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First molar size and wear within and among modern hunter-gatherers and agricultural populations

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ABSTRACT

Apart from reflecting modern human dental variation, differences in dental size among populations provide a means for studying continuous evolutionary processes and their mechanisms. Dental wear, on the other hand, has been widely used to infer dietary adaptations and variability among or within diverse ancient human populations. Few such studies have focused on modern foragers and farmers, however, and diverse methods have been used. This research aimed to apply a single, standardized, and systematic quantitative procedure to measure dental size and dentin exposure in order to analyze differences among several hunter-gatherer and agricultural populations from various environments and geographic origins. In particular, we focused on sexual dimorphism and intergroup differences in the upper and lower first molars. Results indicated no sexual dimorphism in molar size and wear within the studied populations. Despite the great ethnographic variation in subsistence strategies among these populations, our findings suggest that differences in sexual division of labor do not affect dietary wear patterns.

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Introduction

Dental variation among and within modern human populations has been attributed mainly to genetic and environmental factors (Bailit, 1975). Crown length–breadth measurements have been widely used to provide insights into inter- and intragroup variability, and differences in tooth size among modern humans have been reported (Bishara et al., 1989; Brook et al., 2009; Hanihara, 1977; Keene, 1979; Otuyemi and Noar, 1996; Turner and Richardson, 1989). Probably, the most complex study of tooth size differences in modern humans was performed by Hanihara and Ishida (2005), who investigated the mesio-distal and bucco-lingual tooth crown differences among 72 major human populations. The authors have concluded that the Australian Aborigines possess the largest and Philippine Negritos the smallest teeth of all considered groups. They have also stated that Southeast Asians are characterized by dental patterns similar to those of sub-Saharan Africans and that the overall patterns of dental morphology are consistent with genetic and craniometric data. However, many other researchers have argued that the differences in dental measurements do not vary enough to efficiently discriminate contemporary human populations (Ates et al., 2006; Castillo et al., 2011; Harris, 2003; Suazo et al., 2008).

In addition to intergroup differences, the intrapopulation variation in tooth size has also been investigated. In numerous studies, males were found to exceed females in various tooth measurements (Barrett et al., 1963; İşcan and Kedici, 2003; Richardson and Malhotra, 1975; Schwartz and Dean, 2005). Schwartz and Dean (2005) hypothesized that the size difference could be the result of a greater amount of dentin tissue present in male teeth. But other studies found very little sexual dimorphism in tooth size (Garn et al., 1964; Garn, 1977; Hillson, 1996; Mizoguchi, 1988). Harris (2003) reported that sexual variance accounted only for 1.2% of the total variation among studied groups. Additionally, Scott and Turner (1997) have acknowledged that even if there are differences encountered between sexes, they are very often inconsistent among samples and cannot lead to conclusive statements.

Overall dental wear and dentin exposure analyses have also been performed by dental anthropologists. These features have been used extensively to infer dietary habits, subsistence strategies, food preparation techniques, and cultural practices among ancient human populations (Deter, 2009; Hillson, 1996; Rose and Ungar, 1998; Smith, 1984). The abrasive properties of food have a direct impact on enamel loss and on the rates of tooth wear during an individual's life span (Kieser et al., 2001); that is, tough, fibrous, and abrasive diets require high biting forces during chewing and cause severe dental wear (Kiliaridis et al., 1995).

The transition from forager to agro-pastoral lifestyles implied significant changes in dietary habits and food-processing techniques that decreased the abrasiveness of consumed foods (Deter, 2009; Eshed et al., 2006; Hinton, 1982; Smith, 1984). Smith (1984) reported an increase in the inclination of wear surfaces of lower molars in agricultural populations compared to hunter-gatherers, as a result of a reduction in food toughness with the adoption of agriculture. She also stated, however, that due to similar diet abrasiveness, the two groups could not be differentiated by analyzing dental wear rates alone. Hinton (1982), who compared dental wear scores on first and second molars among Archaic, Woodland, and Mississippian samples from the Tennessee Valley, reported higher degrees of this feature in the Archaic sample (hunter-gatherers), followed by the Woodland group (hunter-gatherers with some cultivation admixture) and Mississippian sample (food production with supplementary hunting and gathering). Eshed et al. (2006) analyzed mandibular dental wear between the Natufian hunter-gatherers from southern Levant (10500–8300 BCE) and Neolithic populations (8300–5500 BCE) and found higher rates of dental wear, for all tooth types, in the forager groups. Finally, Deter (2009), analyzing maxillary teeth, found higher percentages of dentin exposure for all tooth types in North American hunter-gatherers (3385 ± 365 BCE) than in more recent agricultural groups ($\sim$1300 CE). The reduction of dental wear in societies with prevalent food production was generally associated with a decrease in diet abrasiveness.

Sex-related intragroup differences in tooth abrasion have also been reported. Generally, women tend to exhibit greater wear on anterior teeth than do men, especially in foraging societies (Berbesque et al., 2012; Clement and Hillson, 2012; Madimenos, 2005; Molnar, 1971; Richards, 1984). Molnar (1971) suggested that differences in roles between the sexes conditioned the types of food consumed, with women consuming greater amounts of fibrous plants and abrasive roots they collect.