H105 Markers of Mechanical Loading in the Postcranial Skeleton: Their Relevance to Personal Identification of Human Remains

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This study offers a new assessment of a methodology for measuring degrees of postcranial muscular-skeletal robusticity (MSR) that can

benefit the forensic anthropologist in personal identification of human remains. The "Femoral Robusticity Index," and some other commonly taken postcranial indices, are demonstrated to be less reliable indicators of robusticity than examination and recording of multiple markers of occupational stress (MOS).

Preservation of muscular tissue from victims of mass casualties resulting from assaults by terrorists, accidents, or acts of nature may allow the forensic anthropologist to assess a hitherto commonly overlooked observation in cases of personal identification - measurement of degrees of postcranial muscular-skeletal robusticity (MSR). This variable refers to degrees of skeletal massiveness, strengthening or structural buttressing of a skeletal element by addition of bone tissue as a response to high mechanical loading, observable girth or "heftiness" of a living individual or a well preserved body, general thickness of long bones, and bone strength relative to body size. Gracile body forms and skeletal elements reflect the reduction of factors contributing to robusticity, but absence or reduced expression of MSR is also critical to positive identification of human remains.

When bodies are taphonomically degraded, their skeletal remains allow a more accurate estimation of this variable from morphometric and radiographic examination of enthesopathic lesions at loci of muscular and ligamentous attachments. Under conditions of intensive mechanical stress, muscular contraction produces on attachment loci rough patches, tuberosites, crests or tubercles with an enlargement or hypertrophy of these attachment areas. While these features of bone remodeling are recognized today as markers of occupational stress (MOS) (the responses of osteological tissue to a range of habitual activities in life) the traditional method to assess MSR has been the calculation of the ratio of the length of a long bone to its mid-shaft diameter or circumference. The "Femoral Robusticity Index" has been regarded by many biological anthropologists for over a century as the diagnostic measure of total skeletal massiveness or gracility. Both forensic anthropologists and palaeoanthropologists have observed that marked cranial robusticity and molar crown tooth sizes are not necessarily correlated with postcranial robusticity for a given individual or a population.

Notation of "robusticity" has been included in protocols of sex determination of skeletal remains, males usually exhibiting more pronounced features and larger body sizes than females in prehistoric and modern human populations. Apart from sexual dimorphism, markers of postcranial muscular-skeletal robusticity have been attributed by some bioarchaeologists to geographical and climatic adaptations to habitats (lower degrees of muscular-skeletal robusticity in hot-humid Tropical regions; higher in peoples of northern latitudes under conditions of coldstress), to athletic activities, socioeconomic patterns, nutrition and pathology, inheritance, secular trends, and locomotion over rough terrains.

It is argued here that bone remodeling as a consequence of habitual patterns of behavior-markers of occupational stress (MOS) - is the major determining factor in the expressions of MSR. This hypothesis was tested by comparing values of the "Femoral Robusticity Index" in three human skeletal samples: modern European males who had been prisoners subjected to hard labor over many years (N = 15), modern males from India who had spent their lives in manual labor and in pulling rickshaws (N = 16), and prehistoric South Asian males from Middle Holocene burial deposits on the Gangetic Plain of India (Sarai Nahar Rai and Mahadaha) who were hunter-gatherers (N = 24).

Multivariate and bivariate analyses indicate that comparative values of the Femoral Robusticity Index are insignificant in measuring muscular-skeletal robusticity in this male sample from the Temperate and Tropical Zones or Europe and Asia respectively. Rather, where MSR are pronounced in femora and other postcranial bones, MOS are the most obvious aspects of bone remodeling under contrasting conditions of habitual stress-related adaptations.

The protocols of the investigation of human remains by forensic anthropologists can be supplemented and advanced by an understanding of the dynamic relationship of MSR to MOS in cases where personal identification is the focus of investigation. Although no single factor can account for degrees of muscular-skeletal robusticity in modern and prehistoric human populations, the effects of habitual patterns of activity imposing stress upon the integrity of the muscular-skeletal system provide another and critical component of the forensic anthropologist's protocol in achieving a positive personal identification of human remains.

Muscular-Skeletal Robusticity, Forensic Anthropology Methodologies, Femoral Robusticity Index

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