more than one area, and the most common primary areas of pain to be the lower back (25.2%), buttock/pelvis/hip (20.8%), head and jaw (14.7%), and neck (14.1%).[250] Pain severity (0-10) was rated greater than 4 (moderate-to-severe) in 84.3% of patients.[250] Patients at the PTPBC similarly had pain greater than 1-year in

duration (98.8%). Fewer patients reported moderate-to-severe pain (66.9%) and fewer had pain in more than one location (40.2%). Reports of axial pain were high (52.1%), followed by lower extremity symptoms (46.7%), and upper extremity symptoms (31.24%).

Assessing emotional health, 59.9% of patients at the multidisciplinary chronic pain clinic were classified as having moderate or severe depression using the Patient Health Questionnaire – 9.[250,251] Using the full Pain Self-Efficacy Questionnaire, [244] the mean of the sample was found to be 29.2 (SD: 13.56) out of 60 points.[250] Fewer patients at the PTPBC were identified as having any type of potential depression using the PHQ-4 (28.6%), however, a similar mean score of 5.65 (SD: 3.60) out of 12-points was found on the PSEQ 2-item questionnaire.

While there are similarities between the multidisciplinary chronic pain clinic and the PTPBC, many differences were also highlighted between the two populations. It is therefore important to perform descriptive research in each practice setting to best identify the needs of the patient population not only clinically but also within the surrounding community. Knowing the potential barriers to improving physical and emotional health can lead to more targeted interventions clinically and initiatives socially to address health inequities driving poorer health-related outcomes.

5.2 Findings from Regression Analysis

5.2.1 Predicting Metabolic Syndrome Risk

Through binary logistic regression, it was determined that systolic blood pressure and waist circumference were the main factors that predict whether someone is classified

as being "at-risk" for MetS risk or not. The model correctly predicted 87% of the cases, demonstrating a good fit, but the odds ratios were small. Intuitively, blood pressure and waist circumference should be main predictors of MetS risk because two of the five components of metabolic syndrome include blood pressure (>130/85) and waist circumference (≥ 89 cm for women, ≥ 102 cm for men).[31] Blood pressure and waist circumference were also likely found to be strong predictors as the criteria to determine MetS risk[161] in this study relied on measures of blood pressure and WtHR. Therefore, when screening for MetS in a clinical setting without access to laboratory testing, clinicians should continue to capture blood pressure, waist circumference, and height to best inform their clinical decision making. The other measures included in the model (sex, age, weight, BMI, hand grip strength, peak expiratory flow rate, predicted VO_2max, 30-second sit-to-stand test, two-minute walk test, fall risk, PHQ-4 anxiety score, PHQ-4 depression score, PSS-4 score, ISS score, and GSES-6 score) were not helpful in identifying those at risk for MetS. These measures can still be used to inform the clinician about the physical and emotional health status of the patient, but they will not add any additional insights regarding the patient's risk of MetS.

5.2.2. Differences Between Groups in Socioeconomic, Pain, and Emotional Health Measures

Race/ethnicity was marginally associated with MetS risk, meaning that patients identifying as Black/African-American had a greater chance of being classified as "at-risk" compared to patients identifying as White/non-Hispanic. Patients who used more medications were also more likely to be classified as being "at-risk" for MetS. In a previous study, patients taking the most number of medications also had the highest

systolic pressures and the largest BMI,[252] which reflects the criteria for MetS diagnosis. Conversely, smoking was found to be slightly protective against being classified as "at-risk" for developing MetS. This is congruent with other studies that have shown smoking to be protective against developing MetS,[253,254] in part due to the lower BMI and narrower waists in smokers compared to non-smokers.[255] Interestingly, there was no association between MetS risk and pain chronicity, pain severity, number of pain descriptors chosen, PSS-4 scores, PHQ-4 anxiety scores, PHQ-4 depression scores, ISS scores, and GSES-6 scores. Thus, the hypothesis that MetS risk would be an important variable to subgroup patients with pain complaints based on the shared physiological pathways and risk factors was not supported by this study. While identification of MetS risk remains an important clinical consideration for the physical health of the patient, within this sample and the included methods, MetS did not inform the pain experience of the patient.

5.2.2 Differences Between Groups in Physical Performance

While not diagnostic, physical performance measures were identified that differed between those that were classified as being "at-risk" for MetS and those that were not at risk. After adjusting for age and sex, those that were classified as "at-risk" for MetS had a predicted VO_2max of 27.8 compared to 29.2 mL/kg/min for those not at risk, a two-minute walk distance of 106 m compared to 117 m, and completed only 8.1 compared to 9.6 reps in 30-seconds for the sit-to-stand test. These adjusted values were ~10 to 20% lower compared to those that were not classified as being at risk for MetS. A recent review has shown that there is a strong link between physical activity, aerobic fitness, and the reduction in systolic blood pressure, improved lipid profiles, and reduction in

metabolic syndrome prevalence.[256] Therefore, it is expected that those "at-risk" for MetS would demonstrate lower scores in measures of cardiovascular and pulmonary health and musculoskeletal function.

5.3 Findings from the Latent Class Analyses

Latent class analysis identified three unique patient subgroups with distinguishing characteristics. Class-one was more likely to present with a greater pain experience (high pain severity, greater number and affective pain descriptors chosen, and pain constancy) along with greater psychosocial involvement (lower pain self-efficacy, lower general self-efficacy, higher stress, potential anxiety, potential depression, and potential sleep disturbance). Class-two demonstrated a less impactful pain experience and lower psychosocial involvement, but poorer scores on the physical health measures of peak expiratory flow rate and right and left grip strength. Class-three, similar to Class-two, demonstrated a less impactful pain experience and lower psychosocial involvement, but instead demonstrated better scores on physical health measures. Therefore, when hypothesizing strategies to maximize outcomes in each of the three classes, having a greater focus on the psychosocial variables potentially influencing the pain experience seems reasonable when managing a patient belonging to Class-one. Emphasizing cardiopulmonary fitness and musculoskeletal strength along with other musculoskeletal impairment would be a comprehensive approach to managing members of Class-two, and primarily focusing on musculoskeletal impairments to manage members of Class-three may be appropriate. Interestingly, MetS risk again was not a significant discriminating

variable in the latent class analysis, which does not support the hypothesis that MetS would be an important feature in subgrouping patients with pain complaints.

CHAPTER 6. SUMMARY, FUTURE DIRECTIONS, LIMITATIONS, CONCLUSION

6.1 Summary and Clinical Directions

In summary, analysis of descriptive statistics revealed many components of physical, emotional, and socioeconomic health that if addressed, could improve the quality and longevity of life in the patient population at the PTPBC. Compared to the general population, these indicators of poorer health were present as similar rates, or in many cases, higher rates in the clinical population. As it relates to the patient's pain experience, psychosocial factors such as pain and general self-efficacy, stress, anxiety, depression, and sleep disturbance appear to distinguish patients reporting greater pain severity, number of and affective pain descriptors used, and pain constancy. The risk of MetS was not an important distinguishing variable in regression analysis or latent class analysis in identifying patient subgroups that may need to be managed differently to promote better clinical outcomes. However, improving physical health measures remain an important consideration as pro bono physical therapy grows as often these clinics will serve as the main point of contact to healthcare for patients without health insurance. As medical providers, physical therapists must consider the whole health of the patient for intervention planning and triage, as well as creatively think about how to improve the organizational structure of pro bono clinics to improve patient outcomes.

Managing multiple aspects of a patient's health and wellness is an impossible task for a single provider based on scope of practice, time, and resources.[5,13] Thus, a multidisciplinary team is ideal to promote the best outcomes for the patient population. A review of organizational interventions to increase healthcare access and improve outcomes for vulnerable populations investigated the most effective approaches to deliver

multidisciplinary care.[257] The results of the 39 studies included in this review revealed that "formal integration of services", meaning patients are able to access multiple providers at one time/location, resulted in a reduction in hospitalizations, fewer emergency department admissions, and reduced the number of health care needs for the populations studied. This model appeared to out-perform non-centralized services requiring the coordination of a case worker or network of providers to facilitate referrals between multiple locations. Therefore, as the PTPBC grows to meet the needs of the clinical population, it will be important to integrate additional health and wellness providers into the clinic so that patients can consult with the necessary professionals at one point-of-service. Similarly, opportunities for physical therapists from the PTPBC to consult with patients in the clinics of our community partners will also help move toward a more integrated care model for the shared clinical population.

While access to quality medical and mental health care is paramount to manage many comorbidities seen in the clinical population at the PTPBC, it is also important to provide the clinical populations access to quality health and wellness opportunities to improve quality of life. In particular, modification to diet, exercise habits, sleep patterns, and breathing practices can have a significant impact on many of the physical and emotional health measures explored in this study.

Many dietary approaches to improve health exist which can create confusion as to which dietary guidelines are the best to follow. A recent meta-analysis reviewed 14 named diets: Atkins, Biggest Loser, DASH, Jenny Craig, Mediterranean, Ornish, Paleolithic, Portfolio, Rosemary Conley, Slimming World, South Beach, Volumetrics, Weight Watchers, and Zone.[258] Across all diets, there was "moderate-certainty" evidence

that at 6-months, modest reduction in body weight and substantial changes in SBP and DBP could be achieved.[258] There was little difference between diets regarding these outcomes, therefore it appears personal preference for diet can be weighted more heavily than the perceived efficacy when selecting one named diet program over another.[258] However, with all the named diets, a regression to baseline body weight and blood pressure was noted at 12-months.[258] The authors cited that adherence to the diet programs was usually not reported and therefore the trend back to baseline may be explained by subjects not fully adhering to the dietary guidelines. The recently updated Dietary Guidelines for Americans, 2020-2025, recommend nutrient-dense foods within calorie limits that include vegetables of all types, fruits, grains (particularly whole grains), dairy (particularly no- and low-fat), lean animal- and plant-based proteins, and healthy oils.[259] Added sugars, saturated fat, sodium, and alcoholic beverages are limited in these guidelines. Emphasis is also placed on customizing choices "to reflect personal preferences, cultural traditions, and budgetary considerations."[259] Therefore, consulting with a nutritional expert to navigate the options and personalize a dietary strategy can promote early adherence to dietary habits. In order to maintain adherence to any particular diet, it would be reasonable to have multiple patient interactions over a long period of time to support motivation and address the individual needs of each patient. Trained support staff or student volunteers could use telehealth or virtual platforms to have scheduled check-ins with the patient, using strategies to support motivation or identify when another visit with the appropriate provider is indicated.

Multiple options to engage in physical activity also exist, again making it difficult for a patient to know where and how to start.[21] The Department of Health and Human

Services released the second-edition of the Physical Activity Guidelines for Americans in 2018.[225] The goal of the physical activity guidelines is to recommend the proper dosage of exercise that optimizes the physical and mental benefits of exercise including reduced mortality, lowered risk of chronic disease, improved ability to perform daily tasks, improved sleep, and reduced risk of depression, anxiety, and dementia.[225] Using these metrics, 150-minutes to 300-minutes of moderate-intensity aerobic, or, 75-minutes to 150-minutes of vigorous-intensity aerobic activity per week is recommended.[225] Exercising beyond these time frames does provide further health benefits, however, the dose-response relationship diminishes once exceeding 300-minutes of moderate- or 150-minutes of vigorous-intensity aerobic activity.[225] Along with aerobic activity, strength training is also recommended to be performed two-days per week, targeting the major muscle groups.[225] According to Cochrane reviews, exercise as an intervention for pain conditions such as fibromyalgia,[260-262] non-specific low back pain,[263-266] and neck pain[267] may be a beneficial, however, more high-quality studies are necessary. Yet, emerging evidence is indicating that the symptomatic improvements seen in these conditions with exercise may not be due to improvement of physical health measures such as body weight. In patients with knee osteoarthritis, "moderate-credibility" evidence demonstrated that weight-loss interventions alone were not more effective than exercise only for pain and disability.[268] While improving physical health measures is still important to improving quality and longevity of life, exercise is also of particular focus in patients with musculoskeletal conditions due to other physiologic mechanisms that can reduce pain symptoms. The term, "exercise-induced hypoalgesia", has been coined to capture the mechanisms of pain reduction with physical training.[269-271] Mechanisms of

aerobic and strengthening exercise-induced hypoalgesia include activation of central endogenous opioid and serotonin pathways, as well as reducing inflammatory cytokines and increasing anti-inflammatory cytokines.[272-274] These mechanisms support a reduction in pain symptoms along with any added benefit from improving cardiovascular or musculoskeletal fitness through exercise. Much like diet, in order to sustain the benefits of exercise, long-term adherence must be adopted by the patient. Given the benefits of exercise for physical health, emotional health, and pain, strategies to improve long-term exercise adherence has been of interest for researchers in both general populations and those with musculoskeletal complaints.[275-278] Briefly, evidence has shown that long-term adherence to exercise can be supported by individualizing programs, supervising sessions, offering booster sessions to review/revise programing, using motivational strategies, and properly grading exercise to match the patient's capabilities based on physical health and pain symptoms. This is also supported by the physical activity guidelines, which recommend people engage with any level of physical activity they are capable of based on their individual needs regardless of whether or not it meets the proposed guidelines.[225] Meta-analysis has also demonstrated that longer duration, low-intensity cardiovascular training can improve aerobic capacity to the same extent as shorter duration, high-intensity cardiovascular training,[279] thus making aerobic exercise to improve aerobic capacity more accessible to patients with pain interference. Again, using support staff and student volunteers to regularly engage with patients regarding physical activity and exercise adherence can promote more positive outcomes for the patients attending the PTPBC beyond the physical therapy plan of care.

Related to physical activity and exercise, breathing exercises can be an entry-point to pain control, health, and wellness for those particularly limited by musculoskeletal pain. Breathing exercise have been shown to reduce blood pressure, help with pain symptoms, and promote mental health.[280-283] Briefly, purported mechanisms for this include improved regulation of the autonomic nervous system as well as potential musculoskeletal improvements in mobility of the spine and rib cage, lung capacity, and control of postural/stabilizing musculature involved in respiration.[280,281,283-286] A meta-analysis investigating the use of voluntary slow breathing exercises found that SBP could be reduced by 6.36 mmHg (CI 95%: 10.32 to 2.39) and DBP by 6.39 mmHg (CI 95%: -7.30 to -5.49) in randomized controlled trials of 2-weeks to 6-months in duration.[282] While meta-analysis of breath therapy for patients with chronic nonspecific low back pain is underway,[287] previous studies in this population have demonstrated some improvements in pain, function, and quality of life.[280,288,289] However, breathing exercise prescription and length of follow-up are variable in available studies on blood pressure, pain, and mental health, making standardized treatment recommendations difficult. Much like diet and exercise, adherence is an important consideration for breathing practice as it relates to outcomes. Schmidt et al introduced a breathing intervention to patients with painful temporomandibular disorders or fibromyalgia.[283] Those who responded to this intervention demonstrated significant changes in autonomic function as well as self-report measures in the domains of fatigue and pain.[283] Interestingly, those who responded to the breathing intervention practiced on average 25-minutes per day, while those who did not responded practiced on average only 15-minutes per day.[283] Thus, adherence strategies need to be explored when promoting long-term outcomes for patients.

In regards to insomnia, management can be successful without pharmaceutical management through the use of sleep hygiene[290] and cognitive behavioral methods.[291] Sleep hygiene focuses on avoiding stimulating substances, such as caffeine and nicotine, in the hours preceding bed time.[290] It also encourages relaxing activities before bed, such as breathing exercises or warm baths, while avoiding stimulating activities, such as exercise, engaging television shows, books, or computer work.[290] Cognitive behavioral therapy for insomnia (CBT-i) incorporates sleep hygiene, but also promotes techniques to associate the bed with sleep only.[292] For example, no other activities, with the exception of sexual activity, are allowed while the patient is in bed. Sleep titration is another important component of CBT-i, which has the goal of making the time in bed nearly equal to the total sleep time.[292] To achieve this, the patient participates in sleep journaling to determine the amount of actual sleep they achieve per night versus the amount of time they are lying in bed. Once this is established, the amount of time in bed is prescribed as actual sleep time plus 30-minutes.[292] The goal is to improve sleep quality first, then slowly increase sleep quantity. If a patient is unable to improve sleep through sleep hygiene and CBT-i, referral for medical management is indicated.[293] The patient can work with his/her medical practitioner to choose the best pharmaceutical intervention based on characteristics such as medication half-life, side-effects, abuse risk, and dependence risk.[293] However, CBT-i has been recommended as the first-line treatment for insomnia by the American College of Physicians.[294] While poor sleep has been demonstrated to be a risk factor for pain,[118-120,295] disease,[296-298] anxiety,[95] depression,[95-97] hypertension,[98,99] and obesity,[93,94] the impact of improving sleep on these comorbidities remains understudied.

To summarize, in order to improve physical health, mental health, and pain and functional outcomes, the PTPBC will need to integrate on-site physical and mental health providers into the physical therapy plan of care as well as establish our physical therapy providers in the community pro bono medical clinics so that patients can access multiple providers during a visit to the clinic. Efforts of the physical and mental health providers can be supported through programming to assist patients with developing dietary, physical activity, breathing, and sleep habits along with structured patient engagement initiatives to promote adherence in these domains to promote health and wellness. By doing so, an environment can be created to best support our clinical population, while also reducing the burden on a single healthcare provider by distributing care and engagement across multiple professionals and support staff.

6.2 Future Research Directions

Identifying the need for additional physical and mental health care management opportunities for this clinical population, future research is needed on implementation strategies for integrated care as well as the resultant outcomes across domains of pain, physical health, emotional health, and quality of life. For example, if a patient with chronic pain presents with severely limiting pain and symptoms of depression and anxiety, similar to Class-one identified in this study, should the initial focus be working with a mental healthcare provider before addressing needs in physical therapy, physical fitness, and nutrition? Or, should all of these services be introduced concurrently? Based on patient subgrouping, it may be that certain aspects of health and wellness require greater emphasis initially to achieve outcomes across health domains in those specific

populations. In other terms, sequencing of interventions and the emphasis placed on those interventions may prove to be important in optimizing patient outcomes, as asking the patient to make multiple changes in lifestyle at once may be overwhelming. Similarly, within the domain of physical fitness itself; if a patient presents to the clinic with pain complaints and low cardiovascular and musculoskeletal fitness, similar to Class-two in this study, should exercise prescription initially include aerobic exercise, strength training, motor control, and breathing training? Or, are outcomes improved when one is introduced at a time? Direction on the prioritization of interventions, particularly for unique patient subgroups, is needed. This would develop models for interdisciplinary care and define patient pathways that then could be adopted by other clinics as well.

As mentioned, adherence to lifestyle changes are necessary to maintain health and wellness. Therefore, strategies to improve adherence are another research target. Using approaches to patient engagement such as telehealth, virtual check-ins, or automated surveys/texts/emails, determining the proper amount of contact that keeps the patient engaged without overburdening the patient is of interest. Likely, there will be different patient groups with specific preferences about how much contact is appropriate and therefore identifying these subgroups is important to tailor communication approaches to the patient. Similarly, when connecting with patients remotely, monitoring objective indicators that suggest the patient should return to the clinic for follow-up with a physical or mental health provider would be useful along with patient report. For example, psychosocial status could be monitored using the PSS-4, PHQ-4, and ISS, while physical health monitoring could include blood pressure, BMI/WtHR, and 30-second sit-to-stand test, or other psychosocial or physical health measures not investigated in this study.

Monitoring these measures over time may help identify changes that fall outside of normal variation, indicating a booster session with a healthcare professional is warranted. Again, determining the proper frequency of these screening tests will be important so that these measures can be meaningfully monitored without being burdensome to the patient.

6.3 Limitations

While the clinical population is of interest given the high prevalence of persistent pain, the uniqueness of this clinic compared to those within the healthcare system will limit external validity of the findings (e.g. an uninsured/minimally insured population versus an insured population), as there are likely large differences in the social determinants between these populations. The inclusion criteria for this study is intentionally broad to capture the heterogeneity of people with presenting to the clinic with pain, given the multifactorial causative factors demonstrated in the literature. Also, clinical data is not as well controlled compared to the laboratory setting. While protocols were in place to capture the included measures, the flow of the typical clinic day as well as being a training facility for student physical therapists can introduce error to the measurement. This has to be considered with interpreting the results of this study.

Also, while pain severity, chronicity, location, and description are important variables in capturing the pain experience, additional items such as pain interference[299] would have provided a much broader portrait of the effect of pain on the patient's functioning and measures of quality of life could have provided better insight to the patient's overall wellbeing. Also, including a tool such as the painDETECT[300] or the revised version of the Short-form McGill Pain Questionnaire (SF-MPQ-2)[301] which ask

more specific questions about the presence of neuropathic pain symptoms would have allowed for more accurate patient grouping based on pain neurophysiology, separating out those with features related to neuropathic pain which has a different underlying pathophysiologic mechanisms compared to musculoskeletal pain. Similarly, including clinical measures suggested by the Pain-Oriented Sensory Testing (POST) guidelines[302] to test for dynamic mechanical, punctate mechanical, pressure-evoked, and cold allodynia would help inform grouping based on pain neurophysiology.

Last, given that diagnosis of medical and mental health conditions fall outside of the scope of physical therapy practice, subjects were grouped by potential risk of these conditions rather than a more definitive diagnosis from medical or mental health provider. These measures included MetS, aerobic capacity, anxiety, depression, PTSD, OSA, and sleep disturbance. Having a diagnosis from a medical or mental health provider would allow for a better comparison of whether those with these conditions are significantly different from those without these conditions.

6.4 Conclusion

The first aim of this study was to statistically describe the population attending the PTPBC in the domains of socioeconomic, physical, and emotional health as well as pain complaints. This analysis identified that the majority of patients presented with long standing pain complaints, described a lower socioeconomic status, presented with comorbid emotional health conditions near or above the rate of the general population, and scored particularly poorly on physical health measures related to blood pressure, body mass, pulmonary function, and lower body strength and endurance. Thus,

improving the patient population's health and wellness in these domains can lead to improvements in quality and longevity of life.

The second aim of this study was to determine which physical and emotional health measures could be used to better inform MetS in a clinical setting without access to laboratory values. Only SBP and waist circumference were found to be predictive of MetS risk, therefore no novel measures to inform clinical reasoning were identified in this study. Practitioners should continue to use blood pressure and waist circumference/WtHR to screen for MetS risk when laboratory values are not available.

The third aim of this study was to determine if significant difference between groups existed between those "at-risk" for MetS and those not at risk. Given the similar physiology and risk factors between MetS and musculoskeletal pain, it was hypothesized that those "at-risk" for MetS would demonstrate poorer scores in the domains of physical health, emotional health, and pain. Ultimately, there was only an approximate 10-20% in scores on select physical health measures between groups. No additional meaningful differences were discovered, meaning that MetS risk was not a useful subgrouping to inform the patient's pain presentation using the measures included in this study with this clinical population

The final aim of this study was to identify unique patient subgroups within the sample that may require a more tailored plan of care based on needs. Using latent class analyses, three groups were identified. The only group presenting with a high pain experience using the domains used in this study was Class-one, which also demonstrated greater emotional health involvement. Class-two and Class-three presented with a lower pain experience, with Class-two demonstrating poorer pulmonary function and upper

extremity strength than Class-three. Thus, in regards to pain, emotional health may impact the patient's pain presentation greater than physical health.

In conclusion, many opportunities to improve the physical, emotional, and socioeconomic health of the population attending the PTPBC. Novel methods to clinically determine MetS in absence of laboratory values were not discovered and MetS risk was not identified as a useful strategy to subgroup patients with pain complaints attending the clinic. While measures of physical health and emotional health are useful in measuring the health status of the patient, poorer scores on emotional health measures were more often in present in patients describing a greater pain experience in this sample. Therefore, while employing strategies to raise the physical, emotional, and socioeconomic health of the clinical population can support increased quality and quantity of life, addressing emotional health may most greatly impact pain outcomes.

APPENDICES

APPENDIX 1. INTAKE QUESTIONNAIRE

Physical Therapy Intake Questionnaire

Date: _____ Patient Name: _____

Street Address: _____

Telephone: _____ City: _____ Zip Code: _____

Age: _____ Date of Birth: _____ Sex: [ ] Male [ ] Female [ ] Other

Marital Status: [ ] Single [ ] Married [ ] Divorced [ ] Widowed [ ] Civil partner

Number of persons living in your home: _____

Do you feel you have good support? [ ] Yes [ ] No

Are you presently employed: [ ] Yes, [ ] full-time [ ] part-time

[ ] No, [ ] unemployed [ ] disabled [ ] retired

What do you do or what did you do? _____

Highest level of education: [ ] Did not complete high school [ ] High school/GED [ ] Some college

[ ] Bachelor's or technical degree [ ] Some postgraduate [ ] Master's degree

[ ] Advanced academic or clinical graduate degree

How did you hear about our clinic? _____

Did someone suggest you come here? [ ] Yes [ ] No

If so, who? _____

Is this the first time you have seen a healthcare provider for this problem in North Carolina?

[ ] Yes [ ] No

If you have seen a physical therapist, did you think physical therapy was helpful? [ ] Yes [ ] No

Please explain: _____

_____

How did you get to the clinic today (drove, got a ride, bus, etc.)? _____

Do you **typically**: [ ] Drive [ ] Take the bus [ ] Rely on friends for your transportation

Do you believe that you may have difficulty with reliable ways to get to the clinic? [ ] Yes [ ] No

What is your preferred language? _____ What is your birth country? _____

What do you consider your race? _____

What do you consider your ethnicity? _____

Do you have health insurance? [ ] Yes Name: _____ [ ] No

If yes, did you run out of physical therapy visits? [ ] Yes [ ] No If Yes, when? _____

Do you use the orange card? [ ] Yes [ ] No

What brings you in today? _____

When did this begin? _____

How did it begin? _____

What is the usual severity of your pain? (Circle the appropriate number)

|_____|

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

No pain Extreme pain

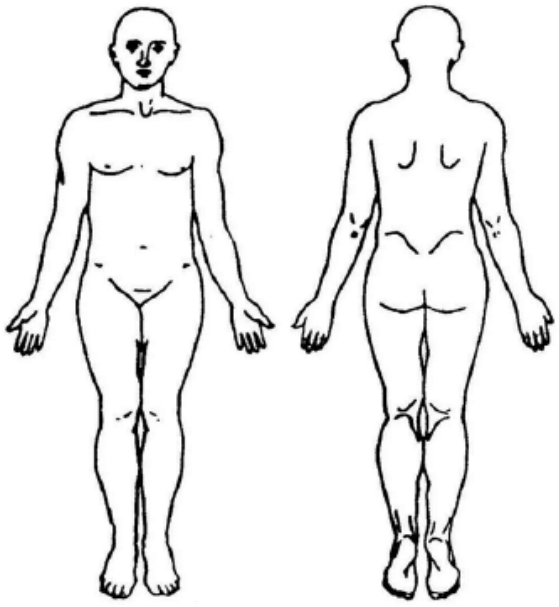
Describe the way your pain typically feels: (please check all that apply)

[ ] Throbbing	[ ] Gnawing	[ ] Splitting	[ ] Shooting
[ ] Hot/Burning	[ ] Tiring/Exhausting	[ ] Stabbing	[ ] Aching
[ ] Sickening	[ ] Sharp	[ ] Heavy	[ ] Fearful
[ ] Cramping	[ ] Tender	[ ] Punishing/Cruel	[ ] Other_____

On the diagrams below, please mark the areas where you feel pain:

How long does the pain typically last?

What time of day is the worst?



[ ] Less than 1 minute	[ ] 6-12 hours	[ ] Early morning
[ ] 1-10 minutes	[ ] 13-24 hours	[ ] Mid-day
[ ] Less than 1 hour	[ ] Several days	[ ] Evening
[ ] 1-5 hours	[ ] Constant	[ ] At night, wakes me up

How many days during the past month did you have the pain? _____ days

What makes the pain worse? _____

_____

What do you do to manage your pain? (mark all that apply)

[ ] Home remedies _____

[ ] Over the counter medications _____

[ ] Hot packs [ ] Cold packs [ ] Prayer [ ] Exercise [ ] Changing my thinking

[ ] Other _____

What do you think physical therapy can do to help you make your pain better? _____

_____

Check any of the following that you experience associated with this problem:

[ ] Numbness/tingling	[ ] Weakness	[ ] Heart racing in your chest
[ ] Earache	[ ] Ringing/buzzing in the ears	[ ] Nausea/vomiting
[ ] Ear stuffiness	[ ] Dizziness/lightheadedness	[ ] Fever/chills/sweats
[ ] Eye redness or tearing	[ ] Morning stiffness	[ ] Heartburn/indigestion
[ ] Fatigue	[ ] Changes in taste	[ ] Difficulty swallowing
[ ] Aches and pains all over	[ ] Changes in vision	[ ] Urinary incontinence
[ ] Night sweats	[ ] Changes in hearing	[ ] Difficulty urinating
[ ] Difficulty breathing	[ ] Swelling	

[ ] Other(s):

_____

_____

_____

_____

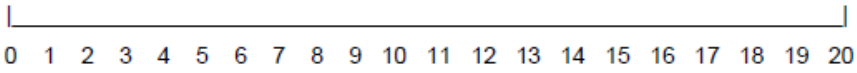
Who have you seen for this problem?

Name	Type of Practitioner	Diagnosis	Treatment	Did it help?

Do you have headaches?

[ ] Yes [ ] No; **If no, skip the questions about headache.**

On average, how painful are your headaches?



Do you have headaches as often as once per week? [ ] Yes [ ] No

Do you have more than one type of headache? [ ] Yes [ ] No

Does your headache wake you up at night? [ ] Yes [ ] No

Does the headache cause nausea/vomiting? [ ] Yes [ ] No

Does the headache cause changes in vision? [ ] Yes [ ] No

Does the headache cause light/sound sensitivity? [ ] Yes [ ] No

What relieves the headache? _____

END OF HEADACHE QUESTIONS

Please answer the following:

Have there been times in the last 12 months when you and your family did not have the food you needed or the resources necessary to purchase food? [ ] Yes [ ] No

Would you need access to a food pantry at this time? [ ] Yes [ ] No

Would you be interested in access to a community garden? [ ] Yes [ ] No

Do you know the "Five (5) a day" nutrition guidelines? [ ] Yes [ ] No

If yes, what does that mean: _____

For each of the below, write in the average number you drink per day:

Regular coffee ____ cups/day Alcoholic beverage _____ drinks/day

Sweet tea _____ cups/day Regular soft drink _____ cans/bottles/day

Natural tea _____ cups/day Diet soft drink _____ cans/bottles/day

Decaf tea _____ cups/day Water _____ cups/day

High energy drinks _____ /day Fruit juice _____ cups/day

Latte, espresso, other café drinks _____ /day Other: _____ _____ servings/day

Please answer the following:

Do you exercise? [ ] Yes [ ] No

What do you do for exercise _____

_____

Does your neighborhood have sidewalks? [ ] Yes [ ] No

How often do you exercise?

[ ] 0 to 1 time per week [ ] 2 to 3 times per week [ ] 4-6 times per week [ ] Daily

How hard do you exercise (select "Take it easy" if you do not exercise)?

[ ] Take it easy [ ] Moderately hard [ ] Heavy breath and sweating [ ] Push near exhaustion

How long do you exercise?

[ ] 30 minutes or less [ ] Greater than 30 minutes

What are the benefits of walking? _____

Do you know the physical activity guidelines? [ ] Yes [ ] No

If yes, what are they? _____

General Medical History

Please check the box for any condition which you have or have had in the past

Cardiovascular
[ ] Congestive heart failure
[ ] Heart attack
[ ] Chest pain
[ ] High blood pressure
[ ] Heart murmur
[ ] Mitral valve prolapse
[ ] Rheumatic fever
[ ] Congenital heart defect
[ ] Artificial heart valve
[ ] Arrhythmia(s)
[ ] Pacemaker or defibrillator
[ ] Coronary bypass
[ ] Angioplasty
[ ] Heart transplant
[ ] Dizzy when standing from sitting
[ ] Other: _____

Hematologic
[ ] Blood transfusion
[ ] Anemia
[ ] Hemophilia
[ ] Leukemia
[ ] Sickle cell anemia
[ ] Tendency to bleed longer than normal
[ ] Other: _____

Neurologic
[ ] Vision problems
[ ] Glaucoma
[ ] Earache
[ ] Ringing in ears
[ ] Hearing loss
[ ] Severe headaches
[ ] Fainting/dizzy spells
[ ] Stroke
[ ] Epilepsy or seizure
[ ] Panic attack

Gastrointestinal
[ ] Stomach/intestinal ulcers
[ ] Colitis
[ ] Irritable bowel syndrome
[ ] Persistent diarrhea
[ ] Hepatitis
[ ] Liver disease
[ ] Yellow jaundice
[ ] Cirrhosis
[ ] Eating disorder
[ ] Gastric acid reflux
[ ] Other: _____

Pulmonary
[ ] Hay fever
[ ] Sinus trouble
[ ] Allergies/hives
[ ] Asthma
[ ] Chronic cough
[ ] Emphysema
[ ] Chronic bronchitis
[ ] Tuberculosis (TB)
[ ] Breathing difficulties
[ ] Sarcoidosis
[ ] Other: _____

Dermal/Musculoskeletal
[ ] Allergy to latex (rubber)
[ ] Skin rash
[ ] Dark mole(s)
[ ] Change mole(s) appearance
[ ] Osteoarthritis
[ ] Rheumatoid arthritis
[ ] Systemic lupus
[ ] Artificial joint(s)
[ ] Fibromyalgia
[ ] Chronic fatigue syndrome
[ ] Scleroderma
[ ] Sjögren's syndrome
[ ] CRPS

Endocrine
[ ] Diabetes
[ ] Thyroid disease
[ ] Taking steroid medications
[ ] Hormone replacement therapy
[ ] Other: _____

Genitourinary
[ ] Urinate frequently
[ ] Kidney or bladder problem
[ ] Dialysis
[ ] Kidney transplant
[ ] Sexually transmitted disease
[ ] HIV positive
[ ] Multiple sexual partners
[ ] Interstitial cystitis
[ ] Endometriosis

Other Conditions
[ ] Anxiety disorder
[ ] Depression
[ ] Frequent sore throats
[ ] Enlarged lymph nodes/glands
[ ] Use alcohol
[ ] Use tobacco
[ ] Use injectable drugs
[ ] Drug/alcohol addition
[ ] Tumor or cancer
[ ] Radiation therapy
[ ] Chemotherapy
[ ] Sleep apnea
[ ] Snoring
[ ] Observed not breathing during sleep
[ ] Daytime time tiredness, sleepiness, or fatigue
[ ] Other, please list:
_____
_____
_____

Please list any diseases that run in your family (cancer, diabetes, heart disease, etc.) and who in your family has/had those diseases:

_____

_____

Please list any allergies:

_____

_____

Please list any surgeries or treatments (type and date) unrelated to the current problem:

_____

_____

Which tests have you had for the problem?

[ ] X-rays [ ] CT scan [ ] MRI [ ] EMG [ ] Blood tests

[ ] Other _____

_____

Please provide any additional comments you feel are important for the physical therapist to know about your health:

_____

_____

Please list any current or recently tried medications:

Name of Medication	Reason for taking	Dosage	How long have you been taking it?	What side effects does it cause?

Please rate how confident you are that you can do the following things at present:

I can do some form of work, despite the pain ("work" includes housework and paid/unpaid work).

[ ] 0 [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ]5 [ ] 6

Not at all confident — Completely Confident

I can live a normal lifestyle, despite the pain.

[ ] 0 [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ]5 [ ] 6

Not at all confident — Completely Confident

Please choose the best answer – In the last month:

How often have you felt that you were unable to control the important things in your life?

[ ] Never [ ] Almost Never [ ] Sometimes [ ] Fairly Often [ ] Very Often

How often have you felt confident about your ability to handle your personal problems?

[ ] Never [ ] Almost Never [ ] Sometimes [ ] Fairly Often [ ] Very Often

How often have you felt that things were going your way?

[ ] Never [ ] Almost Never [ ] Sometimes [ ] Fairly Often [ ] Very Often

How often have you felt difficulties were piling up so high that you could not overcome them?

[ ] Never [ ] Almost Never [ ] Sometimes [ ] Fairly Often [ ] Very Often

Over the past 2 weeks, have you been bothered by these problems?

Feeling nervous, anxious or on the edge? [ ] No [ ] Several days [ ] Most days [ ] Nearly every day

Not being able to stop/control worrying? [ ] No [ ] Several days [ ] Most days [ ] Nearly every day

Feeling down, depressed, or hopeless? [ ] No [ ] Several days [ ] Most days [ ] Nearly every day

Little interest or pleasure in doing things? [ ] No [ ] Several days [ ] Most days [ ] Nearly every day

Thoughts that you would be better off dead or hurting yourself in any way? [ ] Yes [ ] No

Please answer the following:

Have you experienced a traumatic event (serious accident; fire; disaster such as a hurricane, tornado, or earthquake; physical or sexual attack or abuse; war; homicide; or suicide)? [ ] Yes [ ] No

If yes, in the past month, have you:

Have had nightmares about it or thought about it when you did not want to? [ ] Yes [ ] No

Tried hard not to think about it or went out of your way to avoid situations that reminded you of it? [ ] Yes [ ] No

Were constantly on guard, watchful, or easily startled? [ ] Yes [ ] No

Felt numb or detached from others, activities, or your surroundings? [ ] Yes [ ] No

Felt guilty or unable to stop blaming yourself or others for the event(s) or any problems the event(s) may have caused? [ ] Yes [ ] No

Please rate your current (i.e. last two weeks) quality of sleep:

Difficulty falling asleep?

[ ] None [ ] Mild [ ] Moderate [ ] Severe [ ] Very Severe

Difficulty staying asleep?

[ ] None [ ] Mild [ ] Moderate [ ] Severe [ ] Very Severe

Problems waking up too early?

[ ] None [ ] Mild [ ] Moderate [ ] Severe [ ] Very Severe

How satisfied/dissatisfied are you with your current sleep pattern?

[ ] Very Satisfied [ ] Satisfied [ ] Moderately Satisfied [ ] Dissatisfied [ ] Very Dissatisfied

How noticeable to others do you think your sleep problem is in terms of impairing your quality of life?

[ ] Not noticeable at all [ ] A little [ ] Somewhat [ ] Much [ ] Very much Noticeable

How worried/distressed are you about your current sleep problem?

[ ] Not worried at all [ ] A little [ ] Somewhat [ ] Much [ ] Very much worried

To what extent do you consider your sleep problem to interfere with your daily functioning (i.e. daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, etc.)?

[ ] Not interfering at all [ ] A little [ ] Somewhat [ ] Much [ ] Very much interfering

Please select the best answer:

If someone opposes me, I can find means and ways to get what I want.

[ ] Not at all true [ ] Hardly true [ ] Moderately true [ ] Exactly true

It is easy for me to stick to my aims and accomplish my goals.

[ ] Not at all true [ ] Hardly true [ ] Moderately true [ ] Exactly true

I am confident that I could deal efficiently with unexpected events.

[ ] Not at all true [ ] Hardly true [ ] Moderately true [ ] Exactly true

Thanks to my resourcefulness, I know how to handle unforeseen situations.

[ ] Not at all true [ ] Hardly true [ ] Moderately true [ ] Exactly true

I can remain calm when facing difficulties because I can rely on my coping abilities.

[ ] Not at all true [ ] Hardly true [ ] Moderately true [ ] Exactly true

No matter what comes my way, I'm usually able to handle it.

[ ] Not at all true [ ] Hardly true [ ] Moderately true [ ] Exactly true

Please rate the following:

How often do you have problems learning about your medical condition because of difficulty understanding written information?

[ ] Always [ ] Often [ ] Sometimes [ ] Occasionally [ ] Never

How often do you have someone help you read hospital/medical materials?

[ ] Always [ ] Often [ ] Sometimes [ ] Occasionally [ ] Never

How often do you have a problem understanding what is told to you about your medical condition?

[ ] Always [ ] Often [ ] Sometimes [ ] Occasionally [ ] Never

How confident are you filling out medical forms by yourself?

[ ] Not at all [ ] A little bit [ ] Somewhat [ ] Quite a bit [ ] Extremely

Please answer the following:

Do you currently smoke? [ ] Yes [ ] No If yes, how much? _____ pack(s)/day for _____ years

Did you smoke in the past? [ ] Yes [ ] No

If yes, what year did you quit? _____

In the past, how much did you smoke? _____ pack(s)/day for _____ years

Have you fallen in the past year?

[ ] Yes [ ] No

Do you feel unsteady when standing or walking?

[ ] Yes [ ] No

Do you worry about falling?

[ ] Yes [ ] No

By signing below, I certify all the information contained in these forms is true and correct to the best of my knowledge. I understand that a false statement may disqualify me from treatment at this clinic:

_____ _____

Name Date Clinic Witness Date

APPENDIX 2. INITIAL EXAMINATION DATA FORM

Name: Date:

Date of Birth:

Pro Bono Physical Therapy Clinic Examination – Initial Examination Data Form

Patient Specific Functional Scale

	Unable										No Difficulty
Activity	0	1	2	3	4	5	6	7	8	9	10
1.											
2.											
3.											

Total: _____ /30 Average: _____ /10

Round to the first decimal place, ex. 35.46 would become 35.5):

Temperature: _____ F
Blood pressure: _____ /_____mmHg **Category:** _____
Resting HR (30 sec): _____ bpm **Category:** _____
SpO2: _____
Weight: _____ kg_____ lbs
Height: _____ cm; _____ in
BMI: _____ **Category:** _____
Waist: _____ cm; _____ in
Waist/height ratio: _____ **Category:** _____
Neck: _____ cm; _____ in
STOP BANG: _____ /8 **Category:** _____
Metabolic Syndrome _____ /2
Peak expiratory flow: _____ L/min **Category:** _____
Predicted VO2max: _____mL/kg/min **Category:** _____

STOP BANG

- ☐ Snore loudly (heard through closed door)
- ☐ Feel tired, fatigued, or sleepy during daytime
- ☐ Observed stopped breathing during sleep
- ☐ Have high blood pressure
- ☐ BMI ≥ 35
- ☐ 50 years or older
- ☐ Neck ≥ 41 cm
- ☐ Male

Risk Scoring Cutoff:
High ≥ 5, Intermediate 3-4, Low 0-2

Metabolic Syndrome Checklist

- ☐ Waist-to-height ratio ≥ 0.56?
- ☐ Blood pressure ≥ 128/80?

Positive if both criteria are met.

Fall Risk Screening Questions

- ☐ Answered "yes" to ≥ 1 intake question

Or:

- ☐ 30-sec sit-to-stand: men < 14, women < 12
- ☐ None

Functional Examination:

Grip strength
Right: _____ kg; _____ lbs **Category:** _____
Left: _____ kg; _____ lbs **Category:** _____

30-second Sit-to-Stand
Number of reps: _____
Fall risk: Intake ☐ Yes ☐ No; Sit-to-stand ☐ Yes ☐ No
Overall fall risk: ☐ Yes ☐ No

2 min. Walk Test (120 seconds)
Distance: _____ ft; _____ m; Gait speed _____ meters / seconds **Category:** _____

Mechanical Detection Threshold
Most painful site: _____
Ascending – first monofilament detected: _____ g
Descending – last monofilament detected: _____ g
Geometric mean: _____ g
Allodynia with monofilament testing? ☐ Yes at ____ g ☐ No

Metabolic Syndrome: ☐ Yes ☐ No Protective sensation (10 g)? ☐ Yes ☐ No. If no, where? _____

_____

Name: Date:

Date of Birth:

Medication	Drug class	Patient spelling of medication

*Place a "star" next to any medication not listed on the drug class lists

Total number of medications listed: _____

Total number of pain descriptors selected: _____

Total number of associated symptoms selected: _____

Pain (circle): **Regional** or **Generalized**

"What brings you in today?" (Check one)

Pathoanatomic description (disk bulge, arthritis, etc.) _____ Symptom description _____

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VITA

Garrett S. Naze, PT, DPT, OCS, CCTT, NBC-HWC, FAAOMPT

EDUCATION / DEGREES AWARDED

- Doctor of Physical Therapy, Marquette University, Milwaukee, WI: May 2009
- BS Exercise Science, Marquette University, Milwaukee, WI: December 2007

PROFESSIONAL POSITIONS HELD

- Clinical Assistant Professor, High Point University, High Point, NC: Nov. 2017 to Present
- Physical Therapist, University of Kentucky Orofacial Pain Clinic, Lexington, KY: July 2014 to Nov. 2017
- Adjunct Instructor in Physical Therapy, Elon University, Elon, NC: Nov. 2013 to Dec. 2013
- Clinical Assistant Professor, Carroll University, Waukesha, WI: Sept. 2012 to Sept. 2013
- Physical Therapist, Bellin Health, Green Bay, WI: Jan. 2012 to Aug. 2012
- Physical Therapist (Fellowship), University of Illinois at Chicago, Chicago, IL: July 2010 to Jan. 2012
- Physical Therapist (Residency), University of Wisconsin Hospitals and Clinics, Madison, WI: June 2009 to June 2010

SCHOLASTIC AND PROFESSIONAL HONORS

- Cum Laude, Doctor of Physical Therapy, Marquette University, Milwaukee, WI: May 2009
- Fellow of the American Academy of Orthopaedic Manual Physical Therapists: since June 2010
- Board-Certified Clinical Specialist in Orthopaedic Physical Therapy, American Board of Physical Therapy Specialties: since July 2012
- Board-Certified Cervical and Temporomandibular Therapist, Physical Therapy Board of Craniofacial & Cervical Therapeutics: since June 2018
- National Board Certified Health and Wellness Coach, National Board for Health & Wellness Coaching: since July 2019

PROFESSIONAL PUBLICATIONS

- Wright A, **Naze G**, Emerson-Kavchak A, Paul D, Kenison B, Hegedus E. Variables associated with progression of femoroacetabular impingement of the hip: a systematic review. J Sci Med Sport. 2015;18(2):122-7.
- Platt KM, Welleford, AS, **Naze GS**, Hatcher AR. Hatcher. Embracing your Eureka Moments: Perspectives on Fostering Impactful and Innovative Teaching Styles. The Journal of Faculty Development. 2017;31(3):87-94.

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