CHAPTER 8

The Present Informs the Past: Incorporating Modern Clinical Data Into Paleopathological Analyses of Metabolic Bone Disease

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8.1 INTRODUCTION

Paleopathology, the study of disease in antiquity (Ortner, 2011), exists at the intersection of medicine and anthropology (Cook and Powell, 2006). The unique integration of these two disciplines, through contextualization of clinical data using anthropological perspectives, forms the basis of paleopathological understandings of health in the past. However, clinical sciences and anthropology are sometimes characterized as contrasting rather than collaborating forces (Armelagos, 2003; Buikstra, 2010; Bush and Zvelebil, 1991; Meiklejohn and Zvelebil, 1991; Zuckerman and Armelagos, 2011). While perceived dichotomies between method and theory, biology and culture, description and interpretation, and process and categorization often serve to reinforce contrast and tension (Armelagos and Van Gerven, 2003; Huss-Ashmore et al., 1982; Washburn, 1951), it is productive to reconceptualize this relationship as integrative by recognizing that the value of a multifaceted analysis is greater than the sum of its parts. This paper will examine ways in which paleopathological analyses of skeletal evidence for metabolic bone disease have applied clinical data, as well as limitations associated with using clinical information in this context. Uses of clinical data reveal attitudes toward the relative value of clinical approaches to and understandings of metabolic bone disease for methodological, interpretive, and theoretical aspects of paleopathological analysis.

The term metabolic bone disease can refer to any condition that interferes with normal skeletal metabolism, by disrupting normal

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bone formation, mineralization, remodeling, or a combination of these processes (Brickley and Ives, 2008, p. 2). Conditions commonly included within this definition include scurvy (resulting from vitamin C deficiency), rickets and osteomalacia (related to vitamin D deficiency), bone loss including osteoporosis, and Paget's disease of bone; clinical examinations of metabolic bone disease may also encompass rarer hereditary metabolic disturbances that are generally less relevant to paleopathologists, except in isolated cases. Clinical data provide the primary source of evidence for metabolic disease processes. However, significant differences in the types of evidence, methodologies, and approaches available to clinicians and to paleopathologists affect the ways in which clinical data can be utilized in paleopathology. Methods of clinical examination that involve directly evaluating or visualizing the skeleton have more obvious application to paleopathology. This includes radiographic imaging methods (Mays, 2008a) and histological techniques, which have grown out of modern standards for the examination of clinical biopsy samples (Turner-Walker and Mays, 2008). Clinical research on bone biology elucidates the underlying mechanisms of disease processes and their skeletal manifestations, and genetic and endocrinological studies have been instrumental in examining controlling and complicating factors in these processes. Clinical case studies provide detailed information about individual disease manifestations and etiological factors, while epidemiological studies outline broader trends at a population level, providing information on disease incidence rates and trends related to factors such as age, sex, and social determinants of health. The availability of detailed patient histories, descriptions of symptoms experienced, soft tissue evidence for disease, and comprehensive biochemical and genetic laboratory testing augments clinicians' ability to recognize and diagnose metabolic conditions; these data may not be directly applicable to paleopathological cases, but they do provide valuable evidence on individuals' lived experiences of disease.

8.2 NEGOTIATING MEDICINE AND ANTHROPOLOGY WITHIN PALEOPATHOLOGY

Paleopathology has matured since the 19th century from a "physician's hobby" to a discipline in its own right (eg, Armelagos, 1997; Grauer, 2008). The balance of influence in paleopathology has shifted throughout the discipline's development, as analyses expanded from focusing

almost exclusively on clinical research toward a much broader use of information from multiple sources, including anthropological perspectives (Cook and Powell, 2006). While paleopathologists now tend to be trained as anthropologists rather than as clinicians (Mays, 2012a), contributions from both disciplines remain vital to progress within paleopathology (eg, Buikstra, 2010; Ortner, 2011; Rothschild and Martin, 1993). Clinical knowledge is essential for recognizing evidence of disease processes and for updating diagnostic criteria based on relevant advances in clinical literature, while anthropological knowledge is essential for contextualizing and interpreting disease in past populations (Buikstra et al., 2011; Goodman, 1993; Grauer, 2008).

While efforts to improve consistency and transparency in paleopathological recording continue (eg, Appleby et al., 2015), progress within paleopathology is often conceptualized as a movement away from an exclusive focus on description and diagnosis toward applying paleopathological information to larger-scale problems (Armelagos and Van Gerven, 2003; Grauer, 2008; Mays, 2012a; Wright and Yoder, 2003). The latter approach is associated with meaningful interpretation and with problem-oriented research (Knudson and Stojanowski, 2008; Ortner, 2011). Contextualized bioarchaeological analysis imparts greater meaning to interpretations of metabolic bone disease in the past (Knüsel, 2010), as does the explicit integration of anthropological theory (eg, Agarwal, 2012).

During the initial development of biocultural and bioarchaeological perspectives, clinical approaches were characterized as individual in scale, focused entirely on description and diagnosis, and lacking meaningful interpretation (Meiklejohn and Zvelebil, 1991). Biocultural approaches were contextualized, comprehensive, corresponded more closely with lived experience, and involved problem-oriented research that applied paleopathological data to broader, anthropologically significant questions (Zimmerman and Kelley, 1982). This dichotomy sometimes persists in the anthropological literature (eg, Armelagos and Van Gerven, 2003; Zuckerman and Armelagos, 2011), but ultimately reflects a narrow conception of clinical research that equates the clinical approach with descriptive case studies. This does not acknowledge the enormous growth and burgeoning importance of clinical epidemiological research, in which the gold standard for modern evidence-based medicine involves statistical investigation of disease patterns in large numbers

of patients, and overlooks the value that case studies can have for communicating information on uncommon conditions (Mays, 2012a,b). Highlighting connections between perceived analytical problems within paleopathology and its relationship with medicine (Zuckerman and Armelagos, 2011) must be done carefully so as not to promote an inaccurate characterization of clinical approaches, potentially widening the gap between anthropological subfields (Goodman and Leatherman, 1998) and discouraging the development of productive biocultural and bioarchaeological discourse. It is important to recognize that clinical data on the etiology and functional consequences of metabolic conditions affecting the skeleton have been an essential part of many meaningful bioarchaeological interpretations of disease experience and of the implications of disease expression for sociocultural and lifestyle factors in the past (eg, Agarwal et al., 2004; Agarwal and Grynpas, 2009; Mays et al., 2013; Van der Merwe et al., 2010).

8.3 USES OF CLINICAL DATA: PALEOPATHOLOGICAL ANALYSES OF METABOLIC BONE DISEASE

Paleopathological investigations of metabolic bone disease use clinical data to discuss symptoms, skeletal manifestations, and pathophysiology of disease processes, to elucidate etiological factors related to disease occurrence in the present and the past, to discuss functional outcomes, consequences, and disease experiences, and to impart a dimension of time to the static skeletal picture of disease. Time is accessed through clinical evidence for dynamic aspects of disease expression, including severity, manifestations of different disease stages, and differences between active and healed disease (Brickley et al., 2010). Archaeological skeletons present a cumulative picture of disease experience over the life course, as represented at the moment of death (Ortner, 2011). So, as dynamic measures of bone formation and resorption can only be measured in living patients, insights into the dynamic state of osteological processes that can be gained in paleopathology are based on information gleaned from clinical observations of these processes (Cho and Stout, 2003).

Accurate diagnoses, dependent on clinically established associations of skeletal manifestations with other markers of disease, are fundamental to paleopathological analyses of metabolic bone disease (Grauer, 2008; Waldron, 2009). This process of biomedical clinical analogy

(Klepinger, 1983) provides a permanent role for clinical data in paleopathology. At the most basic level, diagnosis involves distinguishing abnormal change from normal structure, as defined using modern medical data (Huss-Ashmore et al., 1982). Clinical diagnoses begin with clusters of symptoms that can be connected to known syndromes; given the combination of symptoms described by a patient, physicians determine which syndrome is likely represented, and attempt to confirm this preliminary diagnosis through laboratory and other diagnostic techniques (Coe and Favus, 2002). Understanding how symptoms are connected within a syndrome requires a complete understanding of the underlying disease process (Schultz, 2001). Similarly, paleopathological diagnosis can best be accomplished by recognizing and connecting skeletal features of disease through the underlying mechanism, rather than matching individual lesion appearances with reference samples (Aufderheide and Rodríguez-Martín, 1998; Ortner, 2003, p. 48, 2011). Thorough differential diagnoses systematically consider the level of clinical and contextual support for several alternatives, and employ multiple types of evidence to differentiate nonspecific lesions (Schultz, 2001).

Paleopathological analyses are also informed by clinical priorities and results, which may serve as the basis for hypotheses (Mays, 2008b). Expectations for etiological associations, severity, and trends of occurrence by age and sex in the past may be based on modern patterns and modern medical paradigms (eg, Agarwal et al., 2004; Brickley and Agarwal, 2003; Mays, 2003; Mays et al., 2006; Stirland, 1991), making it important to recognize the ways that this can limit interpretations of metabolic disease in past societies. For example, Agarwal (2012) demonstrates that patterns of bone maintenance in a British medieval skeletal sample are not constrained by senescence and menopause, as predicted by biomedical models. Therefore, in automatically dividing bioarchaeological samples by sex as the first step in analyzing bone loss, other sources of variation may be underestimated or even missed altogether (Agarwal, 2012).

8.4 CLINICAL DATA AND PALEOPATHOLOGY: AREAS OF DISCONNECT

The majority of clinical information is not directly applicable to paleopathology, but must be adapted into criteria appropriate for

diagnosing metabolic conditions in dry bone (Waldron, 2009, pp. 4–6). Developing specific dry bone diagnostic criteria isolates indicators that are best suited to the evidence available while retaining an important link with clinical data (see Mays, 2012a). This link is most effectively preserved by retaining and applying clinically accepted terminology and definitions, which minimizes confusion in the transfer of clinical information to paleopathological analyses and enables productive dialogue (Cook and Powell, 2006; Grauer, 2008; Ragsdale and Lehmer, 2012). In adapting entire classificatory systems, differences in the objectives of clinical and paleopathological study must be accounted for (Ortner, 2011). A system developed for treating living patients is unlikely to be entirely appropriate for paleopathological samples of individuals who have long been dead and buried. In some ways, clinical and paleopathological understandings of skeletal involvement in metabolic disease differ, as the clinical picture of a condition includes soft tissue, biochemical, and in vivo radiographic features whereas paleopathology relies on dry bone. Despite this limitation, the primacy of skeletal changes in metabolic bone diseases may make paleopathological and clinical conceptions of this category of disorders more directly comparable to one another than is the case for other types of disease.

Clinical and paleopathological analyses utilize many of the same diagnostic methods, including radiography, histology, and clinical imaging technologies, but their applications and levels of importance may vary depending on the type and utility of other methods available to assess evidence for disease (Mays, 2012a; Ortner, 2011). Histological examination of bone using light or scanning electron microscopy is used to interpret pathological structural changes in the skeleton. Since modern clinicians avoid taking invasive and painful samples unless they are absolutely necessary for diagnosis (Mays, 2012a), clinically diagnosed comparative material is more likely to be restricted to historical samples or to the few skeletal conditions for which these analyses remain routine, including renal osteodystrophy (Mays and Turner-Walker, 2008). Radiography, on the other hand, represents the primary clinical strategy for directly accessing information on the skeleton, and is important for investigating bone diseases. Radiographic criteria can often be more directly applied to paleopathology than gross or microscopic criteria for which relevant clinical evidence differs more significantly (Mays, 2008c).

Clinical diagnoses that use skeletal features do so in combination with many other sources of evidence for disease processes that may have greater diagnostic value than features visible in dry bone. For example, vitamin D deficiency can be easily diagnosed biochemically from a blood sample, enabling early detection of disease and negating the need for more invasive procedures such as skeletal biopsy (Brickley and Ives, 2008). Many clinical diagnoses therefore rely on information that is inaccessible in archaeological skeletal material, decreasing the applicability of modern clinical methods in paleopathological diagnosis and encouraging reliance on older clinical research to bridge the gap between the two. Based on modern clinical data, it is evident that "classic" manifestations of disease processes represent a small fraction of the typical distribution of cases (Miller et al., 1996; Ortner, 2011). There is significant variation in disease expression, not all of which is described clinically, and even less of which is described in the clinical literature in terms of features that can be detected in dry bone.

Many uses of clinical data in paleopathological contexts are impacted by the nature of evidence available to clinicians and to paleopathologists. Preservation and potential diagenetic alterations following burial can affect bone structure and lesion appearance. In metabolic diseases bone quantity and quality are often compromised, making elements more vulnerable to fragmentation (Brickley et al., 2005). The adaptation of clinical diagnostic criteria for use in paleopathology must therefore consider how gross, radiographic, and microscopic lesion appearances may be masked, erased, or mimicked by taphonomic processes (Pfeiffer, 2000). It is also necessary to consider differences in disease experience between archaeological individuals and those described in clinical cases or contained in historical pathology collections, and how these might affect the ability to recognize evidence for disease in the past. Most modern clinical cases are prevented from running a full or natural course, and lesion appearance may be altered by treatment or milder than would be expected if the disease had been allowed to progress (Zimmerman and Kelley, 1982). This is where historical medical literature, documenting the natural course of disease prior to the development of effective treatments, may be particularly useful. Some recent cases of disease, diagnosed late due to lack of clinical experience with conditions that are rare in modern developed countries, such as scurvy and severe rickets (eg, Noordin et al., 2012), may also bear closer resemblance to ancient cases.

8.5 DIAGNOSING METABOLIC DISEASE IN THE PAST

Despite difficulties associated with adapting clinical criteria to diagnoses using dry bone, many clinically documented features of metabolic conditions affecting the skeleton are available for application to paleopathological analyses. As well, clinical studies are invaluable in elucidating details of underlying metabolic disturbances and the processes through which they affect the skeleton. Despite the suggestion of various standardized criteria, such as the operational definitions proposed by Waldron (2009), paleopathological diagnoses vary appreciably in terms of the methods and criteria applied. Significant differences of opinion exist regarding how much and what types of clinical data are required to securely establish links between skeletal lesions and specific diagnoses of metabolic bone disease.

One end of this scale is represented by paleopathological analyses of vitamin D deficiency rickets and osteomalacia. Diagnoses of these conditions in archaeological skeletal material are generally directly linked with clinical descriptions of skeletal manifestations and available radiographic data (Brickley and Ives, 2008; Ortner, 2003). Modern medicine recognizes bone as a primary site of abnormalities when vitamin D and calcium metabolism are disturbed due to the integral role of the skeleton in calcium metabolism and its importance as a primary site of action of vitamin D. Skeletal features of rickets including bowing deformities, expanded metaphyses, flaring at the costochondral rib ends, and features of osteomalacia such as pseudofractures, are visible on clinical radiographs (Brickley and Ives, 2008). Accordingly, direct clinical evidence is available to associate skeletal lesions with vitamin D deficiency in both adults and children. In this case, disease manifestations relevant to paleopathologists and to clinicians align, and both utilize methods like radiography that allow skeletal manifestations to be clearly identified. An abundance of historical (eg, Holt, 1908; Jaffe, 1972, 1975) and modern (eg, Meunier and Chapuy, 2005; Pettifor, 2003; Pitt, 2002; Priemel et al., 2010; Reginato and Coquia, 2003) clinical data on macroscopic, radiographic, and histological manifestations of vitamin D deficiency rickets and osteomalacia exist that directly relate to features identifiable in archaeological material.

Conversely, paleopathological recognition of scurvy in juvenile remains tends to rely on indirect clinical evidence. Modern medical understandings of this condition place primary emphasis on defects in

collagen synthesis, making the role of the skeleton less central in scurvy than in vitamin D deficiency. Clinical diagnosis of scurvy relies on soft tissue features (Huss-Ashmore et al., 1982). While skeletal changes are recognized clinically, the disease is known to primarily affect connective tissue, meaning that skeletal manifestations are largely secondary.

Differences in the types of evidence available to paleopathologists and clinicians for diagnosing scurvy are also related to the variation in priorities between those studying human remains and those treating living patients, especially relating to differential applications of radiographic methods. As a result of concerns over exposure to radiation, clinicians only radiograph patients when necessary, and only image the portion of the body in which symptoms are reported. Radiographic evidence for the total clinical pattern of skeletal involvement in the body is typically lacking (Ortner, 1991). Paleopathologists have proposed abnormal porosity in the skull as a criterion for skeletal diagnoses of scurvy. However, this is an area of the body that clinicians avoid exposing to X-ray. Since direct clinical evidence for this feature is lacking, paleopathologists have relied on indirect evidence, theoretically explaining how clinically observed soft tissue lesions, mainly swelling and redness in the temporal region, might affect the skeleton in the form of porosity in various areas of the skull, particularly the greater wing of the sphenoid (Ortner and Ericksen, 1997). The physiological reasoning used to support this association, worked through in minute detail by Ortner and Ericksen (1997), elucidates a rather convincing mechanism behind the formation of skeletal changes. The inferred connection between soft tissue lesions associated with chronic bleeding, inflammation, and consequent bone porosity is supported indirectly by established clinical connections between these processes. However, others have emphasized that in order for these criteria to be used in rigorous diagnoses, the proposed link must be confirmed by direct and reliable clinical evidence (Melikian and Waldron, 2003; Waldron, 2009), or at the very least cranial lesions must be shown to co-occur with more securely established manifestations such as clinical radiological indicators, periosteal new bone, and abnormal porosity in the long bones (Stark, 2014). While one documented historical medical case does exist and shows cranial porosity (Ortner, 2011), this individual was originally diagnosed as having congenital syphilis, and the diagnosis was retrospectively

changed to scurvy. Cranial porosity can be productively viewed as a potential manifestation of scurvy in the juvenile skeleton, but until more direct clinical evidence is available to support this linkage, it seems prudent to avoid utilizing this feature as a major determinant for diagnoses.

Subsequent researchers have variously incorporated criteria suggested by Ortner and Ericksen (1997). Despite the relatively conservative attitude originally displayed toward diagnosing scurvy based on porosity (Ortner and Ericksen, 1997), subsequent papers (Ortner et al., 1999, 2001; Trainer, 2012) have presented porosity on the greater wing of the sphenoid as pathognomonic of scurvy, and some have gone so far as to eliminate skeletal individuals from an analysis if they are missing this element. Some paleopathological diagnoses of scurvy in the skeleton are therefore reliant on a single criterion based upon indirect clinical supporting evidence, allowing assumptions of its validity to dictate not only interpretations but also methodology and research design. Ortner et al.'s (1999) use of the term "pathognomonic" implies a very high level of certainty in their diagnoses of scurvy, despite the use of qualifying terminology like "probable" and "most likely" in other areas of the paper. Other analyses acknowledge the dangers of overreliance on this single skeletal indicator, considering it in combination with several other skeletal features and maintaining a level of caution in diagnosis (eg, Brickley and Ives, 2006; Brown and Ortner, 2011; Geber and Murphy, 2012; Lewis, 2010; Mays, 2008c), often incorporating thorough differential diagnoses that consider other etiological possibilities. Melikian and Waldron (2003) go so far as to conclude that certain diagnosis based on cranial porosity is not possible. Ortner (2003, pp. 390–393) suggests that further research will be able to confirm the linkage suggested from indirect evidence but maintains that a diagnosis can be made on the basis of such evidence if carefully considered; on the other hand, Waldron (2009) rejects these criteria outright until direct evidence is provided. Opinion regarding the security of paleopathological diagnoses of scurvy based indirectly on clinical data therefore varies from confident (Ortner et al., 1999, 2001) to cautious (Waldron, 2009). While well-reasoned manifestations of scurvy like abnormal cranial porosity should be considered in the overall skeletal picture of disease, they should not be relied upon to support the weight of diagnoses, and certainly not to determine methodology.

In concordance with the use of both direct and indirect clinical evidence to evaluate skeletal manifestations, the paleopathological literature reveals clear trends in how diagnostic features supported by clinical information are referenced, either by directly citing clinical studies or by indirectly using clinical data collated by paleopathological reference texts or analyses. Following the initial paleopathological association of clinical manifestations of scurvy indirectly to dry bone manifestations (Ortner and Ericksen, 1997), some analyses cite this and subsequent paleopathological papers (eg, Ortner et al., 1999, 2001) rather than directly engaging with clinical literature (eg, Bourbou, 2003; Buckley, 2000; Lambert, 2006; Lewis, 2002, 2010; Ortner et al., 2007; Salis et al., 2005; Stirland, 2000). This is understandable, particularly given the lack of direct clinical corroboration for this feature; however, if clinical data have not been rigorously applied in the cited studies then the certainty of subsequent diagnoses may be affected.

On the other hand, many paleopathological studies, especially those dealing with diagnostic criteria that are closely linked to clinical evidence, directly cite modern medical studies of metabolic bone disease (eg, Brickley and Agarwal, 2003; Brickley and Ives, 2008; Mays, 2003, 2010; Pinto and Stout, 2010). Clinical data tend to be cited directly when describing new or unusual manifestations that have not been previously documented in paleopathological cases of disease, such as putative scorbutic lesions associated with involvement of the scapula (Brickley and Ives, 2006) or ilium (Brown and Ortner, 2011), proliferation of new bone around the foramina rotundi (Geber and Murphy, 2012), or subdural hemorrhage (Mays, 2008c). This trend is also reflected in the literature on vitamin D deficiency, where clinical data are often directly referenced when documenting disease manifestations rarely observed paleopathologically (eg, Blondiaux et al., 2002; Formicola, 1995; Mays et al., 2006; Mays and Turner-Walker, 2008; Pfeiffer and Crowder, 2004), including lesions in adults (Brickley et al., 2007).

8.6 INTEGRATING CLINICAL AND ANTHROPOLOGICAL PERSPECTIVES

Clinical data also have significant and largely unrecognized potential for application within relevant anthropological theoretical models, including

studies of identity and the life course perspective. The biocultural approach, already well established within bioarchaeology, emphasizes the interrelation of biology and culture and the importance of communication in bridging the divide between sciences and humanities (Knüsel, 2010). Explicit engagement in identity studies has developed within bioarchaeology along with increasing recognition that meaningful interpretation can take place at both individual and population levels (eg, Armelagos, 2003; Knudson and Stojanowski, 2008). Given the necessary role of individuals within populations (Buikstra et al., 2011), examining the two levels in concert with one another may be particularly valuable. The cultural relevance of biological processes, including disease, relates to how socially meaningful identity groups differentially experience these conditions, and how these experiences become embodied in the skeleton (Fausto-Sterling, 2005). Clinical descriptions of patients' lived experiences identify the embodied effects of disease processes, as well as how these physical—including skeletal—manifestations relate to symptoms described by an individual during the course of disease and to the severity of the disease process itself. For example, a study by Palkovich (2012) examines the case of a 14th-century Puebloan woman with evidence for severe impairment from childhood rickets, including severe bending deformities and poor muscle development in both upper and lower limbs. Palkovich (2012) discusses ways in which residual rickets may have limited this individual's everyday life as an adult, including limitations to her ability to participate in physically demanding chores typical of the ancestral Puebloan lifestyle, but also how her completely typical burial treatment provides no evidence for differential treatment despite obvious physical impairment. In this case, clinical information regarding potential lasting functional consequences of rickets can be combined with archaeological evidence for potential social roles to explore aspects of individual identity in the past (Palkovich, 2012).

Clinical information on disease progression in relation to processes of growth, aging, and reproductive function can also contribute to paleopathological understandings of metabolic bone disease using a life course approach. This theoretical model conceptualizes the body as a material object produced over the course of an individual's life through biologically meaningful and socially defined actions (Sofaer, 2006a,b). Integrating clinical data could be especially significant in connecting rickets with growth processes, osteomalacia and bone

maintenance with pregnancy and lactation, and bone loss with aging. For example, several studies of osteoporosis in archaeological material from Britain incorporate clinical evidence for the effects of pregnancy, lactation, or age-related changes on the skeleton, and focus on how the cumulative product of gendered life-history experiences constructs the skeleton and explains changes in bone status observed in individuals at different stages of the life course (Agarwal, 2012; Mays, 1996, 2000, 2001, 2006).

Paleopathological evidence for metabolic bone disease has been used extensively to provide meaningful information on life in the past. Clinical data, technologies, and approaches have contributed significantly to paleopathological understandings of metabolic bone disease in terms of recognition, diagnosis, and interpretation, and have the potential to contribute to theoretical understandings as well. However, the tendency to reference paleopathological rather than clinical studies for diagnostic criteria that are more "established" paleopathologically reduces direct engagement with clinical information, and may endanger these essential understandings of pathological processes and their relationship with skeletal lesions. There are significant areas of disconnect between clinical and paleopathological evidence and approaches; this is true not only for metabolic bone disease, but also for other conditions relevant to paleopathologists including infectious disease. Despite these differences, research designs in medical and paleopathological research are fundamentally similar. The gold standard for modern evidence-based medicine involves statistical examination of disease patterns in large numbers of patients (Mays, 2012a,b), similar to the population-level studies prioritized by bioarchaeologists. Excellent paleopathological research will continue to apply clinical data as directly as possible, while incorporating anthropological perspectives to contextualize and deepen interpretations.

Bioarchaeological examinations of skeletal evidence for metabolic bone diseases provide important insight into the occurrence of metabolic conditions in environments that both resemble and differ from modern contexts. As paleopathologists continue to negotiate the boundaries between dichotomized elements, maintaining close correspondence with the research goals and methods of clinicians will facilitate mutual engagement with the potential to expand understandings of metabolic disease processes both in the present and in the past.

Paleopathology is in a unique position to bridge the divide between science and art by integrating clinical data with anthropological theoretical perspectives to answer questions with broad contemporary relevance both to medicine and to anthropology.

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