



Wealth and Well-being in an Ancient Maya Community

A Framework for Studying the Quality of Life in Past Societies

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Abstract

Inequality is an intrinsic element of contemporary societies, with high income disparity impacting everything from life expectancy to violent crime. While inequality in today's society is complex and multifaceted, the prominence and persistence of inequality that existed throughout human history raise important questions about its broader impacts in the past. In this paper, we discuss the concept of quality of life (QOL) for archaeology and introduce methods for studying multiple dimensions of wealth and well-being in past societies. Using previously published burial data from the ancient Maya site of Altar de Sacrificios, we illustrate this approach employing notions of personhood that treat individuals embedded in complex socio-material relations. These data enable diachronic analyses in the degree and kinds of inequality that characterized this Maya community over a span of nearly 2000 years. We further discuss how these techniques can apply to other units of archaeological analysis and comparative case studies. Tracing the disparities in material wealth, social well-being, and health through time enables a more detailed analysis of the specific contexts and historical processes that gave rise to varying degrees of inequality in the past.

Keywords Inequality · Wealth · Well-being · Quality of life · Personhood · Gini · Maya

Introduction

Significant economic research over the last decade identifies the negative impacts of increasing inequality in today's society. For modern industrialized nations, high levels

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of wealth inequality are associated with increased rates of health disparities and social problems, political and economic instability, deepening poverty, and deleterious changes to social norms and institutions (Stiglitz 2012; Wilkinson and Pickett 2009). While the effects of inequality in today's society are multifaceted—influenced by race, class, gender, and urban-rural divides—the prominence and persistence of inequality in most large-scale societies that existed throughout human history raise important questions about its impact on ancient societies.

High disparities in economic wealth and social capital as well as differential access to specialized knowledge and other intangible resources directly impact people's quality of life (QOL). QOL is a broad if somewhat ambiguous concept that refers to the overall well-being of individuals and societies (Nussbaum and Sen 1993; Phillips 2006). In contemporary usage, QOL encompasses a wide domain including physical health, family, education, employment, wealth, safety, civic engagement, religious beliefs, the environment, among other facets of life. Understanding how inequalities across these dimensions shape the human condition is a central goal of contemporary human development and public policy research, and of increasing interest to archaeology. However, there is significant scholarly debate surrounding what factors to use in assessing QOL as well as how they should be measured (Deneulin and McGregor 2010; Nussbaum and Sen 1993; Phillips 2006)—methodological issues that are equally relevant for archaeologists to consider as we investigate inequality's long-term impacts on human society.

In this paper, we discuss the relevance of QOL for developing more inclusive archaeological studies of ancient inequality. While material goods and physical resources have long-provided important sources of information about ancient wealth inequality, such estimates incompletely capture the noneconomic dimensions of QOL. In order to investigate what it might have meant to “live well” in the past, we introduce new ways to study multiple dimensions of wealth and well-being in ancient societies. Drawing upon Amartya Sen's capabilities approach, we outline a conceptual framework and methodology for studying QOL in archaeological contexts that emphasize the material, social, and somatic means by which people could have achieved “a good life” in the past. We then illustrate this with a case study using burial remains from the ancient Maya site of Altar de Sacrificios to examine changes in the degree and kinds of inequality that existed within this community over a span of nearly 2000 years. By examining the specific contexts and historical processes that gave rise to different degrees of inequality, archaeologists are poised to better understand the factors that impacted QOL in past societies.

Studying Socioeconomic Differentiation in the Past

Recent studies have begun to track long-term trends in wealth differences across a range of societies to better understand the origins, diversity, and causes of socioeconomic inequities. For example, economic historians have extended the study of inequality into the past, but few of these studies go beyond the documentary sources of Western preindustrial societies (Lindert and Williamson 2016; Milanovic et al. 2010). Recent archaeological research, however, is filling this gap with a number of case studies that identify broad trends in household inequality over the last 10,000 years

(Kohler et al. 2017; Kohler and Smith 2018). Such comparative approaches use the Gini coefficient to quantify disparities in ancient wealth based on common proxy measures of house size. While these studies permit general assessment of household wealth differences across a range of societies, we argue that they are limited in their ability to capture the full social and economic dimensions of ancient inequality. In other words, it is not just a question of whether the rich become richer but rather whether those at the top, bottom, and everywhere in between were better or worse off in terms of other noneconomic aspects of life. Furthermore, we argue for the need to examine the shorter-term dynamics of inequality operating within specific sociohistorical contexts as a complement to these broad comparative studies.

A related and important point that deserves mention is how archaeologists conceptualize socioeconomic differences in the past, particularly within the Mesoamerican context. Over the last 30 years, archaeologists have made significant contributions to our understanding of household organization, domestic economies, and the diverse social positions that existed within prehispanic communities (e.g., Carballo 2011; Douglass and Gonlin 2012; Inomata and Houston 2001; Robin 2003; Santley and Hirth 1993; Sheets 2000). Within the Maya region, much of this research frames socioeconomic differences in categorical terms that oppose elites and non-elites, royals versus commoners, and so on. Such an approach, however, perpetuates static and false dichotomies of ancient social inequality that prioritize the structural organization of political hierarchies. In contrast, relational explanations of inequality emphasize the dynamic and asymmetrical interactions that created social boundaries and fostered advantages for certain groups over others in specific sociohistorical circumstances (Tilly 2001). From this perspective, inequality is an embedded feature of social interaction that “appears everywhere, but rarely crystallizes into neat, continuous hierarchies somehow arraying whole populations into strata” (Tilly 2001, pp. 362–363). Although previous work has established clear status distinctions between the noble and farming classes of Classic Maya society, investigating the conditions of life beyond these social extremes and the interactions among these heterogeneous populations—especially in earlier time periods—remains understudied. From this perspective, we argue that relational epistemologies are better able to conceptualize inequality as a continuum operating across a wide variety of dimensions and over long periods of time.

Defining QOL Concepts for Archaeology

Most broadly, quality of life (QOL) refers to the overall well-being of individuals and societies (Nussbaum and Sen 1993; Phillips 2006). More formally, it is a term that is meant to represent how well human needs are met and the degree to which individuals or groups are satisfied or dissatisfied across various life domains (Costanza et al. 2007, pp. 268). The concept emerged from recent economic research showing that traditional measures of income and economic activity are limited in their ability to capture overall well-being for rich industrialized nations as well as developing countries (Phillips 2006; Stiglitz et al. 2010). QOL research therefore relies on comparative and distributional measures, rather than single indices like gross domestic product, to examine “the full range of factors that influences what we value in living, reaching beyond its material

side” (Stiglitz *et al.* 2010, pp. 61). This paper draws upon Sen’s capabilities approach to propose a broad and flexible set of criteria by which archaeologists can approximate various factors that may have influenced QOL in past societies. Building upon recent archaeological adaptations of this approach introduced by Smith (2015) and Arponen *et al.* (2016), we propose a broad set of variables that are evaluated with a case study.

Capabilities Approach

As defined by Sen, the capabilities approach emphasizes the economic and noneconomic means by which individuals or groups achieve their life goals. Central to this approach is the conceptualization of human life as a set of ‘beings and doings’ which shifts attention away from the goods that people *have* to what goods or resources allow people to do and thus become (Sen 1993). Capabilities thus account for people’s conditions and the opportunities available to them, which enables them to perform the actions necessary to live a fulfilling life. Such an approach aligns well with the central tenets of practice theory familiar to archaeology (Dobres and Robb 2000; *e.g.*, Preucel and Mrozowski 2010). In some cases, “these capabilities may be quite elementary, such as being adequately nourished and escaping premature mortality, while others may be more complex, such as having the literacy required to participate actively in political life” (Stiglitz *et al.* 2010, pp. 62). In Late Neolithic Europe, the ability to feed oneself and family would have required access to specific tools to process cereals; thus, the recovery of quern stones from houses excavated at the Bosnian site Okolište provides a way to assess a household’s critical capability to nourish itself (Arponen *et al.* 2016).

Rather than a precise theory of well-being, the capabilities approach is generally conceived as a flexible and multi-purpose framework that operationalizes the study of QOL. However, there is a problem with finding adequate criteria for assessing QOL since what people value in life (*e.g.*, what they strive ‘to be and do’) differs not only between societies but within them as well. This relates directly to a core argument within the capability literature: the list vs. non-list debate (see Deneulin and McGregor 2010, pp. 511). Sen’s version of the capability approach takes into account cultural relativism and inter-individual differences within social groups, which leads him to resist promoting “one pre-determined canonical list of capabilities” (Sen 2005, pp. 158). In contrast, philosopher Martha Nussbaum takes an objectivist stance and reasons that what people do and become is a product of entrenched structural inequalities that crosscut human society. She therefore proposes a list of ten central human capabilities that constitute universal policy objectives (Nussbaum 2000, pp. 78–80). Sen is resistant to this approach, but somewhat vague in responding to the question of how to select and weigh different capabilities in different cultural and historical contexts. Since “doings and beings can be seen from different perspectives, with varying emphases,” he argues that “the task of specification must relate to the underlying motivation of the exercise” (Sen 1989, pp. 45–46). Although Sen does not oppose Nussbaum’s list, he cautions against one predetermined list and instead favors identifying those capabilities and goods that are most critical to the specific case in question, which ultimately allows for broader applications of this approach (Arponen *et al.* 2016, pp. 544).

While there is value in using universal categories to facilitate cross-cultural studies, the critical capabilities and critical goods relevant to a Neolithic farmer or a Classic

Maya king are of a very different kind than those pertaining to the modern world. Although archaeology faces the added constraint of what can be observed and how those capabilities and goods can be measured, we outline three general categories of wealth and well-being that account for the core economic, social, and somatic dimensions of QOL in past societies.

Archaeological Analogs

There exist just a handful of archaeological studies that have explored the capabilities concept and other ideas related to studying the conditions of life in past societies. For example, Michelle Hegmon and colleague's *Archaeology of the Human Experience* (2016) uses the United Nation Development Project's (UNDP 1994) seven dimensions of human security as a way to measure how well-being is affected by social and environmental changes in a number of cases (Hegmon *et al.* 2008; Hegmon and Peeples 2018; Nelson *et al.* 2016; Vésteinsson *et al.* 2019). Such initiatives align with the list-based approach described above and aim to identify a set of variables that are important to overall human well-being in a wide variety of contexts. However, most applications of this approach only consider one or two components due to limitations in the availability of archaeological proxy data (Hegmon and Peeples 2018; except see Ortman 2016).

In another example, Michael Smith (2015) outlines a more conceptual model based on two key components from Sen's work: standard of living and capabilities. According to this approach, *standard of living* refers to the critical goods and economic opportunities available to an individual or group that are traditionally measured by wealth, income, or per capita production. For archaeology, standard of living can be easily estimated using common indicators of house size, material possessions, or burial goods (Smith 1987, 2015). *Capabilities*, on the other hand, reference the noneconomic means by which individuals or groups achieve their goals; for example, by having specialized knowledge, good health, strong social ties and institutions, or participating in community activities. While the notion of capabilities may seem intuitive, developing ways to assess them archaeologically is not so straightforward; recent ethnographic work, however, demonstrates the empirical potential of capabilities.

In a large cross-cultural study, Borgerhoff Mulder *et al.* (2009; Bowles *et al.* 2010) estimate the degree of intergenerational transmission for three different types of wealth (*e.g.*, material, relational, embodied) as well as the extent of wealth inequality across 21 different populations. These researchers found that different forms of wealth have variable outcomes on the degree of inequality within hunter-gatherer, horticultural, pastoral, and agricultural societies. Among horticultural and foraging populations, studies found that embodied and relational forms of wealth, measured by ecological knowledge and social networks, are more important than traditional economic forms of material wealth based on land and household possessions (Gurven *et al.* 2010). This is important for archaeology because it underscores the need to consider multiple indicators of wealth and well-being in order to examine the diverse impacts of inequality over long periods of time. This is especially true for studying groups transitioning to agriculture, such as the earliest Maya who established a sedentary lifestyle beginning around 1000 BCE (Inomata *et al.* 2015). Examining the impacts of different kinds of inequality on people's overall well-being—whether in the past or the present—clearly

necessitates a multidimensional approach that considers factors beyond basic household size and assets.

QOL Components

An archaeological model of QOL that can be applied to a wide range of cases calls for a flexible framework that is grounded in relevant theory and can be tested with empirical data. This study builds on the work cited above to identify a set of economic and noneconomic variables that approximate forms of wealth and well-being that are generalizable across a wide range of archaeological cases. In this model, QOL is divided into three primary components. The economic dimension is represented by material wealth, which is synonymous with the standard of living concept defined by Sen and Hawthorn (1987). Such critical goods should provide the economic means to achieve basic human needs. The noneconomic dimension is divided into two components that we call social well-being and embodied well-being. Social well-being refers primarily to an actor's position in social networks, which enables them to access critical immaterial resources and build social capital (Lin 1999). According to the capabilities approach, being connected enables individuals, households, or larger groups to carry out specific life goals which may be especially important in the face of catastrophic events (Gjesfjeld 2021). Lastly, embodied well-being encompasses the domains of human health, diet, appearance, physical labor, and specialized knowledge that describe the overall physical condition of an individual and provide the essential functions to achieve life goals.

Proxy measures are essential for understanding past processes and attributes that leave no direct trace, so we define several indices for each category of wealth and well-being and describe how these indices were calculated after introducing the case study. Table 1 provides a summary of this information. While these specific variables should not be viewed as fixed or exhaustive, the categories of wealth and well-being introduced here provide a general framework to make comparisons between different forms of inequality that produce more holistic reconstructions of socioeconomic life in the past. We illustrate the utility of this original approach with a case study and then propose ways that it can be expanded and applied to other archaeological contexts.

Chronology and Sociopolitical Changes in the Western Maya Lowlands

Archaeological research on quality of life is fundamentally related to questions about the emergence of inequality and sociopolitical complexity. Although most explanations of long-term inequality focus exclusively on power and wealth, there is a need to evaluate these dimensions independently (Smith *et al.* 2018) and consider how different forms of political organization (*e.g.*, network vs. corporate) may have differentially impacted quality of life through time and across all levels of society. Disarticulating these aspects of inequality further enables archaeology to move beyond neoevolutionary typologies of past societies and consider a wider range of structural inequities that existed at different points in time. Well-documented settlements with extensive and long-term occupation like Altar de Sacrificios therefore provide crucial contexts to study the rapid transformations associated with the emergence of political institutions and concomitant changes in wealth and well-being across multiple social

Table 1 Description of wealth and well-being indicators and their proxy estimates used in the current study

Category	Definition	Indicator	Variables	Estimate	Range
Material wealth	Individual wealth	Personal ornaments	Qty. of beads, earpools, pendants, pins, and other items of personal adornment	Total number	0–∞
	Supra-household wealth	Utilitarian objects	Qty. of whole ceramic vessels, lithic tools, ground stone artifacts and other substance items	Total number	0–∞
Social well-being	Position in local and long-distance social networks	Material richness Grave index	Material class Grave type (pit = 1, urn = 2, cist = 3, crypt = 5) Grave context Domestic = 1, Ceremonial = 2	Richness Grave type × grave context	0–∞ 1–10
Embodied well-being	Factors considered essential to the overall physical condition of an individual over the course of their lifetime	Body modification index Adjusted health index	(# decorated teeth/16) × 100% Cranial modification Presence = 100 Absence = 0 Dental health (completeness) based on tooth loss, abscesses and caries Enamel hypoplasias Anemia indicated by porotic hyperostosis Infections indicated by osteitis Degenerative joint disease indicated by arthritis Evidence of trauma indicated by healed fractures	% decorated teeth + cranial modification 1 – (# caries + # premortem tooth loss)/32 Scores for other variables were transformed according to Saul's (1972) analysis to align with Steckel et al.'s (2002) health index See Supplemental Materials for full description and R code	0–200 0–100

scales. A brief overview of the chronology and sociopolitical changes characterizing this region of the Maya lowlands provides the necessary background to situate the case study.

The narrative arc of Maya prehistory is unique in Mesoamerica in that the transition to a sedentary agricultural lifestyle occurred relatively late and was followed by a fairly rapid succession of social and political changes over the next two millennia. Incipient food production is poorly understood in the tropical lowlands, especially in the Maya area due to the small number and geographically dispersed sites dating to the Archaic period (Lohse 2010). Of the few pre-ceramic sites that have been found, most are located in riverine environments where freshwater resources would have been attractive to mobile horticulturalists (Kennett 2012; Rosenswig *et al.* 2014). Although most of these early sites lack habitation features, recent investigations at nearby Ceibal have identified the earliest ceremonial architecture in the Maya lowlands, constructed by coexisting mobile groups of early ceramic users beginning around 1000 BCE (Inomata *et al.* 2015). This E-group architectural plan became formalized and spread across the Maya lowlands over the next several centuries (Inomata 2017). Early signs of social stratification also appear during the Middle Preclassic period (ca. 1000–400 BCE) based on patterns of residential architecture and burials recovered from various lowland Maya sites (Hammond *et al.* 1992; Hammond and Gerhardt 1990; McAnany 2004; Triadan *et al.* 2017). Developments during the Late Preclassic (ca. 400 BCE–200 CE), including settlement expansion, population growth, economic exchange, and the establishment of political institutions centered on divine rulership (Lucero 2003; McAnany 1995), set the stage for continued growth and centralization of political power during the subsequent Classic period (ca. 200–800 CE). By the end of this period, population increase, prolonged drought, and increased competition led to intense warfare at numerous sites, particularly in the Petexbatun-Pasion region, which ultimately resulted in the abandonment of many centers by the middle of the tenth century CE (Demarest 2004; Demarest *et al.* 1997).

Previous Research at Altar de Sacrificios

Located in southwestern Petén, Guatemala, Altar de Sacrificios is strategically situated at the confluence of the Usumacinta River, where the Pasión and Salinas-Chixoy rivers come together (Fig. 1). Following early twentieth century explorations (Maler 1908; Morley 1937), archaeological investigations were carried out here from 1958 to 1963 under the direction of Willey and Smith (1969) sponsored by the Peabody Museum at Harvard University. As the first large-scale archaeological project in southern Petén, the primary goal of the project was to establish a site chronology based on an intensive excavation program and ceramic analysis. Deep trench excavations in the ceremonial core and test pits in all of the house mounds documented at the time ($n = 41$) yielded the discovery of a new ceramic complex named the Xe complex (Adams 1971). Throughout the Preclassic and into the Early Classic, Group B was the center of ritual activity and ceremonial construction which relied upon locally available building materials including river clams and red sandstone (Smith 1972). By the early seventh century CE, however, the focus shifted to Group A with a major building campaign that imported limestone quarried from distant sources. Monuments were also carved in a style more typical of central Petén with numerous stelae dedicated in the main plaza

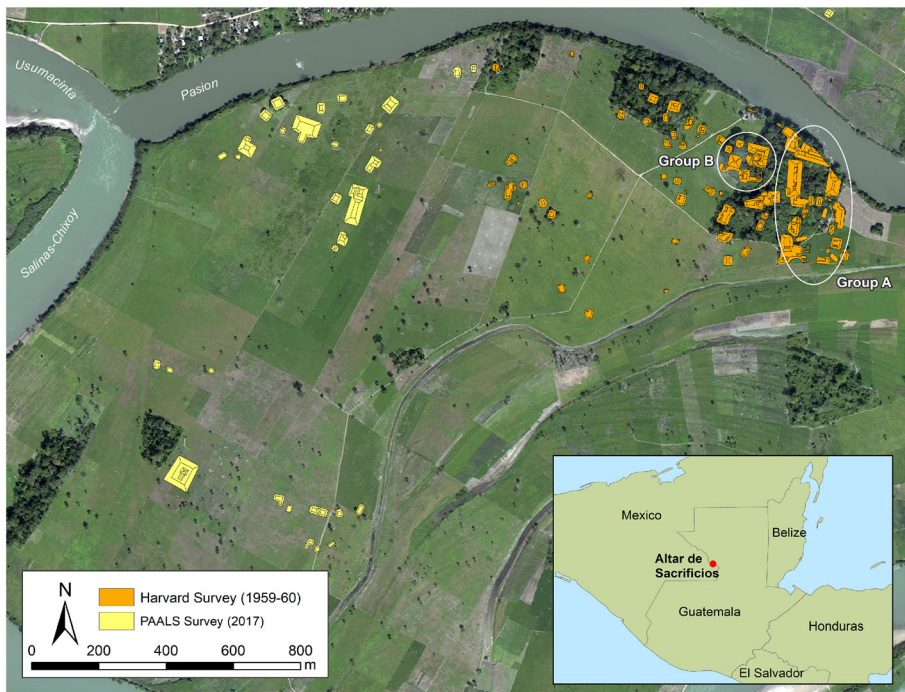


Fig. 1 Settlement map of Altar de Sacrificios showing the location of previous and recently documented structures. Satellite image courtesy of the DigitalGlobe Foundation

during the Late Classic period (Polyukhovych, personal communication). The usage of a new emblem glyph during this time as well as possible references to foreign rulers from Tikal signal the arrival of a new dynastic lineage and the tightening control exerted by political elites, perhaps drawn to the region because of its strategic access to important trade routes.

Ceramics, legible monument dates, and radiocarbon data generated from Harvard's investigations established Altar de Sacrificios as one of the earliest continuously occupied sites in the Maya lowlands that spans the Preclassic and Classic time periods (Fig. 2). Based on previous research and recent investigations at the nearby center of Ceibal, we now know that the lower Pasión region was a hotspot of human occupation for close to 2000 years. Since 2016, the Proyecto Arqueológico Altar de Sacrificios (PAALS) has conducted pedestrian and UAV-based surveys in the Upper Usumacinta Confluence Zone (UUCZ) to better understand the population history and settlement patterns of this region (Munson *et al.* 2019).

In addition to developing a detailed ceramic chronology, Harvard's original investigations recovered a large assemblage of human burials and associated grave goods that form the basis of the current study. A total of 140 individuals were excavated from a variety of stratified contexts including house mounds, ceremonial platforms, temples, and under plaza floors (Smith 1972). An additional 5 burials were excavated by our project in 2016 and 2017 (Paiz Aragón and Munson 2017) and are also included in the tabulated results (see [Supplemental Materials](#)). Published descriptions of the burial contexts, contents of these graves, and osteological markers were recorded in the

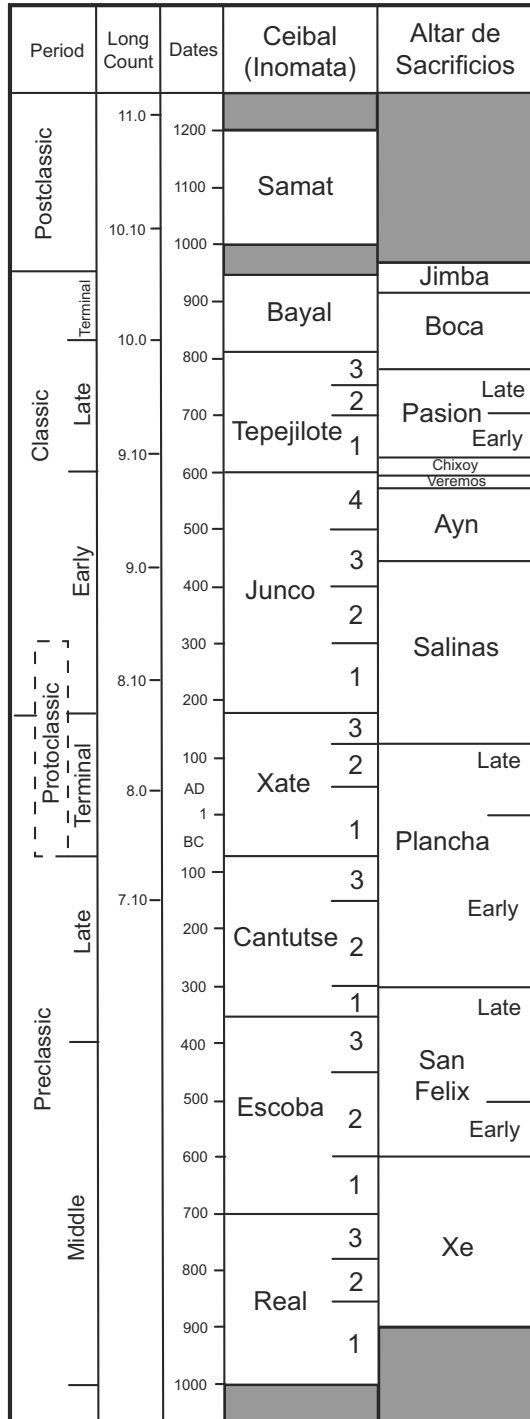


Fig. 2 Ceramic chronology chart showing the ceramic phase dates for Altar de Sacrificios (Adams 1971) in comparison to the revised high-precision chronology for Ceibal (Inomata et al. 2017)

PAALS database. A number of the burials originally excavated by Harvard were too poorly preserved to recover but were recorded in the field before being discarded (Saul 1972; Smith 1972). The collected remains of these 90 individuals were subjected to further osteobiographic analysis (Saul 1972), which provides information on cranial and dental modifications as well as skeletal pathologies. In the late 1990s, Lori Wright (2006) re-analyzed a sample of these skeletons as part of a regional study on diet and health differences among the ancient Maya, which includes isotopic data as well as updated estimates on age and sex designations used in the current study. Table 2 presents a summary of the burial population used in the current study with age classes defined as adult (20 years and older) and child (19 years and below) for analysis purposes.

Since this study focuses on diachronic changes in the distribution of wealth and well-being, the analysis only includes burials that could be assigned to a designated phase based on stratigraphy and diagnostic ceramic artifacts found in these burial contexts. While there are limitations to inferring population health from skeletal remains (DeWitte and Stojanowski 2015; Wood *et al.* 1992), we assume the samples are drawn from a single social group and restrict our interpretations to this specific community. Although we recognize that these samples may be biased representations of the once-living population, our analyses highlight distributional patterns of health inequality and other forms of well-being such that our interpretations are minimally impacted by the effects of hidden heterogeneity.

Archaeological Indicators of Wealth and Well-being

Based on the conceptual model of QOL outlined above, this study identifies several archaeological indicators of wealth and well-being. In particular, we focus on proxies derived from mortuary archaeology and bioarchaeology to take advantage of the multidimensionality of these contexts and the temporal resolution of the extant burial dataset. In doing so, we emphasize that archaeological studies of QOL are not limited to burial remains but rather best complement household-level analyses. Although the indicators we propose are specific to the former, comparable measures can be derived

Table 2 Descriptive summary of the burial population from Altar de Sacrificios. Individuals include those excavated by the Harvard Project ($n = 140$) as reported in Smith (1972) and Saul (1972) and those recovered by PAALS ($n = 5$; Paiz Aragón and Munson 2017)

Period	<i>N</i>	Female	Male	Indeterminate sex	Adult	Child	Ceremonial core	House mound
Terminal Classic	44	12	14	18	33	11	39	5
Late Classic	45	7	13	25	36	9	25	20
Early Classic	27	4	6	17	18	9	9	18
Late Preclassic	15	4	6	5	11	4	6	9
Middle Preclassic	10	2	4	4	6	4	7	3
NA	4	NA	1	3	3	1	NA	4
Total	145	29	44	72	107	38	86	59

for other units of analysis and tested with available data as demonstrated by Smith (2015); however, careful attention should be directed to the analytical challenges posed by different archaeological contexts.

One advantage of studying mortuary remains is their primary context. The patterned remains of funerary rituals reflect intentional and culturally meaningful behaviors that are generally the result of symbolically and politically charged practices. While the information encoded by mortuary rituals may be difficult to interpret, the commingling of personal adornments, mundane objects, symbols, and skeletal remains provide opportunities to examine multiple dimensions of past social lives in single coherent contexts. Another advantage of grave contexts is their tight chronological control. Unlike most household assemblages, mortuary remains generally represent single depositional events. Some Classic Maya tombs, however, were reentered and perhaps reused during certain “fire-entering” rituals that can be read as *muknal* in hieroglyphic inscriptions (Stuart 1998). Other interpretations of *muknal* suggest these rituals placed the deceased in his/her final resting place (McAnany 1998, pp. 289), thus marking an individual’s “social death” as opposed to its “biological death” (Gillespie 2001, pp. 89–91). While archaeologists always need to pay attention to taphonomic processes when interpreting burial remains, their primary contexts and chronological controls help facilitate analyses of temporal variability and diachronic change more readily than from mixed household refuse.

Mortuary contexts may provide valuable information about the social and biological lives of ancient people, but the symbolic nature of funerary rituals presents an added layer of analytical difficulty that cannot be ignored. These interpretative challenges echo debates between processual and post-processual archaeologists who either interpreted mortuary patterns as reflections of the past social organization informed by ethnographic comparison (Binford 1971; O’Shea 1984; Peebles 1971; Peebles and Kus 1977; Saxe 1971; Tainter 1978) or critiqued such analyses and advocated for more culturally specific reconstructions of ideology and belief (Hodder 1984; Shanks and Tilley 1987; Ucko 1969). Such debates were unnecessarily dichotomous (e.g., Carr 1995) and do not need to be repeated here. One of the more significant—if rather obvious—observations to emerge from these debates, however, was the recognition that “the dead do not bury themselves” (Parker Pearson 1999). The material remains of mortuary ritual are thus not a simple mirror on the past. Rather, they reflect relationships between the living and the dead and among the surviving population themselves (Joyce 1999, 2008; Parker Pearson 1993). These include next-of-kin ties, social relations between household members as well as interactions within the decedent’s wider social network, including political and economic connections. Building on this relational understanding of mortuary remains, we follow more recent theoretical developments that employ the concept of personhood (Fowler 2004; Gillespie 2001). Emphasizing the multidimensional nature of these contexts, Gillespie (2001, pp. 75) argues that personhood comprises the everyday experiences and connections within society including relationships between different individuals, individuals and groups, individuals and objects, as well as the living and the dead. Archaeological evidence derived from human burials therefore need to be contextualized and understood as being shaped by the embeddedness of individuals within these social units. Applying this notion of personhood to Classic Maya royal burials allows Gillespie (2001) to explore the relationships that created and maintained the aristocracy through multigeneration kin-based, hierarchically-organized corporate groups she calls the

‘house’ (Gillespie 2001, pp. 94–98). We extend this notion of personhood to study a wider range of grave contexts and derive indices of wealth and well-being that account for this relational perspective of QOL.

Material Wealth

Material wealth corresponds to the economic component of QOL and approximates the standard of living concept outlined by Sen and Hawthorn (1987). Archaeological indicators of material wealth are perhaps most obvious to define, traditionally relying on studies of domestic artifact assemblages and residential architecture. Objects interred with human burials provide another important source of information on wealth inequality although the interpretation of grave goods is by no means straightforward. Quinn and Beck (2016) point out the difficulty of distinguishing between “lived inequality”—those identities, experiences, and institutions that affect daily life—and “performed inequality” that are preserved in osteological records and materialized in mortuary contexts. Others similarly demonstrate the confounding and oftentimes contradictory interpretations derived from analyses that compare data from skeletal biology and material culture (Gamble *et al.* 2001; Kamp 1998; Robb *et al.* 2001). Nonetheless, many Mayanists use mortuary remains to reconstruct status differences (Hammond 2015; Krejci and Culbert 1995; Rathje 1970; Scherer *et al.* 2007; Welsh 1988; Williams and White 2006; Wright 2006), even though this likely conflates the social status of the deceased with those responsible for the funerary ritual (Gillespie 2001; Pader 1982, pp. 58). Such definitions of status, moreover, are vague and combine aspects of wealth, prestige, and rank in unclear ways. As Smith (2015) points out, “archaeologists would do best to avoid using the concept of status...[in favor of] measures derived from theory and concepts that have direct applicability for archaeological data on premodern societies, such as wealth or some of the indicators of household capabilities.” We follow this advice and apply the concept of personhood described above to estimate two independent measures of material wealth from grave goods.

For analytical purposes, we divided grave goods into three categories (personal ornaments, utilitarian objects, and ritual items) that best approximate the various levels of meaning associated with these contexts (see also Gamble *et al.* 2001). Objects that were worn and used to decorate the body, such as beads, ear spools, pendants, and pins are classified as personal ornaments and often signal aspects of a person’s identity or status (Aizpurúa and McAnany 1999; Joyce 2000). A simple count of these durable possessions therefore provides a comparative estimate of individual wealth. Other grave goods including ceramic vessels, obsidian blades and knives, and ground stone fragments are classified as utilitarian objects based upon their use as tools primarily in subsistence-related activities by the living community. Regardless of their symbolic significance within the grave context, what matters for our purpose is that these objects index the available disposable wealth of the decedent’s household or wider community, as they gave gifts and had to forgo some of their critical goods to provide offerings to the deceased (see also Fochesato *et al.* 2019). Although we cannot rule out that some of these objects may have been used by or belonged to the decedent, these items were placed in the grave by other members of the living community knowing that they would no longer be available for their intended purpose. Therefore, we count the total

number of utilitarian objects within a grave as an estimate of material wealth for some collective supra-household social unit.

While we argue that grave goods can be used to estimate different levels of wealth, it is also important to recognize that they may also be entirely symbolic or have little direct economic value. Therefore, we created a separate class of ritual paraphernalia that includes stingray spines, stone effigies, censers, lithic eccentrics, whistles, mirror fragments, copal, and other non-utilitarian items to distinguish these functions. These items are confined to ritual activities based on comparable archaeological and iconographic evidence and have little bearing on the standard of living defined here but provide important information for estimating other dimensions of well-being.

Social Well-being

Social well-being refers primarily to the critical capabilities made available through social networks. A network approach to social capital (Lin 2001) emphasizes the resources available through network ties as well as the structure of the network itself as important features that facilitate access and can be mobilized for purposive action. In short, being connected enables an individual or group the ability to carry out specific goals and mitigate risk, which aligns with the noneconomic component of QOL described above.

This study assesses social well-being using two proxy indicators that reflect an individual's relative position in local and long-distance social networks. We employ a measure of richness to estimate the number of long-distance ties based on the different classes of material present in each grave (*e.g.*, jade, riverine shell, marine shell, obsidian, etc.). Richness measures the total number of different categories represented in each burial assemblage and counts each material class equally regardless of the artifact's interpreted function. Because these objects derive from local and non-local sources, material richness is thus a measure of the relative connectedness of an individual to these different sources. However, it does not account for the intensity of those interactions, whether they are direct or indirect, nor does it assume that individuals physically traveled to distant areas to obtain these objects. In this case, higher material richness simply indicates more long-distance connections and a larger social network.

For the other indicator of social well-being, we generated a grave index to assess an individual's position in local networks. This index estimates the relative communal or familial costs of grave construction and an individual's ability to leverage that support, which is comparable to other energetic measurements of funerary rituals (Tainter 1978). The index is calculated by multiplying two variables representing grave type and burial context. Values were assigned to each of the four grave types identified by Smith (1972, pp. 214) and then multiplied by a factor of 2 if the burial was in a ceremonial structure (see Table 1 and Supplemental Materials). Scores range between 1 (for simple burial pits found in house mounds) and 10 (for crypts located in temples or other ceremonial structures), thus indicating a ten-fold increase in effort expended for constructing the most elaborate royal tombs in the ceremonial core of the settlement in comparison to the most common residential burials.

Embodied Well-being

The other noneconomic component of QOL is captured by the critical capability of embodied well-being. Previous ethnographic studies measured an analogous form of embodied wealth based on grip strength, immune function, fertility rates, cultural knowledge, and practical skills indicated by foraging and harvest returns (Bowles *et al.* 2010). Since many of these indicators are difficult to ascertain archaeologically, we developed two indices of embodied well-being that can be measured with bioarchaeological data. These proxies represent some of the most basic noneconomic aspects of the capabilities approach and should be widely applicable in most archaeological contexts.

The body modification index estimates the investment in physical appearance over the course of an individual's lifetime through cranial modification and dental decoration. Alteration of the physical body to achieve permanent phenotypic change is a costly, possibly painful, practice that requires specialized knowledge, skill, and was usually restricted to individuals with certain status or identity (Tiesler 1999, 2011). This index may therefore also account for those embodied aspects of ritual life. In this case, the body modification index is based on the sum of two attributes related to the presence or absence of cranial modification and the percentage of decorated labial teeth (see Table 1 and [Supplemental Materials](#)). Cranial modification is initiated during infancy, whereas most dental decorations are observed on adult teeth, so these attributes account for body modifications that span an individual's life history.

We also calculate an adjusted health index adapted from Steckel *et al.* (2002) to estimate an individual's overall health status. This index is based on the sum of six osteobiographical markers, which were originally recorded by Saul (1972). Attributes accounted for include enamel hypoplasia, anemia, evidence of trauma, infection, degenerative joint disease, and dental health (see Table 1 and [Supplemental Materials](#) for a description of variables and values). Data on stature was not available for this dataset and was therefore excluded from the index; however, future studies could take into account additional variables that reflect contemporary standards of paleopathological analysis. Our formula differs slightly from the one developed by Steckel *et al.* (2002) due to the way the observations were originally coded and rescaled, and to account for missing observations. The adjusted health index ranges between 0 and 100 with high scores indicating better health status. This analysis excludes infants, children, and adolescents to minimize the impacts of selective mortality and heterogeneous frailty. A detailed description of the methods used to calculate this index along with the R code and full equations for all the indices are provided in the [Supplemental Materials](#).

Measuring Disparities in Wealth and Well-being

Conceptually, QOL is a comprehensive and balanced approach to investigate the human condition in the past and present but attempts to operationalize it—especially in archaeological contexts—yield a set of issues that require further discussion. While the identification of relevant variables is central to any study that seeks to understand the complex range of factors that impact inequality, the search for appropriate measures

is still perceived as one of the most important challenges faced by contemporary QOL research (Stiglitz *et al.* 2010, pp. 91). For archaeology, this translates into the need to consider (1) the quantification of indices and (2) measuring the degree of differentiation within these QOL components.

Quantifying Indices

All of the proxy indicators described above rely on data collected in previous studies. While this highlights the ability to leverage legacy datasets to address new questions, there are inherent challenges in making those data usable for the kinds of quantitative analyses we performed, including the need to tabulate, rescale, and convert from one data type to another. We addressed these issues and generated a set of quantitative indices that approximate a range of economic, social, and somatic factors that may have affected inequality in the past. Although the conversion of data types and designation of certain values could be viewed as arbitrary, we have aimed to justify our selections in the sections above and provide additional transparency with the release of the full dataset and R code used to generate these indices ([Supplemental Materials](#)). In generating these indices, our goal is not to propose a single absolute measurement of inequality but rather to explore the multidimensional parameter space of QOL to better understand the temporal trends and relationships between these variables within a particular sociohistorical context.

Measuring Degrees of Inequality

While the quantification of proxy indices is necessary to evaluate the different dimensions of QOL, it is difficult to assess these values in an absolute sense. In this regard, it is perhaps most important to detail the inequalities (or disparities) in wealth and well-being across meaningful units of analysis rather than simply measuring the average conditions within each category (Stiglitz *et al.* 2010, pp. 86). For this reason, researchers often use the Gini coefficient to measure economic inequality between individuals or households in a population.

Gini coefficient values range between 0 and 1, with 0 representing a completely equal distribution of whatever is being measured and 1 representing the total concentration within a single unit. The simplicity of this measure allows for comparisons across different categories of wealth and well-being, social groups, or time periods. In this paper, we calculate Gini coefficients for all the indicators of wealth and well-being outlined above. In addition, we estimate confidence intervals in order to make systematic comparisons across these categories and track longitudinal trends. We refer the reader to Peterson and Drennan (2018) and Smith *et al.* (2014) for more detailed methodological descriptions of the Gini and its application to archaeology.

In recent years, archaeologists have adopted this quantitative index of inequality to assess specific types of household wealth inequality across a wide range of past societies (Ellyson *et al.* 2019; Kohler and Higgins 2016; Kohler *et al.* 2017; Kohler and Smith 2018; Smith *et al.* 2014), but few have used this measure to analyze other kinds of inequality (except see Wright 2014). Although commonly used today to analyze income distributions, it is important to keep in mind that the Gini coefficient is not inherently a measure of wealth inequality (Peterson and Drennan 2018). As a

measure of statistical dispersion, the Gini coefficient simply captures the unevenness in the distribution of a population whether the observations are counts of ground stone artifacts, grave goods or paleopathologies. When applied to noneconomic data, Gini coefficients can be a powerful technique for measuring disparities across a wide variety of domains that archaeologists would like to compare, but care should be taken when interpreting these results. For this reason, we prefer to use the terms disparity or differentiation when referring to social well-being and embodied well-being.

Results

All the analyses were computed in R (R Core Team 2019). Gini coefficients were calculated for each of the wealth and well-being indicators described above using the package DescTools (Signorell 2019). Gini computations were performed so as to be unbiased for small sample sizes (Dixon *et al.* 1987) using bootstrapping replications and 80% biased-corrected confidence intervals following procedures used by Kohler *et al.* (2017) and Ellyson *et al.* (2019). Table 3 presents the aggregated inequality results for each indicator of wealth and well-being and the full descriptive results for each time period are reported in Table 4.

Aggregated Indicators of Wealth and Well-being

Overall Gini scores were computed to derive baseline measures of inequality for each indicator defined above. While these aggregate scores do not account for temporal changes, they permit systematic comparisons between wealth and well-being variables to evaluate differences in the degree of inequality across these categories.

Material wealth shows high degrees of inequality for each indicator. The Gini coefficient for individual wealth measured by personal ornaments is 0.99 with an 80% confidence interval between 0.98 and 0.99. Since the Gini is sensitive to outliers, such a high score can be explained by the concentration of adornments found in one

Table 3 Aggregated Gini scores with 80% confidence intervals for each indicator of wealth and well-being

Category	Indicator	<i>N</i>	Gini	Lower bounds	Upper bounds	Mean	Std. Dev.	Median	Min	Max
Material wealth (individual)	Personal ornaments	141	0.99	0.98	0.99	8.9	93.4	0	0	1108
Material wealth (supra-household)	Utilitarian objects	141	0.65	0.61	0.71	1.3	2.3	1	0	19
Social well-being	Material richness	141	0.60	0.56	0.65	1.1	1.4	1	0	9
Social well-being	Grave index	141	0.25	0.21	0.30	1.8	1.3	2	1	10
Embodied well-being	Body modification index	105	0.80	0.75	0.84	24.4	46.0	0	0	200
Embodied well-being	Adjusted health index	58	0.15	0.13	0.18	68.0	18.8	70.2	12.5	100

Table 4 Descriptive statistics and Gini scores with 80% confidence intervals for all wealth and well-being indicators through time. (*MidPreC* Middle Preclassic, *LPreC* Late Preclassic, *EC* Early Classic, *LC* Late Classic, *TC* Terminal Classic)

	Period	<i>N</i>	Gini	Low bounds	High bounds	Mean	Std. dev.	Median	Min	Max
Material wealth										
Personal ornaments	TC	44	0.97	0.93	0.98	0.68	4.2	0.00	0.00	28.00
	LC	45	0.98	0.96	0.98	25.91	165.16	0.00	0.00	1108.00
	EC	27	0.82	0.75	0.89	1.26	2.65	0.00	0.00	11.00
	LPreC	15	0.67	0.40	0.73	0.33	0.49	0.00	0.00	1.00
	MidPreC	10	0.90	0.60	0.90	1.30	4.11	0.00	0.00	13.00
Utilitarian objects	TC	44	0.76	0.68	0.82	0.57	0.95	0.00	0.00	3.00
	LC	45	0.67	0.60	0.74	2.11	3.68	1.00	0.00	19.00
	EC	27	0.44	0.37	0.54	1.41	1.22	1.00	0.00	5.00
	LPreC	15	0.54	0.45	0.68	1.40	1.45	1.00	0.00	4.00
	MidPreC	10	0.32	0.17	0.48	1.00	0.67	1.00	0.00	2.00
Social well-being										
Material richness	TC	44	0.73	0.64	0.79	0.41	0.66	0.00	0.00	2.00
	LC	45	0.61	0.52	0.70	1.11	1.71	1.00	0.00	9.00
	EC	27	0.43	0.39	0.52	1.67	1.41	1.00	0.00	5.00
	LPreC	15	0.49	0.37	0.63	1.33	1.23	1.00	0.00	4.00
	MidPreC	10	0.43	0.34	0.61	1.80	1.48	1.50	0.00	4.00
Grave index	TC	44	0.05	0.02	0.07	1.89	0.32	2.00	1.00	2.00
	LC	45	0.33	0.26	0.41	2.00	1.73	2.00	1.00	10.00
	EC	27	0.17	0.16	0.17	1.37	0.49	1.00	1.00	2.00
	LPreC	15	0.43	0.29	0.50	2.20	2.51	1.00	1.00	10.00
	MidPreC	10	0.12	0.05	0.15	1.70	0.48	2.00	1.00	2.00
Embodied well-being										
Body modification index	TC	35	0.69	0.59	0.77	35.71	50.88	0.00	0.00	162.50
	LC	29	0.83	0.75	0.90	25.86	55.19	0.00	0.00	200.00
	EC	22	0.81	0.74	0.90	14.77	30.29	0.00	0.00	100.00
	LPreC	13	0.89	0.77	0.92	9.62	28.02	0.00	0.00	100.00
	MidPreC	6	0.80	0.50	0.83	18.75	40.12	0.00	0.00	100.00
Adjusted health index	TC	23	0.15	0.14	0.19	60.65	16.74	63.93	28.13	90.63
	LC	13	0.11	0.09	0.13	73.20	15.27	68.00	54.02	100.00
	EC	10	0.21	0.15	0.34	65.36	26.73	73.66	12.50	96.88
	LPreC	7	0.05	0.04	0.07	84.11	8.84	81.70	75.00	99.41
	MidPreC	5	0.09	0.06	0.13	70.66	13.56	72.66	50.00	87.50

grave. Beads are by far the most common personal ornaments in the Altar burial assemblage. These include deposits of single jadeite beads as well as strands of multiple beads that were likely worn as necklaces and made from shell, pottery, precious stone,

and one fashioned from perforated feline teeth. The average number of personal ornaments in the Altar burial assemblage is close to 9, but one individual stands out. This Late Classic royal female (B-128), interred in a stone-lined crypt in Str. A-III within the ceremonial core, was adorned with over 1000 beads made from greenstone and *Spondylus* shell and is the only person found with ear spools in the entire assemblage. In total, this grave contains over two orders of magnitude more personal ornaments than any other individual grave at Altar. This single outlier clearly contributes to the high Gini score for individual wealth. Although not as extreme, the Gini for supra-household wealth measured by utilitarian objects is also quite high (Gini = 0.65; 0.61–0.71 80% CI), which indicates that these forms of disposable wealth were not evenly distributed throughout the population. In addition, the low average number of utilitarian objects ($\bar{x}$ = 1.3) suggests that there may not be much available disposable wealth within the community to begin with. An alternative explanation might suggest that these offerings were simply not common burial practices at Altar de Sacrificios, but this does not fit with more general patterns of mortuary practice in lowland Maya society (Hammond 2015; Rathje 1970; Welsh 1988). Although overall material wealth inequality is high for both variables, it is not constant over time and we discuss these diachronic changes in the following section.

Significant differences in the degree of disparity were observed between social well-being indicators. The Gini coefficient for material richness is 0.60 with an 80% confidence interval between 0.56 and 0.65, which overlaps with the Gini for material wealth measured by utilitarian objects. Notably, the maximum number of long-distance ties estimated by material richness is 9 but on average individuals only have one network tie. Based on this observation, we hypothesize that participation in long-distance socioeconomic exchanges may have been highly restricted with only certain members of the community having multiple access points to these critical capabilities. In contrast, access to local community networks as estimated by the grave index is more equally distributed based on the lower overall Gini score (Gini = 0.25; 0.21–0.30 80% CI). This implies that most individuals had the capability to leverage local connections through a strong emphasis on community participation and household ties as estimated by funerary preparations with few individuals buried in elaborate tomb constructions within the site core.

Indicators of embodied well-being show the greatest difference in their degree of disparity. The lowest Gini score across all categories was the adjusted health index (Gini = 0.15; 0.13–0.18 80% CI), indicating low degrees of health disparity. However, it is important to emphasize that this reveals nothing about the estimated health status of the burial population. Such low disparity could be interpreted as positive, but not if everyone has poor health. We examine these diachronic trends and discuss the relationship between health disparity and the adjusted health index in greater detail below. The other estimate of embodied well-being, the body modification index, has the second highest overall Gini score at 0.80 with an 80% confidence interval between 0.75 and 0.84. Such high disparity suggests these bodily practices were not widely shared and may reflect restricted access to the specialized knowledge required to perform them. This contrasts with findings from the Classic period kingdoms of Piedras Negras and Yaxchilan located downriver from Altar de Sacrificios. There, Scherer (2018) reports observable cranial modification in 85.5% of the skeletons he analyzed from Usumacinta sites

with an additional 57.8% demonstrating evidence for dental modification. What is notable about this comparison is that these samples include elite and non-elite individuals from both primary and secondary centers that are much smaller than Altar de Sacrificios. While these practices may correlate with social rank or political affiliation in some regions, future comparative studies could examine a broader range of data sources to evaluate the degree to which neighboring populations exhibited similar or dissimilar QOL as proposed in this paper.

Wealth and Well-being Disparities Over Time

While the aggregated Gini scores permit general comparisons between wealth and well-being categories, this level of analysis is not sensitive to historical changes that may alter QOL over long periods of time. Given the chronological controls and temporal resolution of this burial dataset, we analyze wealth and well-being indicators over a span of nearly 2000. Given the paucity of archaeological studies that address QOL in past societies, it is difficult to generate expectations for these variables, so this should be viewed as an exploratory analysis at this stage. Figure 3 shows the chronological trends of the computed Gini scores for all wealth and well-being variables.

Both indicators of material wealth inequality show a steady increase throughout the Classic period. These patterns align with well-accepted views about the way that status differences were materialized and changed over time throughout lowland Maya society (Lucero 1999). Krejci and Culbert (1995) and Hammond (2015), for example, note that the earliest elite burials appeared in the Late Preclassic and became more elaborate during the Classic period. They suggest that the increasing number of vessels and amount of jade, shell, and obsidian are better indicators of wealth than the presence of cranial modification, decoration, or burial type (*e.g.*, Healy *et al.* 1998)—variables that we assign to other forms of well-being. Interestingly, individual wealth inequality is higher than expected during the Middle Preclassic in the current dataset. While the effects of small sample size should not be ignored for these early time periods, it is also possible these large differences might indicate restricted access to, or preference for, certain kinds of ornaments rather than utilitarian goods. These could include jade beads and shell necklaces, which had different forms of value and ritual importance throughout Maya society (Kovacevich and Callaghan 2019), and seem to be preferred grave goods during the late Middle Preclassic period at Altar de Sacrificios. Although both forms of wealth inequality generally increase over time, personal wealth inequality is consistently higher than disparities in supra-household wealth. From this, we hypothesize that household wealth as estimated by more traditional measures of house size or domestic possessions would follow similar trends over time and fall somewhere in between these curves.

In contrast, disparities in social well-being show markedly different trends over time (see Fig. 3b). Material richness, or people's access to long-distance networks, becomes increasingly circumscribed over time. The increasing disparity in material richness suggests that fewer and fewer individuals had access to trading partners or other long-distance social ties based on the range of raw materials represented in each burial assemblage. Although this trend is positive, the most dramatic increase occurs between the Early and Late Classic periods. We hypothesize that this reflects increasing political control over these long-distance

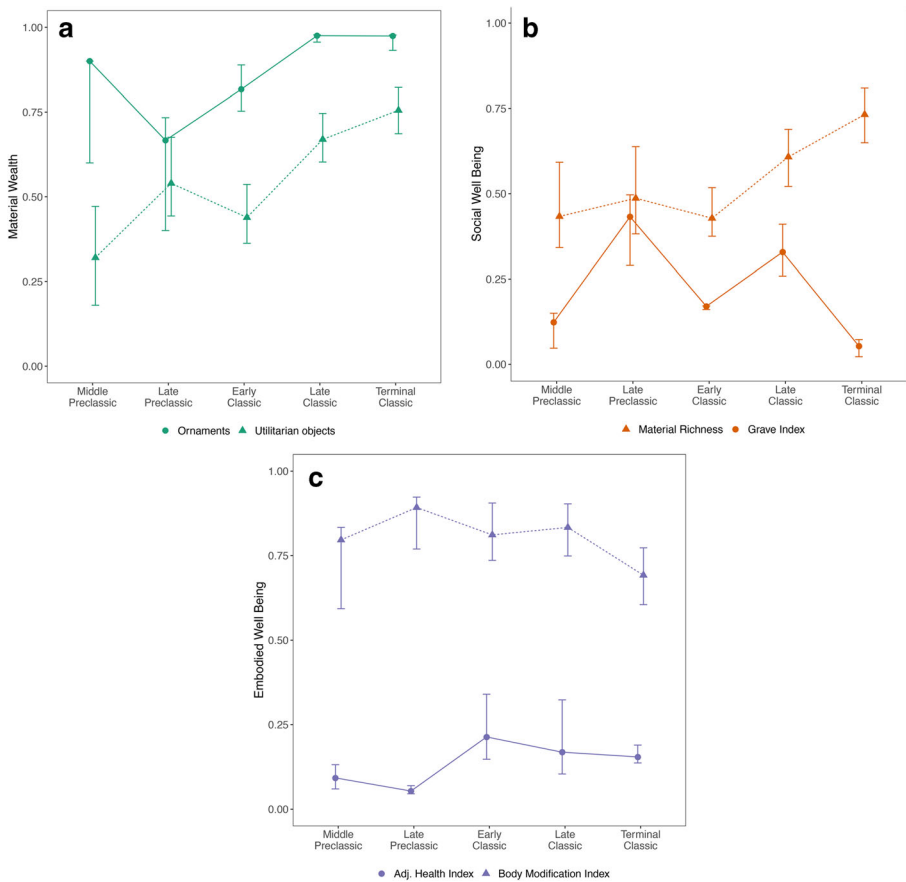


Fig. 3 Gini scores with 80% confidence intervals for all of the material wealth (a), social well-being (b), and embodied well-being (c) indicators through time

exchanges, which may be at least partially supported by architectural and epigraphic changes documented at Altar de Sacrificios during this period (Smith 1972; Houston, personal communication). For local networks, Gini scores for the grave index fluctuate dramatically over time with peak disparity occurring during the Late Preclassic and Late Classic periods. This may correspond to times when local leaders were most influential and able to leverage wide participation in construction projects for building tombs and other monumental structures, such as those documented in the ceremonial core of Groups B and A.

In comparison to the other variables, disparities across both categories of embodied well-being are relatively stable over time (see Fig. 3c). The consistently high disparity in the body modification index is notable because it suggests that dental and cranial modification were unique and important practices that may have been restricted to individuals of a certain rank or status throughout the entire occupational sequence. This might also suggest that access to the knowledge required to perform these bodily modifications was similarly restricted even though it was more commonly practiced in neighboring regions (Scherer 2018). Gini scores for the adjusted health index are

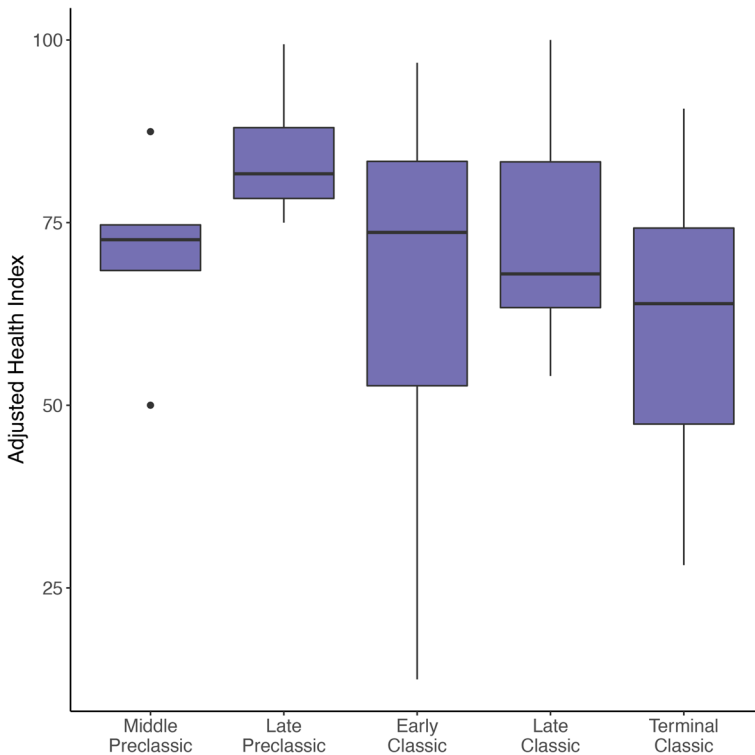


Fig. 4 Box-and-whisker plot of the adjusted health index through time. Note that lower health status during the Classic period is associated with higher degrees of health inequality in comparison to earlier time periods (see Fig. 3c)

also relatively stable over time and consistently indicate the lowest disparities among all the variables measured. Notably, the highest median score for the adjusted health index occurs during the Late Preclassic, which coincides with the lowest Gini score (Fig. 4). This suggests that during this time period adults had more similar health status and, at least on average, that health status was quite high. In contrast, health disparities increase slightly over time as the overall health status declines (see Fig. 3c). This pattern is further supported by Wright's (2006) isotopic findings of increased meat consumption among high-status individuals in the Classic period, which may be linked with higher health disparity during this time. Although we recognize potential confounding factors associated with the osteological paradox, this finding has important implications for tracking community health changes that can be investigated with future research.

Discussion and Conclusions

This study contributes to archaeological research on ancient inequality on multiple levels. Analyzing complementary forms of wealth and well-being at a single site over a span of nearly 2000 years enables a more detailed understanding of the changing human condition within specific sociohistorical contexts. Such a granular focus,

however, does not restrict the broader implications of this study. Rather, this approach and the framework outlined in this paper presents the concepts and analytical tools needed to initiate larger-scale comparative studies of QOL across a range of past societies.

Implications for Altar de Sacrificios

Archaeological studies of socioeconomic difference within ancient Maya society tend to identify individuals as elite or commoner based primarily on their material possessions. However, analyses based on single indicators of wealth are limited in their ability to capture the full range of factors that contributed to ancient inequality. Moreover, these opposing categories represent a false dichotomy that obscures the continuous distribution of wealth and underlying socioeconomic variability that characterized ancient Maya life. The methods and approach outlined in this paper offer a way to examine the degree of wealth and well-being distributions that are independent of these preconceived social categories. Applying these techniques to a burial population from a secondary center in the western periphery of the Maya lowlands allows us to characterize general patterns and chronological trends, which have important implications for generating and testing hypotheses in future investigations at this site.

QOL is a broad and multidimensional concept that cannot be reduced to a single measure. However, by approximating the various social, economic, and somatic factors that may have influenced QOL in past societies, archaeologists can produce more holistic and dynamic reconstructions of socioeconomic life in the past, especially when paired with chronological datasets. Based on the degrees of inequality and relative values of these different dimensions of wealth and well-being (see Table 4), it appears that the Late Preclassic was a period of optimal QOL for the local population. In comparison to other points in time, there was relatively low wealth inequality and modest amounts of disposable goods available within the community. Access to long-distance ties was moderately constrained although less so than during later time periods, but there was strong community support and participation in grave construction. In addition, health disparities were minimal with the highest health status reported during this period despite the small sample. Although it is not yet possible to make comparisons between other populations with these data, we hypothesize that the third century BCE through the mid-third century CE was a period of relative “good living” in Altar’s long history of occupation. Future household investigations will test this hypothesis and determine the extent to which the broader population may have experienced similar quality of life.

Studying the distribution of wealth and well-being in ancient societies requires a large dataset that is representative of the range of socioeconomic differences that were present in the past—not just a few cases picked from a small number of elite and commoner contexts. While the burial data used in this study offers an empirical assessment of these general trends, there are limitations in extrapolating these individual-level data to the larger living population (Wood *et al.* 1992). In addition, burial assemblages may overestimate inequality as suggested in several recent studies (Kohler *et al.* 2017; Windler *et al.* 2013) though we hypothesize that the observed chronological trends are robust even if the Gini scores are aberrantly high in comparison to other studies. Although previous archaeological applications of the Gini focused on measures of wealth inequality from burial assemblages (McGuire 1983; Schulting 1995), households

have become the preferred unit of analysis for making cross-cultural comparisons of inequality across a wide range of societies (Kohler and Smith 2018). The comparative approach, however, tells us little about the specific contexts and historical processes that gave rise to different degrees of inequality in past societies, especially when analyzing single dimensions of wealth. While it is still possible to track broad chronological trends with household data over long spans of time (Kohler *et al.* 2017), such studies lack the necessary detail and high-frequency data to examine the shorter-term dynamics of inequality operating within societies or certain communities. Future research at Altar de Sacrificios is designed to collect and analyze a larger sample of multicomponent household data to generate comparable measures of wealth and well-being that will address further questions about QOL changes in ancient Maya society.

Implications for Studying QOL in Past Societies

While the current dataset is limited in its ability to draw definitive conclusions about overall QOL at Altar de Sacrificios, the conceptual framework and analytical tools presented in this paper outline a new approach to studying ancient inequality that has important implications for future archaeological research. Many researchers recognize wealth as a multidimensional concept that crosscuts various social, economic, and material domains (Bowles *et al.* 2010; Kusimba 2020), yet attempts to operationalize these are hampered by archaeology's necessary reliance on proxy variables and development of consistent and comparable measurement techniques. The framework developed in this paper is designed to be flexible and scalable to allow archaeologists to investigate multiple dimensions of wealth and well-being that may have influenced QOL in the past. Drawing upon Sen's notion of capabilities, this approach does not propose a strict set of criteria to assess but focuses instead on the conditions and activities that enabled individuals or groups to pursue their livelihoods using culturally- and historically-appropriate proxy measures. Importantly, analyzing the distribution of these factors using the Gini coefficient enables researchers to not only quantify the degree to which populations had equal access to these critical goods and resources, but should also facilitate richly comparative studies of ancient inequality.

As archaeology moves toward more comprehensive analyses of inequality in past societies, we conclude by outlining some areas of future research that are particularly promising for QOL research. Accepting the premise that social well-being, physical health, and material wealth represent the primary means by which people in the past achieved their goals, archaeologists should be interested in examining the degree to which these factors differentially contributed to QOL. Previous ethnographic studies, for example, indicate that societies depend upon different forms of wealth according to their subsistence economy (Smith *et al.* 2010). Archaeologists could generate similar expectations, testing the relative importance of wealth and well-being factors for QOL in different contexts. Beyond basic comparisons of production systems, archaeologists might also consider how these variables contribute to QOL differences in different political regimes, social organizations, or across different levels of technological complexity. Alternatively, researchers working in the same culture area or time period could make intra-societal comparisons or examine differences between rural and urban settlements. Analyzing the relationships among these variables in different contexts would generate richer comparisons of QOL across multiple social scales.

With datasets that span long periods of time, archaeologists are poised to examine QOL changes associated with significant historical or catastrophic events such as volcanic eruptions, severe drought, war, and epidemics. What impacts do such turmoil and disruption bring to a society's quality of life? To what degree do individuals leverage their social connections or rely upon economic wealth to bring them out of strife? Are societies with greater equality better able to overcome disaster? Are societies with high inequality more vulnerable? Such questions align with resilience theory in archaeology (Redman 2005) and would further contribute to understanding the diverse strategies employed by past societies to cope with similar challenges faced today.

Studying the disparities in wealth and well-being enables a more detailed analysis of the specific contexts and historical factors that gave rise to varying degrees of inequality in the past. While the case study presented in this paper examines individual-level differences within a single community over a long period of time, the approach we outline is scalable to larger groups and flexible enough to incorporate additional quality of life estimates. Incorporating multiple dimensions of wealth and well-being into archaeological studies of inequality will facilitate more robust and inclusive analyses of what it meant to "live well" in the past.

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Data Availability All relevant data are within the paper and its Supporting Materials files.

Code Availability All relevant code is provided in the Supporting Materials.

Declarations

Conflict of Interest The authors declare no competing interests.

References

- Adams, R. E. W. (1971). *Ceramics of Altar de Sacrificios, Guatemala (Vol. 63, No. 1)*. Cambridge: Harvard University.
- Aizpurúa, I. I. I., & McAnany, P. A. (1999). Adornment and identity: Shell ornaments from Formative K'axob. *Ancient Mesoamerica*, 10(1), 117–127.
- Arponen, V. P. J., Müller, J., Hofmann, R., Furholt, M., Ribeiro, A., Horn, C., & Hinz, M. (2016). Using the Capability Approach to Conceptualise Inequality in Archaeology: the Case of the Late Neolithic Bosnian Site Okolište c. 5200–4600 bce. *Journal of Archaeological Method and Theory*, 23(2), 541–560.
- Binford, L. R. (1971). Mortuary Practices: Their Study and Their Potential. *Memoirs of the Society for American Archaeology*, 25, 6–29.

- Borgerhoff Mulder, M., Bowles, S., Hertz, T., Bell, A., Beise, J., Clark, G., et al. (2009). Intergeneration Wealth Transmission and the Dynamics of Inequality in Small-Scale Societies. *Science*, 326, 682–688.
- Bowles, S., Smith, E. A., & Borgerhoff Mulder, M. (2010). The Emergence and Persistence of Inequality in Premodern Societies. *Current Anthropology*, 51, 7–17.
- Carballo, D. (2011). Advances in the Household Archaeology of Highland Mesoamerica. *Journal of Archaeological Research*, 19, 133–189.
- Carr, C. (1995). Mortuary practices: Their social, philosophical-religious, circumstantial, and physical determinants. *Journal of Archaeological Method and Theory*, 2(2), 105–200.
- Costanza, R., Fisher, B., Ali, S., Beer, C., Bond, L., Roelof, B., & Danigelis, N. L. (2007). Quality of Life: An Approach Integrating Opportunities, Human Needs, and Subjective Well-Being. *Ecological Economics*, 61(2–3), 267–276.
- Demarest, A. A. (2004). After the Maelstrom: Collapse of the Classic Maya Kingdoms and the Terminal Classic in Western Petén. In A. A. Demarest, P. M. Rice, & D. S. Rice (Eds.), *The Terminal Classic in the Maya Lowlands* (pp. 102–124). Boulder: University Press of Colorado.
- Demarest, A. A., O'Mansky, M., Wollley, C., Tuerenhout, D. V., Inomata, T., Palka, J., & Escobedo, H. (1997). Classic Maya Defensive Systems and Warfare in the Petexbatun Region. *Ancient Mesoamerica*, 8(2), 229–253.
- Deneulin, S., & McGregor, J. A. (2010). The capability approach and the politics of a social conception of wellbeing. *European Journal of Social Theory*, 13(4), 501–519.
- DeWitte, S. N., & Stojanowski, C. M. (2015). The Osteological Paradox 20 Years Later: Past Perspectives, Future Directions. *Journal of Archaeological Research*, 23(4), 397–450.
- Dixon, P. M., Weiner, J., Mitchell-Olds, T., & Woodley, R. (1987). Bootstrapping the Gini Coefficient of Inequality. *Ecology*, 68(5), 1548–1551.
- Dobres, M. A., & Robb, J. (2000). *Agency in Archaeology*. London: Routledge.
- Douglass, J. G., & Gonlin, N. (2012). *Ancient Households of the Americas: Conceptualizing What Households Do*. Boulder: University Press of Colorado.
- Ellyson, L. J., Kohler, T. A., & Cameron, C. M. (2019). How far from Chaco to Orayvi? Quantifying inequality among Pueblo households. *Journal of Anthropological Archaeology*, 55, 101073. <https://doi.org/10.1016/j.jaa.2019.101073>.
- Fochesato, M., Bogaard, A., & Bowles, S. (2019). Comparing ancient inequalities: the challenges of comparability, bias and precision. *Antiquity*, 93(370), 853–869.
- Fowler, C. (2004). *The Archaeology of Personhood: An Anthropological Approach*. London and New York: Routledge.
- Gamble, L. H., Walker, P. L., & Russell, G. S. (2001). An Integrative Approach to Mortuary Analysis: Social and Symbolic Dimensions of Chumash Burial Practices. *American Antiquity*, 66(2), 185–212.
- Gillespie, S. D. (2001). Personhood, Agency, and Mortuary Ritual: A Case Study from the Ancient Maya. *Journal of Anthropological Archaeology*, 20(1), 73–112.
- Gjesfeld, E. (2021). Networks and Catastrophes. In T. Brughmans, B. Mills, J. Munson, & M. A. Peeples (Eds.), *Oxford Handbook of Archaeological Network Research*. Oxford: Oxford University Press. (In press).
- Gurven, M., Borgerhoff Mulder, M., Hooper, P. L., Kaplan, H., Quinlan, R., Sear, R., et al. (2010). Domestication Alone Does Not Lead to Inequality. *Current Anthropology*, 51, 49–64.
- Hammond, N. (2015). The Big Sleep: Early Maya Mortuary Practice. In C. Renfrew, M. J. Boyd, & I. Morley (Eds.), *Death Rituals and Social Order in the Ancient World: Death Shall Have No Dominion* (pp. 237–255). New York: Cambridge University Press.
- Hammond, N., Estrada-Belli, F., & Clark, A. (1992). Middle Preclassic Maya Buildings and Burials at Cuello, Belize. *Antiquity*, 66(253), 955–964.
- Hammond, N., & Gerhardt, J. C. (1990). Early Maya Architectural Innovation at Cuello, Belize. *World Archaeology*, 21(3), 461–481.
- Healy, P. F., Awe, J. J., & Helmuth, N. (1998). An Ancient Maya Multiple Burial at Caledonia, Cayo District, Belize. *Antiquity*, 69, 337–348.
- Hegmon, M. (Ed.). (2016). *The Archaeology of the Human Experience*. American Anthropological Association: Washington D.C.
- Hegmon, M., & Peeples, M. A. (2018). The human experience of social transformation: Insights from comparative archaeology. *PLOS ONE*, 13(11), e0208060.
- Hegmon, M., Peeples, M. A., Kinzig, A. P., Kulow, S., Meegan, C., & Nelson, M. C. (2008). Social Transformation and Its Costs in the Prehistoric US Southwest. *American Anthropologist*, 110, 313–324.
- Hodder, I. (1984). Burial, Houses, Women and Men in the European Neolithic. In D. Miller & C. Tilley (Eds.), *Ideology, Power and Prehistory* (pp. 51–68). Cambridge: Cambridge University Press.

- Inomata, T., Triadan, D., MacLellan, J., Burham, M., Aoyama, K., Palomo, J. M., et al. (2017). High-precision radiocarbon dating of political collapse and dynastic origins at the Maya site of Ceibal, Guatemala. *Proc Natl Acad Sci U S A*.
- Inomata, T. (2017). The Emergence of Standardized Spatial Plans in Southern Mesoamerica: Chronology and Interregional Interactions Viewed from Ceibal, Guatemala. *Ancient Mesoamerica*, 28(01), 329–355.
- Inomata, T., & Houston, S. D. (2001). *Royal Courts of the Ancient Maya (Vol. Volume Two: Data and Case Studies)*. Boulder: Westview Press.
- Inomata, T., MacLellan, J., Triadan, D., Munson, J., Burham, M., Aoyama, K., et al. (2015). Development of sedentary communities in the Maya lowlands: Coexisting mobile groups and public ceremonies at Ceibal, Guatemala. *Proc Natl Acad Sci U S A*, 112, 4268–4273.
- Joyce, R. A. (1999). Social Dimensions of Pre-Classic Burials. In D. C. Grove & R. A. Joyce (Eds.), *Social Patterns in Pre-Classic Mesoamerica* (pp. 15–47). Washington, D.C.: Dumbarton Oaks Research Library and Collection.
- Joyce, R. A. (2000). Heirlooms and houses: materiality and social memory. In R. A. Joyce & S. D. Gillespie (Eds.), *Beyond Kinship: Social and Material Reproduction in House Societies* (pp. 64–76). Philadelphia: University of Pennsylvania Press.
- Joyce, R. A. (2008). Burying the Dead at Tlatilco: Social Memory and Social Identities. *Archeological Papers of the American Anthropological Association*, 10(1), 12–26.
- Kamp, K. A. (1998). Social Hierarchy and Burial Treatments: A Comparative Assessment. *Cross-Cultural Research*, 32(1), 79–115.
- Kennett, D. J. (2012). Archaic-Period Foragers and Farmers in Mesoamerica. In D. L. Nichols & C. A. Pool (Eds.), *The Oxford handbook of Mesoamerican Archaeology* (pp. 141–150). Oxford: Oxford University Press.
- Kohler, T. A., Smith, M. E., Bogaard, A., Feinman, G. M., Peterson, C. E., Betzenhauser, A., et al. (2017). Greater post-Neolithic wealth disparities in Eurasia than in North America and Mesoamerica. *Nature*, 551(7682), 619–622.
- Kohler, T. A., & Higgins, R. (2016). Quantifying Household Inequality in Early Pueblo Villages. *Current Anthropology*, 57(5), 690–697.
- Kohler, T. A., & Smith, M. E. (Eds.). (2018). *Ten Thousand Years of Inequality: The Archaeology of Wealth Differences*. Tucson: University of Arizona Press.
- Kovacevich, B., & Callaghan, M. G. (2019). Fifty Shades of Green: Interpreting Maya Jade Production, Circulation, Consumption, and Value. *Ancient Mesoamerica*, 30(3), 457–472.
- Krejci, E., & Culbert, T. P. (1995). Preclassic and Classic Burials and Caches in the Maya Lowlands. In N. Grube (Ed.), *The Emergence of Lowland Maya Civilization (Vol. 8, pp. 103–116)*. Mockmuhl, Germany: Verlag Anton Saurwein.
- Kusimba, S. (2020). Embodied value: Wealth-in-people. *Economic Anthropology*, 7(2), 166–175.
- Lin, N. (1999). Building a Network Theory of Social Capital. *Connections*, 22(1), 28–51.
- Lin, N. (2001). *Social Capital: A Theory of Social Structure and Action*. Cambridge: Cambridge University Press.
- Lindert, P. H., & Williamson, J. G. (2016). *Unequal Gains: American Growth and Inequality since 1700*. Princeton: Princeton University Press.
- Lohse, J. C. (2010). Archaic Origins of the Lowland Maya. *Latin American Antiquity*, 21(3), 312–352.
- Lucero, L. (1999). Classic Lowland Maya Political Organization: A Review. *Journal of World Prehistory*, 13(2), 211–263.
- Lucero, L. (2003). The Politics of Ritual: The Emergence of Maya Rulers. *Current Anthropology*, 44(4), 523–558.
- Maler, T. (1908). *Explorations of the Upper Usumatsintla and Adjacent Regions: Altar de Sacrificios; Seibal, Itsimé-Sáchuk; Cankuen*. Cambridge: Harvard University.
- McAnany, P. A. (1995). *Living with the Ancestors: Kinship and Kingship in Ancient Maya Society*. Austin: University of Texas Press.
- McAnany, P. A. (1998). Ancestors and the Classic Maya Built Environment. In S. D. Houston (Ed.), *Function and Meaning in Classic Maya Architecture* (pp. 271–298). Washington, D.C.: Dumbarton Oaks Research Library and Collection.
- McAnany, P. A. (Ed.). (2004). *K'axob: Ritual, Work, and Family in an Ancient Maya Village*. Los Angeles: Cotsen Institute of Archaeology, University of California.
- McGuire, R. H. (1983). Breaking Down Cultural Complexity: Inequality and Heterogeneity. *Advances in Archaeological Method and Theory*, 91–142.
- Milanovic, B., Lindert, P. H., & Williamson, J. G. (2010). Pre-Industrial Inequality. *The Economic Journal*, 121, 255–272.

- Morley, S. G. (1937). *The Inscriptions of Peten* (Vol. 1-5). Washington, DC: Carnegie Institution of Washington.
- Munson, J., Mejía Ramón, A. G., & Paiz Aragón, L. (2019). Mapeo de Asentamientos en Alta Resolución con Sistemas Aéreos No Tripulados en Altar de Sacrificios, Guatemala. In B. Arroyo, L. Méndez Salinas, & G. Ajú Álvarez (Eds.), *XXXII Simposio de Investigaciones Arqueológicas en Guatemala, Tomo II* (pp. 637–648). Guatemala City: Museo Nacional de Arqueología e Ethnología.
- Nelson, M. C., Ingram, S. E., Dugmore, A. J., Streeter, R., Peebles, M. A., McGovern, T. H., et al. (2016). Climate challenges, vulnerabilities, and food security. *Proc Natl Acad Sci U S A*, 113(2), 298–303.
- Nussbaum, M., & Sen, A. (1993). Introduction. In M. Nussbaum & A. Sen (Eds.), *The Quality of Life*. Oxford: Oxford University Press.
- Nussbaum, M. C. (2000). *Women and Human Development: The Capabilities Approach*. Cambridge: Cambridge University Press.
- Ortman, S. G. (2016). Discourse and Human Securities in Tewa Origins. *Archeological Papers of the American Anthropological Association*, 27(1), 74–94.
- O'Shea, J. M. (1984). *Mortuary Variability: An Archaeological Investigation*. Orlando, FL: Academic Press.
- Pader, E.-J. (1982). *Symbolism, Social Relations and the Interpretation of Mortuary Remains*. Oxford, UK: British Archaeological Reports.
- Paiz Aragón, L., & Munson, J. (2017). *Proyecto Altar de Sacrificios, Temporada 2017*. Guatemala City: Instituto de Arqueología e Historia.
- Parker Pearson, M. (1993). The powerful dead: Archaeological relationships between the living and the dead. *Cambridge Archaeological Journal*, 3, 203–229.
- Parker Pearson, M. (1999). *The Archaeology of Death and Ritual*. College Station, TX: Texas A&M University Press.
- Peebles, C. S. (1971). Moundville and Surrounding Sites: Some Structural Considerations of Mortuary Practices II. *Memoirs of the Society for American Archaeology*, 25, 68–91.
- Peebles, C. S., & Kus, S. M. (1977). Some Archaeological Correlates of Ranked Societies. *American Antiquity*, 42(3), 421–448. <https://doi.org/10.2307/279066>.
- Peterson, C. E., & Drennan, R. D. (2018). Letting the Gini Out of the Bottle: Measuring Inequality Archaeologically. In T. A. Kohler & M. E. Smith (Eds.), *Ten Thousand Years of Inequality: The Archaeology of Wealth Differences* (pp. 39–66). Tucson: University of Arizona Press.
- Phillips, D. (2006). *Quality of Life: Concept, Policy and Practice*. New York: Routledge.
- Preucel, R. W., & Mrozowski, S. A. (2010). *Contemporary Archaeology in Theory: The New Pragmatism* (2nd ed.). London: Wiley.
- Quinn, C. P., & Beck, J. (2016). Essential Tensions: A Framework for Exploring Inequality Through Mortuary Archaeology and Bioarchaeology. *Open Archaeology*, 2(1).
- Core Team, R. (2019). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing.
- Rathje, W. L. (1970). Socio-political implications of lowland Maya burials: Methodology and tentative hypotheses. *World Archaeology*, 1(3), 359–374.
- Redman, C. L. (2005). Resilience Theory in Archaeology. *American Anthropologist*, 107(1), 70–77.
- Robb, J., Bigazzi, R., Lazzarini, L., Scarsini, C., & Sonego, F. (2001). Social “status” and biological “status”: A comparison of grave goods and skeletal indicators from Pontecagnano. *American Journal of Physical Anthropology*, 115(3), 213–222.
- Robin, C. (2003). New Directions in Classic Maya Household Archaeology. *Journal of Archaeological Research*, 11(4), 307–356.
- Rosenswig, R. M., Pearsall, D. M., Masson, M. A., Culleton, B. J., & Kennett, D. J. (2014). Archaic period settlement and subsistence in the Maya lowlands: new starch grain and lithic data from Freshwater Creek, Belize. *Journal of Archaeological Science*, 41, 308–321.
- Santley, R. S., & Hirth, K. G. (Eds.). (1993). *Prehispanic Domestic Units in Mesoamerica: Studies of the Household, Compound and Residence*. Boca Raton: CRC Press, Inc..
- Saul, F. P. (1972). *The Human Skeletal Remains of Altar de Sacrificios: An Osteobiographic Analysis*. Cambridge: Harvard University.
- Saxe, A. A. (1971). Social Dimensions of Mortuary Practices in a Mesolithic Population from Wadi Halfa, Sudan. *Memoirs of the Society for American Archaeology*, 20, 39–57.
- Scherer, A. K. (2018). Head Shaping and Tooth Modification among the Classic Maya of the Usumacinta River Kingdoms. In V. Tiesler & M. C. Lozada (Eds.), *Social Skins of the Head: Body Beliefs and Ritual in Ancient Mesoamerica and the Andes* (pp. 59–80). Albuquerque: University of New Mexico Press.
- Scherer, A. K., Wright, L. E., & Yoder, C. J. (2007). Bioarchaeological evidence for social and temporal differences in subsistence at Piedras Negras, Guatemala. *Latin American Antiquity*, 18, 85–104.

- Schulting, R. (1995). *Mortuary Variability and Status Differentiation on the Columbia-Fraser Plateau*. Burnaby, B.C.: Burnaby Archaeology Press, Simon Fraser University.
- Sen, A. (1989). Development as capability expansion. *Journal of Development Planning*, 19(1), 41–58.
- Sen, A. (1993). Capability and well-being. In M. C. Nussbaum & A. Sen (Eds.), *The Quality of Life* (pp. 30–53). Oxford: Clarendon Press.
- Sen, A. (2005). Human rights and capabilities. *Journal of Human Development*, 6(2):151–166.
- Sen, A., & Hawthorn, G. (1987). *The Standard of living*. Cambridge University Press.
- Shanks, M., & Tilley, C. (1987). *Social Theory and Archaeology*. Oxford: Polity Press.
- Sheets, P. D. (2000). Provisioning the Cerén Household. *Ancient Mesoamerica*, 11, 217–230.
- Signorell, A. (2019). *DescTools: Tools for Descriptive Statistics*.
- Smith, A. L. (1972). *Excavations at Altar de Sacrificios: Architecture, Settlement, Burials, and Caches (Vol. 62, No. 2)*. Cambridge: Harvard University.
- Smith, E. A., Borgerhoff Mulder, M., Bowles, S., Gurven, M., Hertz, T., & Shenk, M. K. (2010). Production Systems, Inheritance, and Inequality in Premodern Societies. *Current Anthropology*, 51(1), 85–94.
- Smith, M. E. (1987). Household possessions and wealth in agrarian states: Implications for archaeology. *Journal of Anthropological Archaeology*, 6, 297–335.
- Smith, M. E. (2015). Quality of Life and Prosperity in Ancient Households and Communities. In C. Isendahl & D. Stump (Eds.), *The Oxford Handbook of Historical Ecology and Applied Archaeology*. New York: Oxford University Press.
- Smith, M. E., Denchey, T., Kamp-Whittaker, A., Colon, E., & Harkness, R. (2014). Quantitative measures of wealth inequality in ancient central Mexican communities. *Advances in Archaeological Method and Theory*, 2, 311–323.
- Smith, M. E., Kohler, T. A., & Feinman, G. M. (2018). Studying Inequality's Deep Past. In *Ten Thousand Years of Inequality* (pp. 3–38). The University of Arizona Press.
- Steckel, R. H., Sculli, P. W., & Rose, J. C. (2002). A Health Index from Skeletal Remains. In R. H. Steckel & J. C. Rose (Eds.), *The backbone of history: Health and nutrition in the Western hemisphere* (pp. 61–93). Cambridge: Cambridge University Press.
- Stiglitz, J. E. (2012). *The Price of Inequality: How Today's Divided Society Endangers Our Future*. New York: W. W. Norton & Company.
- Stiglitz, J. E., Sen, A., & Fitoussi, J.-P. (2010). *Mismeasuring Our Lives: Why GDP Doesn't Add Up*. New York: The New Press.
- Stuart, D. (1998). "The Fire Enters His House": Architecture and Ritual in Classic Maya Texts. In S. D. Houston (Ed.), *Function and Meaning in Classic Maya Architecture* (pp. 373–426). Washington, D.C.: Dumbarton Oaks Research Library and Collection.
- Tainter, J. (1978). Mortuary practices and the study of prehistoric social systems. *Advances in Archaeological Method and Theory*, 1, 105–141.
- Tiesler, Vera. (1999). Head Shaping and Dental Decoration Among the Ancient Maya: Archaeological and Cultural Aspects. In *Society for American Archaeology*. Presented at the 64th Meeting of the Society for American Archaeology, Chicago.
- Tiesler, V. (2011). Becoming Maya: Infancy and Upbringing Through the Lens of Pre-Hispanic Head Shaping. *Childhood in the Past*, 4(1), 117–132.
- Tilly, C. (2001). Relational origins of inequality. *Anthropological Theory*, 1(3), 355–372.
- Triadan, D., Castillo, V., Inomata, T., Palomo, J. M., Méndez, M. B., Cortave, M., et al. (2017). Social Transformations in a Middle Preclassic Community: Elite Residential Complexes at Ceibal. *Ancient Mesoamerica*, 28(01), 233–264.
- Ucko, P. J. (1969). Ethnography and archaeological interpretation of funerary remains. *World Archaeology*, 1(2), 262–280.
- UNDP, U. N. D. P. (1994). *New Dimensions of Human Security*. New York: United Nations <http://www.hdr.undp.org/en/content/human-development-report-1994>.
- Vésteinsson, O., Hegmon, M., Arneborg, J., Rice, G., & Russell, W. G. (2019). Dimensions of inequality: Comparing the North Atlantic and the US Southwest. *Journal of Anthropological Archaeology*, 54, 172–191.
- Welsh, W. B. M. (1988). *An Analysis of Classic Lowland Maya Burials*. Oxford, UK: British Archaeological Reports.
- Wilkinson, R. G., & Pickett, K. (2009). *The Spirit Level: Why Greater Equality Makes Societies Stronger*. New York: Bloomsbury Press.
- Willey, G. R., & Smith, A. L. (1969). *The Ruins of Altar de Sacrificios, Department of Peten, Guatemala: An Introduction (Vol. 62, No. 1)*. Cambridge: Harvard University.
- Williams, J. S., & White, C. D. (2006). Dental modification in the Postclassic population from Lamanai, Belize. *Ancient Mesoamerica*, 17, 139–151.

- Windler, A., Thiele, R., & Müller, J. (2013). Increasing inequality in Chalcolithic Southeast Europe: the case of Durankulak. *Journal of Archaeological Science*, 40(1), 204–210.
- Wood, J. W., Milner, G. R., Harpending, H. C., Weiss, K. M., Cohen, M. N., Eisenberg, L. E., et al. (1992). The Osteological Paradox: Problems of Inferring Prehistoric Health from Skeletal Samples [and Comments and Reply]. *Current Anthropology*, 33(4), 343–370.
- Wright, K. I. (Karen). (2014). Domestication and inequality? Households, corporate groups and food processing tools at Neolithic Çatalhöyük. *Journal of Anthropological Archaeology*, 33, 1–33.
- Wright, L. E. (2006). *Diet, Health, and Status among the Pasión Maya: A Reappraisal of the Collapse* (Vol. 2). Nashville: Vanderbilt University Press.

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