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Review Paper

Bioarchaeolog: Archaeological Study Via the Biological Perspective

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Abstract: Biological samples such as bones, teeth, and hair obtained from archaeological excavations are mainly used for dating measurements. However, these findings provide valuable information about the diet, lifestyle or migration, genetic interaction of communities, and disease because the biochemical content of biological tissues such as bones, teeth, and hair changes under the influence of the lifestyle of the past population. Therefore, it seems that human remains' biochemical, microscopic, and histological studies could be advantageous for clarifying the dark events of past societies. Bioarcheology, as an interdisciplinary science, assesses the historical-cultural relationships in ancient samples and human remains like hair, bone, or tooth by biological tools and techniques. In this science, the biological data of specimens are combined with archeological information to obtain a more accurate sociology of past civilizations. The purpose of the present review article is to familiarize archeology researchers with the usual methods in bioarchaeological studies.

Keywords: *Skeleton, Archaeology, Paleodietry, Linear Enamel Hypoplasia, Stable Isotope*.

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Introduction

Evaluation of human remains in historical samples is one of the important research fields of archaeology. The introduction and expansion of agriculture and the production of grains by humans, the production of metal tools, drought and long wars, as well as the occurrence of diseases and famine, each in turn, has left a disturbance in the biological structure of the human body. The agricultural revolution by changing the food composition and preparation influenced the ancient human dental and skeletal growth parameters and pathological conditions (Larsen 1995). Moreover, agriculture changes human height, digestion, immune system, and skin color following the human DNA underwent widespread (Lazaridis 2016). The Iron Age has brought other changes to the human body. Animal husbandry development has increased economic power, followed by better human nutrition and growth (Hejebri Nobari 2017).

Bioarcheology, which developed in the 1970s, obtains historical-cultural documents from ancient human remains via the biological perspective. It is possible to determine the age, sex, lifestyle, or diet of the obtained samples (Larsen 2002). Bioarcheological research connects the physio-anatomical properties of past populations to historical events (Yates 2020). Examining the hair of the human remains of the Renaissance period with the help of bioarcheological techniques showed that Renaissance Europe was in contact with toxic amounts of heavy metals such as mercury and lead. However, the health consequences of such toxic heavy metals are unknown (Clifford 2016). In another study, the bone analysis of the first horticulturists in the Atacama Desert (1000 BCE – 600 CE) revealed that there was some intra-violence between local communities due to social and ecological constraints (Standen 2021).

Considering the importance of the relationship between biology and history in archeology research the significant impact of environmental conditions on the human body, and the challenging activity of determining the ancient societies' diseases and lifestyles, this literature review article aimed to introduce the frequent biological samples and techniques for bioarcheology as a multidisciplinary research field.

Materials and Methods

The current review article aims to extract the applied biological methods in archeology research from library documents. Based on the articles cited in this research, in bioarchaeology, bone, tooth enamel, and hair samples are studied by electron microscope devices, computed tomography, and stable isotope analysis techniques such as mass spectroscopy.

Results

Skeleton

Each archaeological skeleton contains a lot of information about the experiences and living conditions of that ancient human and his society (Larsen 2018). These samples provide important insights into nutrition, life activities as well as health, and stressors, genetic history, population dynamics, environment, social and cultural influences, and the population that shaped their lives. It is also possible to study the morphological and biochemical changes in the skeleton caused by the introduction of industry or agriculture in human populations. Skeleton analysis of ancient humans provides reliable evidence of their lifestyle (food resources and violence) and economic condition (C. Larsen 2018).

In bioarcheological studies, bone samples are usually studied with minimal cleaning and preparation. However, in DNA analysis, the removal of environmental organic pollutants such as fungi has a significant effect on increasing the accuracy of the test (Bollongino 2008). The most widely used methods of removing contamination from bones are physical (washing with distilled water and of the outer surface of the bone abrasion) and chemical removal (washing with acetic acid or acetate buffer) (Lambert 1990).

Morphological analysis of bones like skulls provides notable evidence to reconstruct the history of ancient populations. During human life, bone shapes are regulated by mechanical, hormonal, and local signals that could be determined by microstructural features on the bone surface (Perez 2016). Computed Tomography (CT) analysis of adults from farming groups revealed that they had small skulls and gracile facial structures –glabella due to the fewer abrasives diets, while hunter groups have strong skull bones and distinct facial lines and are described with more development of supraorbital and upper arches (Paschetta 2016).

The bones of a corpse undergo physical, chemical, and microstructural changes called bone diagenesis due to the interaction with water and soil. The carbonate apatite nanostructures of bones are restructured to the more ordered and bigger crystals through recrystallization or ion replacement. Bone diagenesis is studied by FTIR spectroscopy equipped with the Platinum ATR (diamond crystal) and XRF. FTIR provides information about aging time by measuring the carbonate to phosphate (C/P) ratio. The morphological analysis generally is evaluated by Scanning Electron microscopy (SEM) (Dal Sasso 2016).

Tooth

In archeology and forensic studies, tooth enamel is very important. Tooth enamel has a dome-shaped-layered structure. It is made by ameloblasts in layers and this process continues during the growth period. The tooth enamel layers' formation, shape, thickness, and order are affected by the growth and nutrition conditions (Ritzman 2008). Linear enamel hypoplasia (LEH), is defined as the incomplete development of enamel in the child. It is an important environmental stress and aging indicator and provides insight into the stresses endured by ancient societies from a bioarcheological perspective (Martin SA 2008). Both macroscopic and microscopic (visual and metric) LEH methods are used in bioarcheological research (Henriquez 2017). In macroscopic studies, tooth layers are carefully examined and with the help of regression equations and analysis models, growth and age information is extracted from the sample. The most important limitation of the macroscopic method is the existence of multiple fractures in the dental samples in archaeological studies, and therefore microscopic studies can provide more detailed information about ancient samples. According to the LEH analysis, Erkman and co-workers (2022) revealed that the Dereköy population from western Anatolians generally has a socioeconomic structure mainly based on agriculture and partly animal husbandry (Erkman 2022).

For the use of dental samples in archaeological studies, a silicone mold must be prepared first. For this purpose, after cleaning and descaling the tooth, the surface of the tooth is cleaned with a soft acetone cloth, and the Polyvinyl siloxane is poured directly on the enamel and crown of the tooth (Temple 2012). After hardening, the silicone material is removed and an inverted mold is made on the outer surface of the tooth. Then, a positive cold replica is prepared from the silicone mold with cold epoxy. However, some color is added to the second mold to make the enamel layers better defined (Henriquez 2017). Ancient dental samples could be studied microscopically by custom-built measuring microscopes at 5×magnification. Enamel surface profile produced by computational software such as Vision Gauge software (Maclellan 2005).

Hair

Human hair is considered an ideal BioSource in paleodietary studies since it is a robust tissue composed mainly of protein and its sampling method is minimally invasive. Moreover, its analysis simplifies the comparative studies on living people. Apart from bones and teeth, hair can also provide valuable information about the lifestyle or age of ancient specimens. Hair has stable carbon and nitrogen isotopes, whose ratio represents the nutritional status or typical diet of a population (White 2009). Geographic relocations and short-term travel between the coast and the highlands affected the 15N/12C of keratin in the specimen, significantly (Mora 2022).

The 15N/12C of hair keratin is measured traditionally by using a dilute solution of methanol. Briefly, 2 cm sections of hair sample were soaked in serial dilution of methanol to extract the amino acids (White 2009). However, the hair whole protein of hair scalp or hair fiber could be evaluated by Isotope Ratio Mass Spectrometer (IR-MS) or chromatography techniques (Dunn 2011).

Discussion

Biological analysis of historical remains has significantly helped archaeological researchers in uncovering historical mysteries. Alesan (1999) uncovered the mystery of the human mortality pattern of a mass grave in S'Illot des Porros (western Mediterranean) by analyzing their skeletal samples (Alesan 1999). Bioarcheological analysis of skeletal samples in Italy (1^{st} to the 15^{th} centuries AD) revealed that the birth rate was higher than the death rate in the years after the outbreak of the epidemic, and therefore the average death rate is lower in this period (Barbiera 2017). According to the osteological and ancient DNA data from the long bone of individuals across Europe spanning the Upper Paleolithic to Iron Age (~38,000 to 2,400 B.P.), Marciniaka (2022) discovered that in comparison between the Neolithic, Paleolithic, and Mesolithic ages, the shortest human height belongs to the Neolithic ages and the average human height increases in the copper, bronze and iron ages (Marciniaka 2022).

13Carbon, St, and 16O isotope analyses on human tooth enamel from Chengdu Plain and its western highlands in Sichuan (China) indicated that rice was an important food source for the people of the Chengdu Plain. However, millet played a significant role in the mountainous areas. Furthermore, the same dietary patterns persisted in the two regions from the late Neolithic to at least the Bronze Age (Lin 2022). Moreover, a study of the starch grains preserved in dental calculus and teeth surfaces of the site of Nanchang (China) suggested that, during 2000-1600 BC, the people of this region used a wide range of plants. Hence, it seems that they had a significant economic and cultural status (Chen 2021).

Stable isotope analysis (13C/15N) of keratin and collagen of hair and bone samples from Uraca (Peru) showed that there have been distinct dietary patterns between coastal and Yunga groups, between men and women, and between wealthy and non-wealthy villagers. In addition, the nature of diet has changed at the end of people's lives (Scaffidi 2021). By examining stable isotopes (carbon, nitrogen, and sulfur) in the hair of modern humans in the villages of southern Ethiopia, Cooper (2019) showed that there were ethnic communities with different economic practices (farmers, herders, fishermen) in this region. In these societies, there are significant differences in food, which shows the difference in economic status (Cooper 2019).

Conclusion

The shape, structure, and biochemical content of body tissues are influenced by environmental factors such as weather, temperature, and place of residence as well as diet and lifestyle. Biological tissues are constantly changing during life and adapt the human body to the environment. The appearance and biochemical characteristics of tissues such as bones, teeth, and hair, due to their structural strength, change less after burial, and therefore bioarcheologists have succeeded in analyzing biological tissues remaining from historical samples with the help of biological study techniques. The investigations of this research show that the use of biological techniques in archeology is not limited to a geographical area and can be used for almost all societies. It seems that with this science, the economic and cultural development of previous societies, and the secrets of past societies will be discovered more accurately.

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Conflict of Interest: The authors declare that they agreed to participate in the present paper and there is no competing interests.

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