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Research Article

Measuring inequality: The effect of units of analysis on the Gini coefficient

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Abstract

To variable degrees, inequality is present in all human societies, but how archaeologists measure inequality varies greatly. In recent research, we used the same unit of analysis, house size, to evaluate residential wealth inequality among the Classic (A.D. 250/300–800) Maya of southern Belize. Using a Gini coefficient, we found that even in this peripheral region, high degrees of inequality were present. However, nuances in inequality metrics vary based on the *analytical parameters* or units of measurement (area versus volume) and the *unit of analysis* (individual residential structures, all structures within a household group, or the entire household group, including the built environment). Generally, Gini coefficients calculated from volume are greater than those from area, and the unit of analysis affects the Gini coefficient and, thus, our interpretations of the degree of inequality present. We discuss the impact of the unit of analysis for house sizes, and how it affects our interpretations of residential wealth inequality in the past in conjunction with previous archaeological research. The findings are instrumental for comparative analyses of wealth inequality through the study of house size variation in ancient and modern societies, highlighting the value of clear definitions of the unit of analysis.

Resumen

En grados variables, la desigualdad está presente en todas las sociedades humanas, pero la forma en que los arqueólogos miden la desigualdad varía mucho. En una investigación reciente, utilizamos la misma unidad de análisis, el tamaño de la casa, para evaluar la desigualdad de riqueza residencial entre los mayas del período clásico (250/300–800 d.C.) del sur de Belice. Usando un coeficiente de Gini, encontramos que aún en esta región periférica estaban presentes altos grados de desigualdad. Sin embargo, los matices en las métricas de desigualdad varían según los parámetros analíticos o las unidades de medida (área versus volumen) y la unidad de análisis (estructuras residenciales individuales, todas las estructuras dentro de un grupo de hogares, o todo el grupo de hogares incluido el entorno construido). Generalmente, los coeficientes de Gini calculados a partir del volumen son mayores que los del área, y la unidad de análisis afecta el coeficiente de Gini y, por lo tanto, nuestras interpretaciones del grado de desigualdad que existía. Discutimos el impacto de la unidad de análisis para el tamaño de las casas y cómo afecta nuestras interpretaciones de la desigualdad de riqueza residencial en el pasado junto con investigaciones arqueológicas previas. Los hallazgos son fundamentales para los análisis comparativos de la desigualdad de la riqueza a través del estudio de la variación del tamaño de las casas en las sociedades antiguas y modernas, destacando el valor de las definiciones claras de la unidad de análisis.

Introduction

Recent research has highlighted the utility of using the same unit of analysis—house size—to compare wealth inequalities cross-culturally (Kohler and Smith 2018; Kohler et al. 2017). Although there are different dimensions and manifestations of inequality, house size (in the past and present) serves as a key indicator to assess patterned inequalities while yielding a material basis for comparison. Here, we build on foundational and global studies that have examined how sample size (Peterson and Drennan 2018), construction methods (Abbott et al. 2021), material culture (Feinman et al. 2018; Hutson 2016; Munson and Scholnick 2022), storage, and scale of community (Thompson et al. 2021a) affect inequality in specific cultural contexts using a Gini coefficient. As highlighted in this article and in this Compact Special Section of *Ancient Mesoamerica*, we find

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that assessments of wealth inequality using house size provide a robust empirical foundation for comprehensively evaluating ancient societies (Ames and Grier 2020; Barnard 2021; Basri and Lawrence 2020; Betzenhauser 2018; Bogaard et al. 2019; Brown et al. 2012; Chase 2017; Ellyson et al. 2019; Feinman et al. 2018; Hutson 2016; Hutson and Welch 2021; Kohler and Ellyson 2018; Kohler and Higgins 2016; Kohler et al. 2017; Pailes 2018; Porčić 2012; Smith et al. 2014; Stone 2018; Strawinska-Zanko et al. 2018; Thompson et al. 2021a, 2021b). However, because houses vary in form and complexity, exploring how the variations in analytical parameters of house size metrics and what is defined as a household impact our interpretations of wealth inequality in archaeological contexts are important considerations that can broaden understandings of residential inequality in the past (see also Munson et al. 2023; Richards-Rissetto 2023) and frame these data (and our findings), contextualizing them in ways that heighten their relevance for the present.

Inequality exists along spectra and is integral to many facets of life. One method to assess inequality is through wealth, which has been categorized into three basic forms: relational (personal connection and networks), embodied (physical health or stature), and material (land, labor, houses, and goods; see Borgerhoff Mulder et al. 2009; Chase et al. 2023; Smith et al. 2010). In this article, we focus on differences in material wealth by using the Gini coefficient based on house size because house size often represents a large share of domestic wealth in ancient societies. Although there is a range of ways to assess material wealth, house size serves as an archaeological indicator that is applicable across many global contexts, including the Maya region. This allows for comparative assessments along multiple scales and dimensions.

The analytical sample employed here is drawn from nearly 2,000 residential structures, clustered into 716 *plazuela* groups among eight Classic Maya (A.D. 250/300–800) centers in southern Belize. Rather than asking *why* inequality developed, we explore *how* metrics of house size, including definitions of households, impact our interpretations of wealth inequality. To do so, we measure house size using area (m^2) and volume (m^3) for three definitions of households or units of analysis. Area provides insights into the total living space and is more readily available cross-culturally than measures of volume. Volume, however, provides potential insights into the labor efforts to construct ancient houses, which alludes to the power and authority of their occupants. But calculations of volume are more difficult to obtain in the absence of detailed survey, excavation, or lidar datasets.

We evaluate house size based on three units of analysis from two forms of households: individual structures and small clusters of structures around a central residential area, which we refer to as *plazuelas*. Among the *plazuelas* we measure the "total roofed area," or the sum of all individual structures in the *plazuela*, and the built environment, including roofed and unroofed areas (Thompson et al. 2021a). Although a household represents the most basic economic and social unit (Wilk and Rathje 1982), what constitutes a "household" remains debated in Maya archaeology. As defined by Hutson and colleagues (2021:101362), "households are people who work together as minimal socio-economic groups, engaging in production, consumption, co-residence, and reproduction." Archaeologically, the household as a social unit is represented by a group of buildings situated around a central plaza where daily activities occurred. In some parts of the Maya Lowlands, these architectural units are easily discernible on the ground. The sizes of domestic units (houses), which serve as an archaeological indicator of households, also represent a large share of domestic wealth visible in archaeological contexts.

To measure inequality, we calculate the Gini coefficient based on house size. The Gini coefficient assesses the unevenness of the distribution of units within a sample (Milanovic et al. 2011; Peterson and Drennan 2018) and is frequently used as a metric for inequality. While the Gini coefficient measures the unevenness in the distribution of house size, the house size Gini coefficients are indices of the degree of inequality in those distributions, where Gini coefficients closer to 0 represent less variation in house size, while Gini coefficients closer to 1 often represent greater variations in house size.

We found that in southern Belize, the Gini coefficients of individual structures and the entire *plazuela* often parallel each other, but, in contrast, the Gini coefficients for all structures within a *plazuela* diverge from the results of the other two metrics. Our findings highlight the importance of defining the unit of analysis (see also Canuto et al. 2023; Horn III et al. 2023), caution against direct comparisons of Gini coefficients for volume and area, and suggest that degree of inequality among individual residential structures largely parallels that of the entire *plazuela*, or the built environment of the household, making it possible to compare these two units of analysis in certain contexts.

Contextualizing southern Belize

Southern Belize is in the Eastern Lowlands, nearly 150 km from the Maya heartland, and is composed of four ecosystems rich in diverse resources. More than 20 Classic Maya centers are dispersed across southern Belize, primarily in the foothills, Maya Mountains, and cayes (small, sandy islands along reefs); few Classic period centers have been identified in the coastal plains (Figure 1). While other regions of the Maya Lowlands had sedentary communities and monumental architecture by the Middle Preclassic (Ebert et al. 2017; Horn III 2020:202; Inomata et al. 2015), these features appear in southern Belize centuries later, around A.D. 100–200 (Braswell 2020; Prufer and Kennett 2020; Thompson and Prufer 2021). Initial occupation likely began centuries before the first permanent architecture, based on the long-term use of rock shelters as mortuary shrines (Prufer et al. 2019) and the presence of cultigens by 2000 B.C. (Kennett et al. 2020). Uxbenká, Nim Li Punit, Ix Kuku'il, Kaq'ru' Ha', and Ek Xux dominated the regional landscape during the latter part of the Early Classic (A.D. 400–600), with the appearance of Lubaatun, Xnaheb, and

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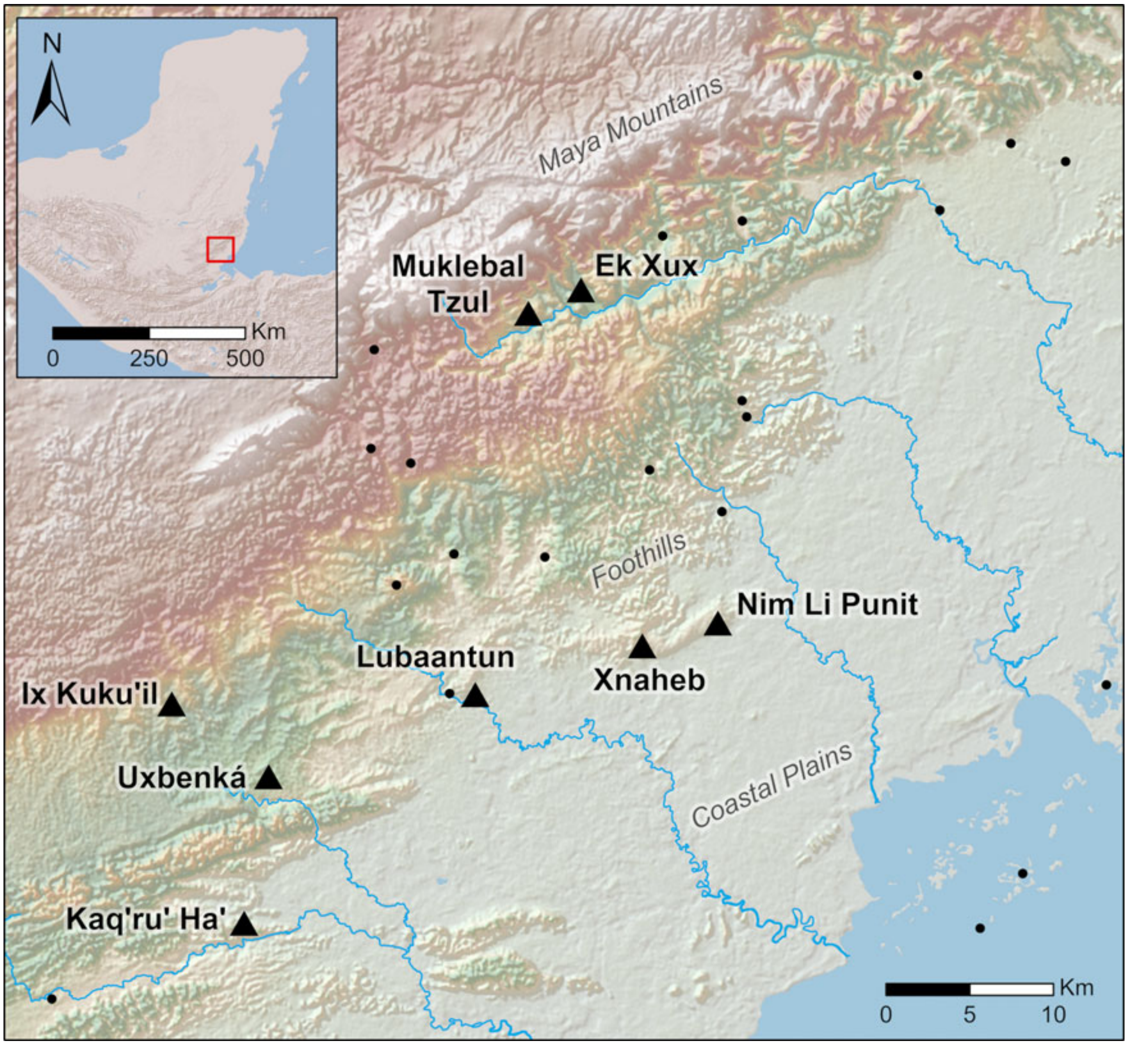

Figure 1. Classic Maya centers in southern Belize (black points), with an emphasis on the eight centers used in this study (black triangles). Figure created by Thompson.

Muklebal Tzul during the Late Classic (A.D. 600–800; Braswell and Prufer 2009; Leventhal 1990, 1992; Prufer 2002; Thompson and Prufer 2019). Inland centers were largely abandoned during the Terminal Classic (A.D. 800–1000), as political disintegration swept across the Maya Lowlands (Ebert et al. 2014). Coastal hamlets, including Ek Way Nal and Ta'ab Nuk Na, persisted well into the Terminal Classic (McKillop and Sills 2023) and Postclassic (McKillop 1996), and some small Maya communities continued to occupy inland southern Belize from A.D. 1000 to the 1880s (Prufer and Kennett 2020; Thompson 2019), when Mopan and Q'eqchi' Maya communities migrated from Guatemala (Wilk 1997).

This study focuses on eight inland centers in southern Belize with robust settlement data (Thompson et al. 2021b). Chronologic data for the centers of southern Belize are based on previously published ceramic, hieroglyphic, and radiocarbon data (see Thompson et al. 2021b). Previous research indicates that approximately 95 percent of dated households at Uxbenká and Ix Kuku'il were occupied during the Late Classic, from A.D. 600–800 (Thompson and Prufer in press), and research at other southern Belize centers indicates similar peak occupation dates (Prager et al. 2014; Thompson et al. 2021b; Thompson et al. 2023). Therefore, based on chronologies for each center in southern Belize, the Gini of house size data represent as a snapshot of wealth inequality just prior to the time of their abandonment, likely dating to around A.D. 700–800.

House size

Pedestrian survey was conducted at all eight Maya centers used in this study, including data from the lead author's doctoral research (Thompson 2019; see also Thompson et al. 2021a:S1 Table) and legacy data (Hammond 1975; Jamison 1993; Kindon 2002; Novotny 2015; see also Thompson et al. 2021b:Appendix A). Most ancient Maya houses in southern Belize consist of small platforms, typically <0.5 m in height, composed of rocks and dirt likely topped with perishable superstructures (Figure 2). Pedestrian survey included documenting the size (length,

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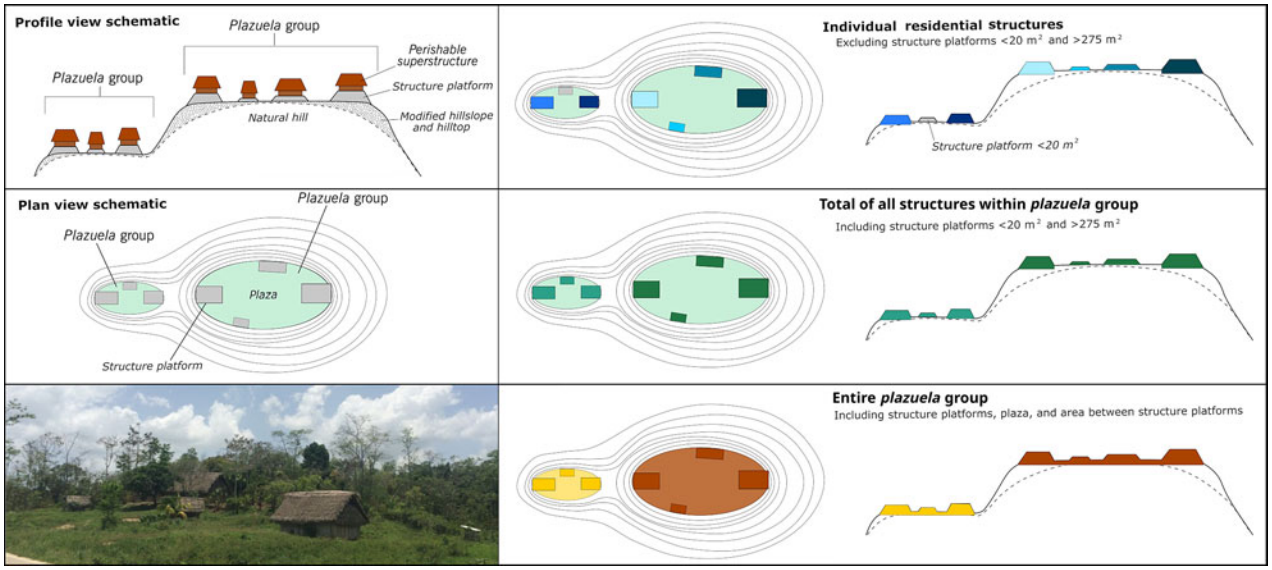

Figure 2. Units of analysis and units of measurement for house size data. Modified from Thompson et al. 2021b:Figure 3.

width, and height), architectural complexity (elaborations such as staircases), location, and organization of ancient Maya houses and their larger patterns across the landscape. In total, this research analyzed 1,942 residential structures from more than 700 *plazuela* groups among eight Classic Maya centers (Table 1).

Units of measurement

In our case study of southern Belize, area and volume data were (1) calculated from digitized survey maps for Uxbenká, Ix Kuku'il, and Lubaantun (Hammond 1975; Thompson 2019) in Esri's ArcGIS; (2) entered from tabular data for Ek Xux, Muklebal Tzul, Nim Li Punit, and Xnaheb (Jamison 1993; Kindon 2002); and (3) entered from data collected from figures and descriptions of Kaq'ru' Ha' (Novotny 2015). Previously, we reported volume data for Uxbenká and Ix Kuku'il (Thompson et al. 2021a) using a method derived from Ebert and colleagues (2016), which uses a triangulated irregular network model developed from a lidar-derived digital elevation model (DEM). Here, we update our assessment at Uxbenká and Ix Kuku'il, calculating new volumes using a lidar-derived DEM in ArcGIS, following methods outlined in Chase and colleagues (2023). Volume data were not obtained for Lubaantun because the legacy data lack detailed platform height.

Units of analysis

House size data were collected for three units of analysis (Figure 2): (1) individual residential structures; (2) all structures within a *plazuela* (i.e., all roofed areas); and (3) the

Table 1. Descriptive data for eight Classic Maya centers in southern Belize. Braswell 2020; Dunham 1990; Dunham et al. 1989; Fauvelle 2012; Hammond 1975; Jamison 1993; Kindon 2002; Leventhal 1992; Novotny 2015; Prager and Braswell 2016; Prager et al. 2014; Prufer 2002; Prufer et al. 2011, 2017; Thompson 2019; Thompson and Prufer 2019, 2021).

Political center	Environment	Number of residential structures (regardless of size)	Number of residential structures 20–275 m^2	% of residential structures that are not outbuildings or serve a different function	Households / *plazuelas*	Surveyed area (km^2)	Chronology (widespread settlement)	Occupational longevity (years)
Uxbenká	Upland	479	270	56%	180	21	A.D. 200–900	700
Ix Kuku'il	Upland	325	191	59%	122	21	A.D. 400–1000	600
Kaq'ru' Ha'	Upland	26	16	62%	7	7.5	A.D. 400–800	400
Ek Xux	Floodplain	159	140	88%	86	0.67	A.D. 400–800	400
Nim Li Punit	Upland	231	201	87%	70	1.3	A.D. 400–900	500
Muklebal Tzul	Upland	205	181	88%	67	2.49	A.D. 600–1000	400
Lubaantun	Upland	120	94	78%	56	1	A.D. 700–900	200
Xnaheb	Upland	397	326	82%	128	0.9	A.D. 700–1000	300

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entire *plazuela* (i.e., roofed and unroofed areas, including the built environment). Drawing on literature from Maya household archaeology in this region, we excluded residential platforms of less than 20 m^2 (Ashmore 1981; Hammond 1975) and greater than 275 m^2 based on regional trends in southern Belize (Hammond 1975) from our Gini calculations for individual structures; these buildings were included when calculating Gini coefficients for all structures per *plazuela* and were included in the Gini calculates for the entire *plazuela*. In general, platforms less than 20 m^2 were likely too small to be domiciles and probably functioned as ancillary buildings, such as turkey coops, storage areas, and so on (Webster and Gonlin 1988). At Lubaantun, Hammond (1975) noted that building platforms greater than 275 m^2 were likely too large to function as domestic units. Therefore, we applied 275 m^2 as the upper end of the spectrum of house sizes in southern Belize. Other articles in this Compact Special Section of *Ancient Mesoamerica* (and beyond) also use 20 m^2 as the minimum house size, while the upper limit for house size varies based on regional contexts.

Results: Gini coefficients and Lorenz curves

In southern Belize, house size and wealth inequalities vary among the centers in this study (Table 2; Supplementary Tables 1 and 2). Regardless of unit input parameters, Uxbenká, Ix Kuku'il, and Nim Li Punit have the highest Gini coefficients, ranging from 0.35 to 0.38 for individual structure area and from 0.62 to 0.63 for individual structure volume. Muklebal Tzul, Lubaantun, and Xnaheb have smaller variations in house size and slightly lower Gini coefficients, ranging from 0.31 to 0.33 for individual structure area and from 0.50 to 0.53 for individual structure volume. Ek Xux and Kaq'ru' Ha' have the lowest Gini, ranging from 0.27 to 0.29 for individual structure area and from 0.35 to 0.44 for individual structure volume. The differences in house size within each of these communities is amplified when assessing volume. Nonetheless, these Gini coefficients show variations in house size as only one measure of wealth inequality, highlighting the heterogeneity of ancient Maya communities even within a single subregion of the Maya Lowlands.

Among the high-status (or elite) households and administrative areas of Uxbenká, Ix Kuku'il, Muklebal Tzul, Nim Li Punit, and Lubaantun there were elaborate, well-constructed tombs that contained prestige items such as jade, polychrome pottery, and chert eccentrics (Kindon 2002; Prager and Braswell 2016; Prufer et al. 2011; Thompson et al. 2021a); Furthermore, Uxbenká, Ix Kuku'il, Nim Li Punit, and Lubaantun had large temples, ballcourts, and carved monuments. Xnaheb and Ek Xux contain some of these features associated with power and authority, such as large temples, elite residential areas, and monuments, but ballcourts and elaborate tombs are yet to be documented at these centers. Finally, Kaq'ru' Ha' exhibits the least evidence for wealth inequality, both in regard to different architectural symbols of power and authority and in terms of house size variation. It is a small hamlet that contains lineage burials lacking elaborated tomb architecture, ballcourts, or carved monuments (Novotny 2015). The archaeological evidence often associated with power and authority parallel the Gini coefficients, where Uxbenká, Ix Kuku'il, Nim Li Punit, and Muklebal Tzul have higher Gini coefficients for both area and volume compared to Kaq'ru' Ha'. The Gini coefficients for Lubaantun, Ek Xux, and Xnaheb are generally higher than Kaq'ru' Ha' and lower than Uxbenká, Ix Kuku'il, Nim Li Punit, and Muklebal Tzul, as may be expected for Ek Xux and Xnaheb, based on their lack of public displays of power and authority, such as ballcourts and elaborate tombs (Thompson et al. 2021b).

The degree of wealth inequality is assessed through the Gini as well as the Lorenz curve (see Chase et al. 2023). The Gini coefficient is the numeric representation of the area under the curve, and the Lorenz curve visually displays the distribution of house sizes. The impact of a single large household on the Gini coefficient is visible in the Lorenz curve for the entire *plazuela* volume of Ix Kuku'il, where the largest house results in a steep rise in the Lorenz curve (Figure 3)—in this case, in a sample with a Gini of 0.64. The Lorenz curve shows that the top 10 percent of the population (0.90 on the *x* axis) has approximately 50 percent of the wealth (0.50 on the *y* axis) based on house size. In contrast, when visually assessing the Lorenz curve of the entire *plazuela* area, the top 10 percent of the population has approximately 30 percent of the wealth (Figure 3).

Impacts of units of measurement: Area versus volume

In the Maya region, household construction tended to accumulate over time, likely as a result of the intergenerational transmission of wealth and land tenure (Borgerhoff Mulder et al. 2009; LeCount et al. 2019; Munson and Scholnick 2022; Thompson and Prufer 2021). In our sample, the Gini coefficients for house size metrics of area versus volume generally parallel each other, but volume Ginis tend to be higher than area Ginis. For example, the Gini for entire *plazuela* area at Uxbenká is 0.39, while the Gini for entire *plazuela* volume is 0.54, with a difference of 0.15 (Table 3 and Figure 4). This trend was noted at other Maya centers as well, including Caracol, which has a *plazuela* area Gini of 0.34 and a *plazuela* volume Gini of 0.60, with a difference of 0.26 (Chase 2017; Chase et al. 2023), El Pilar (Horn III et al. 2023), La Corona (Canuto et al. 2023), and Chunchucmil (Hutson and Welch 2021).

In southern Belize, excluding Kaq'ru' Ha', among individual residential structures, the difference between area and volume Ginis ranges from 0.17 to 0.25. Volume Ginis are higher than area Ginis. For example, at Nim Li Punit, if we report the area Gini of ∼0.38, we may interpret lower degrees of inequality compared to if we report the volume Gini of ∼0.63, which we may interpret as higher degrees of inequality based on differences in house size. This example highlights why we need to compare/contrast the same units of measurement (area or volume). When possible, we strongly caution against directly comparing volume

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Table 2. Results of Gini coefficients for the six metrics, including the upper and lower boundary, at a 95 percent confidence interval and the range of Ginis based on the confidence interval.

Individual residential structures

Center name	Area (m^2) Gini	Lower boundary (95% CI)	Upper boundary (95% CI)	Range	Volume (m^3) Gini	Lower boundary (95% CI)	Upper boundary (95% CI)	Range	Sample size
Uxbenká	0.35	0.33	0.38	0.05	0.60	0.56	0.64	0.07	270
Ix Kuku'il	0.38	0.35	0.41	0.06	0.62	0.56	0.68	0.12	191, *144
Muklebal Tzul	0.32	0.29	0.35	0.06	0.53	0.49	0.59	0.10	181, *180
Nim Li Punit	0.38	0.35	0.42	0.08	0.63	0.58	0.69	0.11	201, *162
Xnaheb	0.31	0.29	0.34	0.05	0.50	0.47	0.56	0.09	326, *317
Lubaantun	0.33	0.30	0.39	0.09	–	–	–	–	94
Ek Xux	0.27	0.24	0.31	0.07	0.44	0.41	0.49	0.09	140
Kaq'ru' Ha'	0.29	0.24	0.37	0.13	0.35	0.26	0.46	0.20	16, *13

All structures per *plazuela*

Center name	Area (m^2) Gini	Lower boundary (95% CI)	Upper boundary (95% CI)	Range	Volume (m^3) Gini	Lower boundary (95% CI)	Upper boundary (95% CI)	Range	Sample size
Uxbenká	0.56	0.52	0.61	0.09	0.74	0.70	0.78	0.09	170
Ix Kuku'il	0.54	0.49	0.63	0.14	0.65	0.60	0.73	0.13	120, *92
Muklebal Tzul	0.51	0.44	0.62	0.18	0.61	0.54	0.70	0.17	67
Nim Li Punit	0.45	0.40	0.52	0.12	0.66	0.60	0.74	0.14	70, *60
Xnaheb	0.44	0.40	0.48	0.08	0.54	0.50	0.59	0.10	128, *125
Lubaantun	0.43	0.38	0.52	0.14	–	–	–	–	48
Ek Xux	0.42	0.37	0.47	0.10	0.51	0.46	0.57	0.10	86
Kaq'ru' Ha'	0.36	0.25	0.51	0.26	0.35	0.18	0.59	0.40	7, *6

Entire *plazuela*

Center name	Area (m^2) Gini	Lower boundary (95% CI)	Upper boundary (95% CI)	Range	Volume (m^3) Gini	Lower boundary (95% CI)	Upper boundary (95% CI)	Range	Sample size
Uxbenká	0.39	0.36	0.42	0.07	0.54	0.50	0.58	0.09	180
Ix Kuku'il	0.42	0.37	0.49	0.12	0.64	0.50	0.81	0.32	122, *93
Muklebal Tzul	–	–	–	–	–	–	–	–	–
Nim Li Punit	0.34	0.29	0.44	0.15	–	–	–	–	70
Xnaheb	0.33	0.30	0.37	0.07	–	–	–	–	131
Lubaantun	0.32	0.28	0.38	0.10	–	–	–	–	56
Ek Xux	–	–	–	–	–	–	–	–	–
Kaq'ru' Ha'	–	–	–	–	–	–	–	–	–

*indicates the sample size for volume if different than the area sample size.

and area Ginis, and recommend clearly stating which unit of measurement is evaluated. This finding shows why using the same unit of measurement—area or volume—for comparative studies of the Maya region is crucial to our interpretations.

Impacts of units of analysis: Individual structure versus all structures in the *plazuela* versus entire *plazuela*

Clear differences in Gini coefficients exist, based on our definitions of a household—that is, individual residential structures or the *plazuela* as the fundamental household

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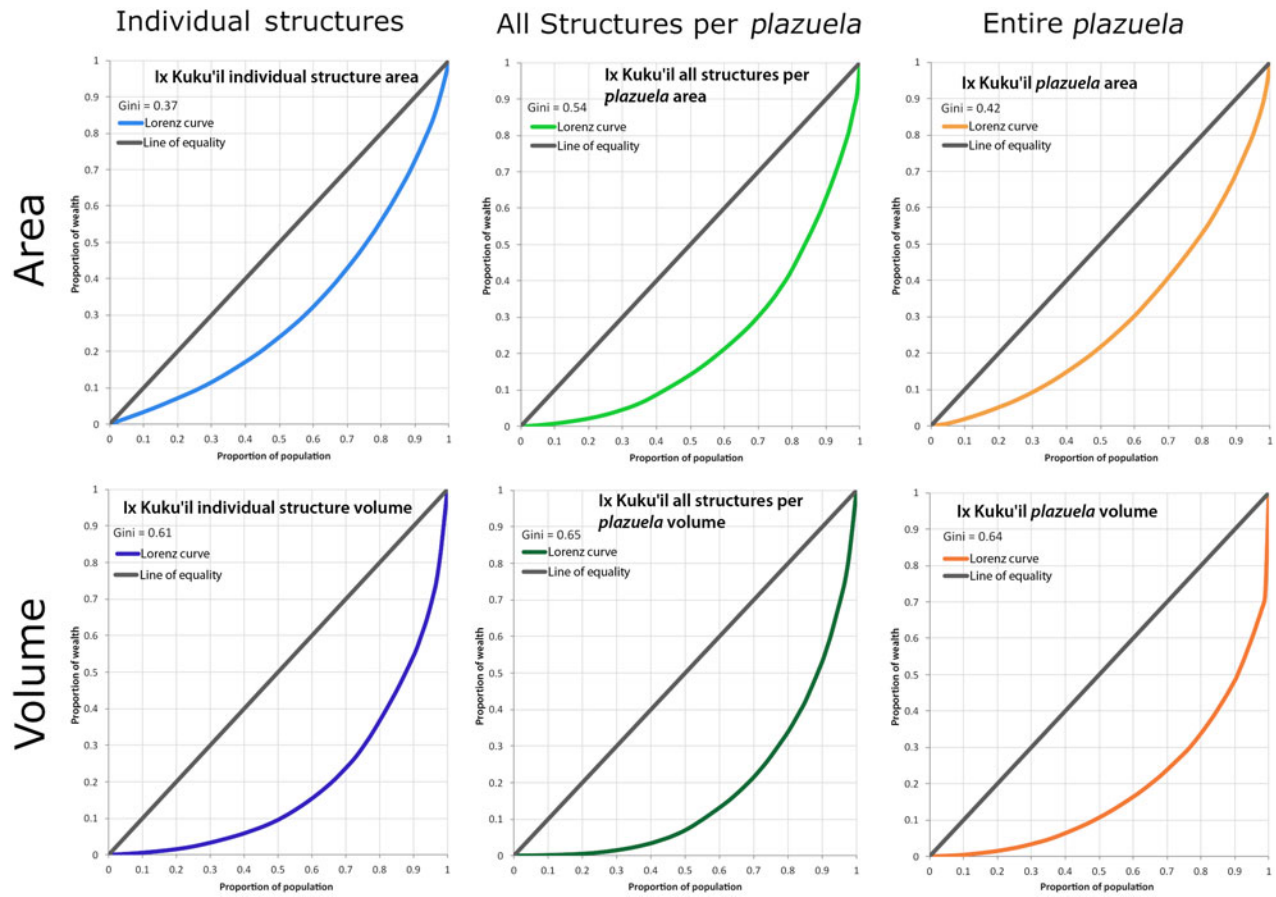

Figure 3. Lorenz curves for the six Gini coefficients at Ix Kuku'il, showing the difference in distribution of house size. A single large household on *plazuela* volume (dark orange, bottom right) results in a steep incline on the Lorenz curve. Figure created by Thompson.

unit (Table 4 and Figure 5). The difference between all structures within a *plazuela* and the entire *plazuela* highlights different uses of space in the past and analysts' selection of data—that is, whether to include the total space that a household maintains or only the clearly delineated roofed spaces. In southern Belize, area Gini coefficients for individual residential structures and the entire *plazuelas* largely mirror each other, with *plazuela* Gini

Table 3. Differences (Diff.) in Gini coefficients between area (Area) and volume (Vol.) for the three units of analysis. Generally, volume Ginis are higher than area Ginis. Data from Caracol from Chase 2017; data from Chunchucmil from Hutson and Welch 2021.

	Individual structures			All structures in *plazuela*			*Plazuela*		
Center	Area	Vol.	Diff.	Area	Vol.	Diff.	Area	Vol.	Diff.
Uxbenká	0.35	0.60	0.25	0.56	0.74	0.18	0.39	0.54	0.15
Ix Kuku'il	0.38	0.62	0.24	0.54	0.65	0.11	0.42	0.64	0.22
Muklebal Tzul	0.32	0.53	0.21	0.51	0.61	0.10	–	–	–
Nim Li Punit	0.38	0.63	0.25	0.45	0.66	0.21	0.34	–	–
Xnaheb	0.31	0.50	0.19	0.44	0.54	0.11	0.33	–	–
Lubaantun	0.33	–	–	0.43	–	–	0.32	–	–
Ek Xux	0.27	0.44	0.17	0.42	0.51	0.10	–	–	–
Kaq'ru' Ha'	0.29	0.35	0.06	0.36	0.35	−0.02	–	–	–
Caracol	–	–	–	–	–	–	0.34	0.60	0.26
Chunchucmil	–	–	–	–	–	–	0.34	0.60	0.26

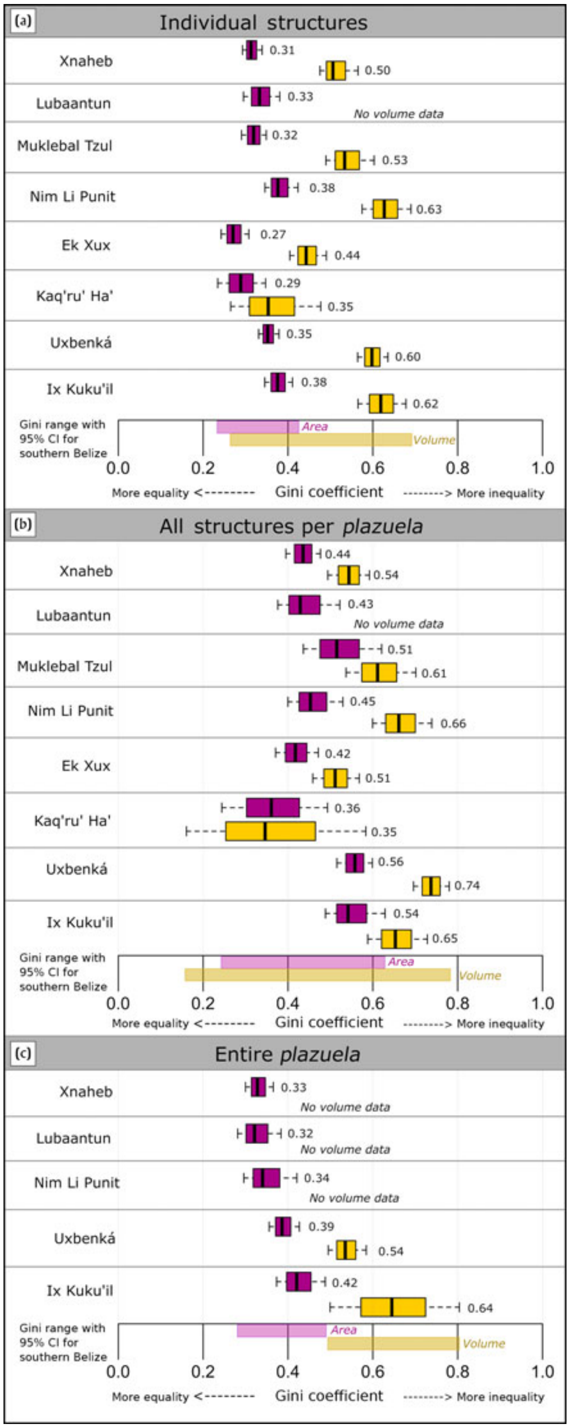

Figure 4. Box-and-whisker plots of Gini coefficients with 95 percent confidence intervals for the three units of analysis, comparing area and volume. These data are presented for (a) individual structures, (b) all structures per *plazuela*, and (c) the entire *plazuela*; see Figure 2. Cumulative range of Ginis with 95 percent CI for studied centers in southern Belize are shown at the bottom of the subfigure. Figure created by Thompson.

coefficients ±0.04 than individual structure Gini coefficients, but the 95 percent confidence intervals increase this difference. The same trend is visible for the volume Gini coefficients of individual residential structures and the entire *plazuelas* as well (Table 4). The parallels between Gini coefficients for individual residential structures and the entire *plazuela* extend beyond southern Belize. At Mayapan, the difference in area Gini coefficients for individual structures (0.32) and *plazuelas* (0.41) is 0.09 (Brown et al. 2012; Kohler et al. 2018; Strawinska-Zanko et al. 2018). At Chunchucmil, individual structure volume Ginis (0.63) are 0.03 greater than *plazuela* volume Ginis (0.60; Hutson 2016; Thompson et al. 2021a).

However, the Gini for all structures in a *plazuela* group, which includes outbuildings, storage buildings, and buildings of other functions, such as temples and shrines, is higher compared to the Gini for individual residential structures and the entire *plazuela* group. For example, for house size areas at Uxbenká, the Gini for individual residential structures is 0.35, 0.39 for the entire *plazuela*, and 0.56 for all structures per *plazuela*. In southern Belize, the difference between individual residential structures and all structures in a *plazuela* area Gini coefficient ranged from 0.07 to 0.20 (Table 4). The same trend is present among the house size volume Gini coefficients for all structures per *plazuela* group compared to the Gini coefficient for individual residential structures at the same center.

Likewise, comparing the area Gini for all structures in a *plazuela* to the area Gini for the entire *plazuela* shows a difference of Gini of 0.10–0.17, with all structures in a *plazuela* exhibiting higher Ginis. This trend holds true for the volume Ginis as well, although the sample size is low and the confidence intervals are wider. These findings highlight why clearly stating which unit of analysis was measured is important in our interpretations of inequality (see Canuto et al. 2023) and that comparing Gini coefficients of individual residential structures with those from all residential structures in a *plazuela* can skew our interpretations.

Discussion and conclusion

We highlight how sample size, units of measurement, and units of analysis impact our interpretations of inequality based on house size metrics among the Classic Maya. Concerns with sample sizes are largely diminished due to bootstrapping and confidence intervals of the Ginis, but nonetheless, small sample sizes result in wide confidence interval ranges (see Deltas 2003). For example, Kaq'ru' Ha' has the largest ranges in Ginis, varying from 0.13 (individual structure area) to 0.40 (all structures per *plazuela* volume; Table 1). We show that area and volume are not comparable units of measurement, resulting in disparate Gini coefficients in places with similar construction methods. Finally, in our dataset there is more overlap between individual structures and the entire *plazuela* than with all structures (roofed areas) in the *plazuela.* There is a wider range in the 95 percent confidence interval for all structures within a *plazuela* likely because it includes non-residential components of house groups, leading us to favor using the entire *plazuela* when possible.

Here, variations in wealth inequalities are assessed using multiple house size metrics. The centers of southern

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Table 4. Differences in Gini coefficients between area and volume for the three units of analysis.

	Area						Volume					
Center	Individual structures	All structures *plazuela*	*Plazuela*	Diff. individual structures and all structures *plazuela*	Diff. individual structures and *plazuela*	Diff. all structures *plazuela* and *plazuela*	Individual structures	All structures *plazuela*	*Plazuela*	Diff. individual structures and all structures *plazuela*	Diff. individual structures and *plazuela*	Diff. all structures *plazuela* and *plazuela*
Uxbenká	0.35	0.56	0.39	0.21	0.03	−0.17	0.60	0.74	0.54	0.14	−0.06	−0.20
Ix Kuku'il	0.38	0.54	0.42	0.17	0.05	−0.12	0.62	0.65	0.64	0.04	0.03	−0.01
Muklebal Tzul	0.32	0.51	–	0.20	–	–	0.53	0.61	–	0.08	–	–
Nim Li Punit	0.38	0.45	0.34	0.08	−0.04	−0.11	0.63	0.66	–	0.04	–	–
Xnaheb	0.31	0.44	0.33	0.12	0.02	−0.11	0.50	0.54	–	0.04	–	–
Lubaantun	0.33	0.43	0.32	0.10	−0.01	−0.11	–	–	–		–	–
Ek Xux	0.27	0.42	–	0.15	–	–	0.44	0.51	–	0.07	–	–
Kaq'ru' Ha'	0.29	0.36	–	0.07	–	–	0.35	0.35	–	-0.01	–	–

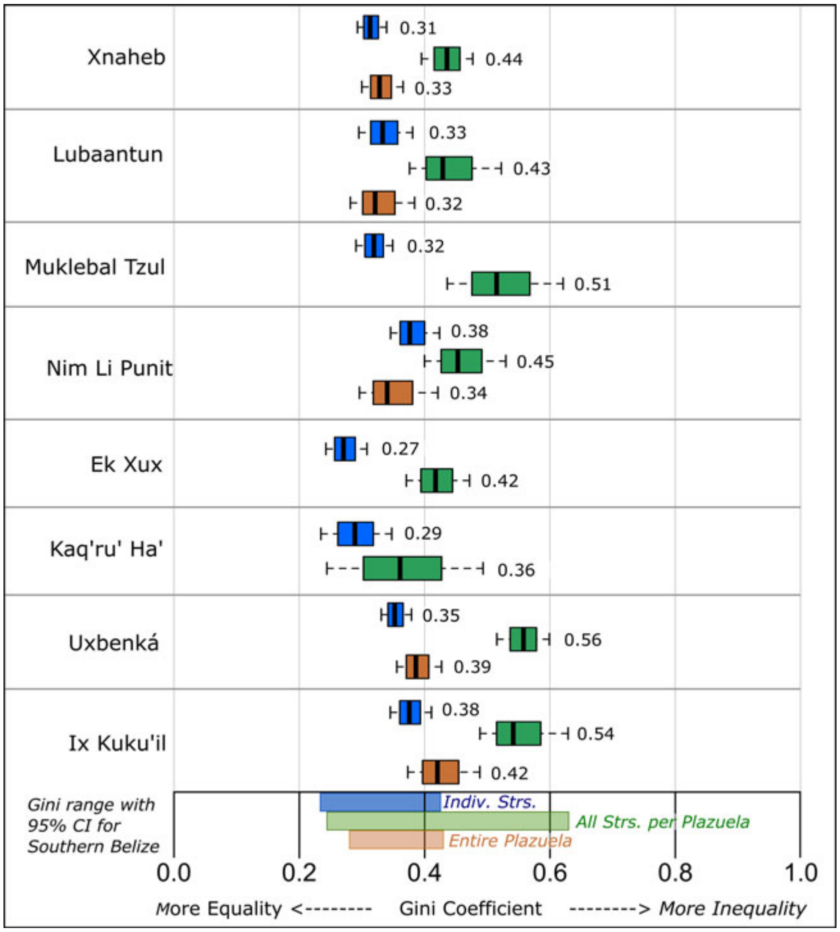

Figure 5. Box and whisker plots of Gini coefficients with 95 percent confidence intervals for area (m^2) data for the three units of analysis at each southern Belize center. Cumulative range of Ginis with 95 percent CI for studied centers in southern Belize shown at the bottom of the figure. Blue = individual structures; green = all structures per *plazuela*; orange = entire *plazuela*. Figure created by Thompson.

Belize show variation in inequality along a spectrum, but seem to group together in small clusters based on the 95 percent confidence interval overlap in their Ginis and the presence of archaeological indicators of power and authority. Uxbenká, Ix Kuku'il, and Nim Li Punit have the highest Gini coefficients, suggesting high degrees of inequality, especially for volume metrics; Muklebal Tzul, Xnaheb, and Lubaantun have lower Gini coefficients compared to the previous group, suggesting the inequality is present, but to a lesser degree, based on house size metrics alone. Kaq'ru' Ha' and, to some degree, Ek Xux, have the lowest Gini coefficients, suggesting lower degrees of inequality based on house size. Comparing the Gini coefficients to other aspects of power and authority, such as carved stelae, ballcourts, E-groups, causeways, and elaborate tombs, higher degrees of inequality are present at centers with more political trappings (Thompson et al. 2021b:Table 2).

Wealth inequalities are present in nearly all human societies. For more holistic and comprehensive comparatives, it is important to assess multiple lines of evidence to study inequality (Munson and Scholnick 2022). Furthermore, we strive to compare and contrast "like with like" to avoid the parameters of our analysis affecting our interpretations. By incorporating confidence interval into comparisons, we can alleviate some issues of sample size; this also provides differing perspectives on which data are more/less similar. Our results from southern Belize do suggest a strong overlap between individual structure Ginis and entire *plazuela* Ginis, and this pattern should be tested in other regions.

Supplementary materials. To view supplementary material for this article, please visit https://doi.org/10.1017/S0956536123000135.

Supplementary Table 1. Descriptive statistics for area (m^2) Gini calculations for individual structure, all structures per *plazuela* group, and entire *plazuelas* group for the eight Classic Maya centers discussed in this study.

Supplementary Table 2. Descriptive statistics for volume (m^3) Gini calculations for individual structure, all structures per *plazuela* group, and entire *plazuelas* group for the eight Classic Maya centers discussed in this study.

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Data availability statement. All relevant data are provided in the manuscript or supplementary materials.

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