Editorial

Establishing a theoretical basis for research in musculoskeletal epidemiology: a proposal for the use of biopsychosocial theory in investigations of back pain and smoking

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Abstract

Objective: This article discusses the need for theoretical foundations in epidemiological research of musculoskeletal conditions and suggests the use of biopsychosocial theory when designing epidemiological studies. The association between smoking and back pain is used as an example.

Discussion: Theory-driven musculoskeletal epidemiologic research is not common. In the epidemiological study of musculoskeletal conditions, there are multiple potential causes of a disease or disorder. Classic biomedical theory is not well suited to explain such phenomena. Biopsychosocial theory is a means through which investigators might formulate hypotheses for testing relationships between smoking, back pain, and other variables. Various types of conceptual frameworks and analytical models can be informed by biopsychosocial theory.

Conclusion: Biopsychosocial theory is well suited for public health and epidemiological studies on musculoskeletal conditions, such as the relation between back pain and smoking, and may be useful to address the multivariable inputs for this association. Although it is not a perfect model, it provides theoretical guidance to inform the research question, an element of research design that is lacking in modern-day epidemiologic reports.

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Introduction

Theory is essential to sound research. Theory helps scientists recognize interactions between social and biological factors that may affect population health¹ and provides explanations for what is observed.²

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Although traditional research uses theory-driven methods, little attention seems to be paid to theoretical foundations and conceptual frameworks for epidemiological research, especially those of musculoskeletal conditions. Given that scientific research is inherently driven by theories and hypotheses,³ we believe this is an essential component to furthering research in musculoskeletal public health research. There are many models to select from when planning public health interventions, such as the theory of planned behavior⁴ or the theory of reasoned action.⁵ However, when planning to conduct secondary data analyses for epidemiologic studies on musculoskeletal conditions and associated behaviors, existing models are rare.

When reviewing the musculoskeletal epidemiologic literature, it is not clear why some researchers select the variables that they do to create their statistical models. Few studies provide explanations for variable selection, and far fewer studies are directed by a clear theoretical framework. Historically, early authors observed apparent interactions of variables of interest and designed observational studies to quantify the magnitude of the association between the variables. More recent studies identify shortcomings in the multivariable analyses of previous publications and design studies to control for such problems. Another tactic is to identify a unique association that has not previously been studied and design an epidemiological study to investigate the relationship. Such studies are grounded in fixing a problem identified in previous research or describing a “first” rather than in a theory that works toward a testable hypothesis.

Limited theoretical guidance is a widespread issue in epidemiologic research. Krieger⁶ states, “... graduate students in epidemiology are far more likely to be taught about study design and data analysis than they are about how to generate epidemiologic hypotheses about the societal dynamics of health and disease.” Weed² also recognizes the heavy emphasis on epidemiologic practice, rather than on theory, “No one should consider contemporary epidemiology a theoretically-rich nor even a theoretically-inclined discipline. Methods and practice far outweigh theory in nearly all professional activities, including education and training, professional publications, and the culture of the discipline.”

In short, much of epidemiologic thought in the past few decades has focused on methods for conducting research and interpreting results, but not on epidemiologic thinking.³ A coherent theoretical background that guides hypothesis development and leads to the selection of variables is greatly needed in the area of musculoskeletal epidemiology. Therefore, if we are

going to progress in the fields of epidemiology and musculoskeletal research, greater attention needs to be given to theoretically driven designs.

The purpose of this article is to discuss the need for theoretical foundations in epidemiologic research of musculoskeletal conditions, to provide a brief synopsis of the biopsychosocial (BPS) model of Engel, and to use BPS theory to select variables for an epidemiologic study of the association between smoking and back pain as an example.

Discussion

Back pain, a chronic disease epidemic, represents the most common chronic painful condition in Americans.⁷ The 3-month prevalence of back pain in the adult population of the United States is estimated to be 17%,⁸ affecting 34 million adults; and the prevalence is increasing.⁹ The lifetime prevalence of back pain exceeds 70%,¹⁰ mainly because back pain is highly recurrent.¹¹ From a financial perspective, back problems rank as the sixth most costly consumer health condition and the fourth most costly health condition for employers in the United States, with direct costs of back pain estimated to be between \$12.2 and \$90.6 billion annually for the United States alone, representing approximately \$45 to \$335 per person each year.¹² People with back pain are high users of the health care system; back pain is the second most frequent reason for physician visits, the fifth most common reason for hospitalization, and the third most common reason for surgery.¹³ There are compelling data to demonstrate that back pain is a significant public health burden and is not well controlled in the population.

As back pain is complicated, there are many possible causes. If we are to reduce the morbidity and suffering from back pain and possibly devise effective back pain prevention strategies, having a clear understanding of the various causative factors is important. Some studies have suggested that smoking may be associated with back pain; however, it is not clear what may be the associated factors that theoretically link these 2 entities.

During the 1970s, scientists began to suspect a deleterious relationship between smoking and back pain.¹⁴ Since then, more than 80 epidemiological studies have reported on the association between smoking and back pain.¹⁵ However, the magnitude of association between smoking and back pain varies among studies,¹⁵ suggesting the potential influence of confounders and/or effect modifiers.¹⁶ Covariates that have been studied in previous research are vast and include variables related to

personal and socioeconomic variables, comorbid conditions, psychological symptoms, health behaviors, and many others.⁸

Biopsychosocial theory is a concept that has been applied in back pain research for 25 years; but its use has been largely limited to clinical investigations, and it has seen insufficient uptake even in this area.¹⁷ Few epidemiological investigations in back pain use the BPS theory, and we are not aware of any association studies on smoking and back pain that use it. The following is a discussion of the BPS model, conceptual frameworks, analytical models, and a rationale for use of BPS theory in epidemiologic studies of back pain.

BPS model

Advocates of a holistic view of health and disease have desired to incorporate social and cultural issues as well as personal experience into medical theory because it is the opinion of many theorists and philosophers that, according to Urdang,¹⁸ illness or disability, "... have profound and widespread biopsychosocial effects." Interest in a more holistic approach to understanding health and its associated factors existed at the time of Hippocrates. However, the "biopsychosocial model" was developed over many years by an American physician and educator, George L. Engel, MD,¹⁹ and given wide dissemination in his seminal article on the topic,²⁰ published in *Science*, which gave rise to the popularity of the model.²¹

Engel's BPS model has at its heart an appreciation for the interplay of biological, psychological, and social factors that affect health.^{19,22} Physical or chemical changes to the body constitute the biological contribution, personal growth and mental health contribute to the psychological influence, and social interactions and context represent the third aspect.²⁰ Through his model, Engel attempted to provide an understanding of the determinants for disease, especially for those diseases or disorders for which the "biomedical model" is not a good fit.²³

The biomedical model views disease as an entity that is independent of the person or population affected.²⁴ This model focuses on the pathology of the disease and typically does not regard the individual or social factors such as those that may have an influence on severity, outcome, treatment, or prevention. Whereas the biomedical model focuses on the disease entity separating the body from other influences such as the mind, the BPS model views these factors as integrated. Thus, Engel's model attempted to transcend the prevailing dualistic separation of mind and body

Fig 1. The epidemiologic triangle. The host is the organism that gets the disease, the agent is the disease-causing organism, and the environment is that realm in which the interaction between the host and agent transpires.²⁵ Whether the host actually gets the disease is dependent upon a variety of factors that are inherent to each point in the triangle. For example, host resistance is a factor determining whether the host is susceptible; agent infectivity is a factor bearing on how likely the agent is to cause infection; and whether environmental conditions are optimal for an infection plays a role in the final point of the triangle. Furthermore, because the triangle is typically used in models of infectious disease causation, the influence of a vector is considered.

prevalent in the biomedical model during the period.²⁴ This dualistic separation of body and mind advocated by Descartes was a popular model for working in the sciences²⁴ and was prevalent in biomedical theory.²⁴ Dualism posits that the mind and body of the host are considered separate and function independently¹⁸ and that the mind is not influential on the disease/injury experience. Engel's model also provided a multicausal pathway to illness that was in opposition to the Henle-Koch approach to disease causation common in the biomedical model, which requires one agent to be present in every cause of disease, for the agent to be able to only cause one disease, and for healthy hosts who are exposed to the agent to get the disease.²⁵ One salient example of biomedical theory is the widely used epidemiologic triangle of disease (Fig 1).²⁵

Engel's BPS approach provides ample room to create conceptual frameworks for research that does not segregate the mind from the body. Engel claimed that his model was based upon general systems theory, as espoused by Ludwig von Bertalanffy.^{20,26} General systems theory posits that there are multiple systems at work in any phenomenon, that these systems also interact with one another, and that there are some universal principles that apply to all of the systems under consideration.²⁷ General systems theory is a

holistic (some might even suggest vitalistic) attempt to understand the functions of organisms or organized entities in a way that considers numerous processes simultaneously and in a hierarchy.²⁸ As von Bertalanffy²⁷ stated, “Since the fundamental character of the living thing is its organization, the customary investigation of the single parts and processes cannot provide a complete explanation of the vital phenomena.” He later elaborated that, from this first conceptualization, general systems theory developed to include social groups and technology in systems theory.²⁷

Von Bertalanffy described general systems theory as a model that helped to explain general aspects of reality in a manner that had previously been overlooked, such that a holistic and intricately woven set of interactions existed within and between various levels of organization.²⁰ Accordingly, a change in any level of human functioning affects all other levels.²⁹ Thus, viewed from the BPS perspective, all diseases or disorders of humans contain biological, psychological, behavioral, and social interactions. As Dr Scott Swisher, past Associate Dean of Research at Michigan State University, eloquently stated, “This is the theme that man is not reducible to a series of interacting biological systems that are totally describable in physicochemical terms.”³⁰

McLaren³¹ argues that the BPS “model” is not a model at all and would best be termed a *theory*. Theories are ideas, whereas models “embody, actualise or realise an idea, notion or concept.” We agree that Engel’s thoughts are not models and that his concepts are better confined to the realms of theory. Thus, for those reasons, we have used that convention in this article when discussing Engel’s concepts outside of their historical context. Hence, the title of this article uses BPS theory and the discussion that follows uses BPS theory to create a conceptual framework and analytical models.

Conceptual framework

As a clinician and medical educator, Engel was focused on making the doctor-patient experience more meaningful. Thus, his BPS view of patient care may be represented by the diagram in Fig 2. Instead of focusing on a single patient, epidemiologists focus on a larger sample (the population) and the effect on population health when one or more variables are changed.³

There are a variety of conceptual schemes used in epidemiology, particularly social epidemiology, that allow one to visualize how variables may interact in diseases or disorders where multicausation is present. One of the earliest and most popular is the “web of

Fig 2. Biopsychosocial theory relates how various factors may interrelate to affect physical and mental health.

causation,” developed by MacMahon, Pugh, and Ipsen.³² Linking variables together with lines representing direct and indirect associations, the web of causation was one of the first conceptual frameworks to challenge researchers to view the many ways that a population could be affected by changing variables and the risk factors and links between variables.⁶ Other conceptual frameworks have been developed for multicausation, including Rothman’s “causal pie,”³³ Haddon’s “matrix,”² and the “wheel of causation,”²⁵ and can be applied in such studies.

When considering the complexities involved in back pain and smoking, not only for individuals but also for the social networks where individuals function, BPS theory provides some guiding thought as to how one may consider multicausation. Merely looking at back pain and smoking through a monocausal model would be inadequate.

Therefore, we elected to use the wheel of causation as a conceptual model to integrate variables related to smoking and back pain, as constructed from BPS theory (Fig 2). The wheel of causation model was proposed by Mausner and Kramer in 1985²⁵ and depicts disease in a multicausal manner. It is a simpler model than the web of causation and is used here because of that reason. The wheel of causation places the host population near the center of the framework. However, at the core of the host are genetic factors that may affect health. Surrounding the host can be factors from the biological, social, and physical environments that affect the host population.³⁴

Fig 3. Wheel of causation conceptual model for epidemiologic study of the association between smoking and back pain. Drawing from BPS theory, the model includes variables from each of these domains. The influence of genetics in the host population is also taken into consideration in the model.

Thus, a wheel of causation for studying smoking (an exposure) and back pain (an outcome) in the United States (a population) may look like Fig 3. The host is represented by US adults. At the center of the adult population are genetic tendencies to experience back pain or pain in general. Until recently, the role of genetics in the understanding of pain has been under-explored.³⁵ Genetics likely play a role in the perception and expression of pain³⁶; however, it is currently unknown which mutations influence the various types of pain perceived by humans.³⁷ Because this is a

nascent area of spine research, that genetics play a role in the back pain experience is acknowledged even though we are not confident regarding genetic determinants of back pain. Variables from the biologic, psychological, and sociological environments are also considered. Each variable was selected from previous research that has shown the variable to be a covariate in the relationship between smoking and back pain.

Analytical model

Once a theoretical basis is established and a conceptual framework is developed that allows one to think about the interrelationship of study variables, an analytical model for secondary data analysis can be constructed. The mainstay of epidemiologic research involves observing for a change in a population's health outcome after the introduction of an exposure. The smoking and back pain wheel of causation can therefore inform an analytical model to select appropriate inputs for multivariable analysis.

With numerous publically accessible data sets available on the Internet, it can be tempting for investigators to select too many variables. One may be tempted to “throw everything in but the kitchen sink” to see if any “significant” statistical relationships surface. However, the problem with this approach is that it is devoid of any meaning and, with large enough data sets, some “significant” relationships may be spurious. By using theory to guide the process, the analytical model intentionally selects biologic variables, psychosocial variables, and the outcome variable of back pain (Fig 4).³⁸

Fig 4. Analytical model informing the multivariable analysis to be used in investigating the association of smoking and back pain from a BPS theoretical perspective.

Rationale for use of the BPS model in epidemiologic studies of back pain

It was first proposed by Waddell³⁹ in 1987 that the BPS model be used in back pain care and research. Perhaps, the greatest appeal of BPS theory is for illnesses that are deemed “functional,” where a distinct physical pathology is difficult to identify.^{19,40} Back pain is one such disorder.⁴¹ Von Korff et al⁴² argue for the use of a BPS approach in the epidemiologic study of chronic back pain, stating:

The dimensions of pain dysfunction identified as components of chronic pain syndrome include: vegetative signs of depression; psychological distress and demoralization; preoccupation with the pain experience; impairment of interpersonal relationships; excessive use of health care and pain medications; significant activity limitations in work, family and social life; and adoption of a chronic sick role.⁴²

Health behaviors must be viewed within a social context if we are to more fully understand the various causal factors leading to illness and how to best prevent disease.⁴³ Back pain is complex and multicausal and therefore not well fit to the biomedical model.⁴⁰ Thus, BPS theory seems to be a good fit for studying the dynamic nature of the back pain experience. Pain is a phenomenon experienced differently by each individual and influenced by various biological, psychological, and sociological factors,^{37,44} making the BPS model “The most widely accepted and most heuristic perspective to the understanding of chronic pain.”³⁷ In fact, one authoritative team has said, “The interaction of smoking and pain can be conceptualized as a prototypical example of the biopsychosocial model.”⁴⁵

BPS limitations

We recognize that BPS theory is not without its limitations. There are likely other instances in the study of back pain when the biomedical model may be the most appropriate one to use.⁴⁰ Biopsychosocial theory is not intended to account for the shortcomings of all other theories or models; it merely is another way to understand the interactions between variables that affect population health. Another concern with BPS theory is that, because it is rather all-inclusive, it can be difficult to demonstrate if the theories derived from it are falsifiable.⁴⁰ Ghaemi⁴⁶ argues that BPS theory can become so all-inclusive that it then becomes fraught

with errors because it is difficult to assign priority to each of the 3 areas (ie, bio, psycho, social). Yet another concern, as we have previously discussed, is that the BPS concept was introduced incorrectly as a model when it should have been called a *theory*; and this has led to inappropriate use of the term *model* in medical practice and research.³¹ Certainly, separating the term *model* from *biopsychosocial* will take some doing, as even now well-respected researchers continue to perpetuate the use of the term *biopsychosocial model* in spine pain literature.¹⁷ Engel’s BPS model was developed as a method for approaching clinical medicine with a more humanistic and holistic perspective than was customary at the time.³¹ That it did not evolve as an epidemiologic concept is another potential limitation of its application to population health studies. Despite the limitations of this model, we feel that it merits application in providing a theoretical direction to spine pain epidemiologic research by serving as one means to view and understand the complex nature of the association between biological factors, health behaviors, environment, and health outcomes.

Conclusion

Biopsychosocial theory is a means through which investigators might formulate hypotheses for testing relationships between smoking, back pain, and other variables. Although it is not a perfect model, it provides theoretical guidance to inform the research question, an element of research design that is lacking in modern-day epidemiologic reports.

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