ANTHROPOLOGY

Female hunters of the early Americas

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Sexual division of labor with females as gatherers and males as hunters is a major empirical regularity of hunter-gatherer ethnography, suggesting an ancestral behavioral pattern. We present an archeological discovery and meta-analysis that challenge the man-the-hunter hypothesis. Excavations at the Andean highland site of Wilamaya Patjxa reveal a 9000-year-old human burial (WMP6) associated with a hunting toolkit of stone projectile points and animal processing tools. Osteological, proteomic, and isotopic analyses indicate that this early hunter was a young adult female who subsisted on terrestrial plants and animals. Analysis of Late Pleistocene and Early Holocene burial practices throughout the Americas situate WMP6 as the earliest and most secure hunter burial in a sample that includes 10 other females in statistical parity with early male hunter burials. The findings are consistent with nongendered labor practices in which early hunter-gatherer females were big-game hunters.

INTRODUCTION

Big-game hunting is an overwhelmingly male-biased behavior among recent hunter-gatherer societies (*1*, *2*). Such observations would seem to suggest that this gendered behavioral pattern is an ancestral one, ostensibly stemming from life history traits related to pregnancy and child care, which constrain female subsistence opportunities (*3*, *4*). However, a number of scholars have theorized that such division of labor would have been less pronounced, altogether absent, or structurally different among our early hunter-gatherer ancestors (*5*–*13*). Early subsistence economies that emphasized big game would have encouraged participation from all able individuals. Alloparenting, which appears to have deep evolutionary roots in the human species (*14*), would have freed women of child care demands, allowing them to hunt. Communal hunting, which also appears to have deep evolutionary roots (*15*), would have encouraged contributions from females, males, and children whether in driving or dispatching large animals. Moreover, the primary hunting technology of the time—the *atlatl* or spear thrower—would have encouraged broad participation in big-game hunting. Pooling labor and sharing meat are necessary to mitigate risks associated with the *atlatl*'s low accuracy and long reloading times (*16*). Furthermore, peak proficiency in *atlatl* use can be achieved at a young age, potentially before females reach reproductive age, obviating a sex-biased technological constraint that would later intensify with bow-and-arrow technology (*17*). Last, the residentially mobile lifestyle entailed by big-game specialization is quite conducive to human reproduction and, thus, female hunting—contrary to previous thinking—because it reduces net movement relative to central-place foraging strategies (*18*). This hypothesis is consistent with high population growth rates among early hunter-gatherer populations (*19*).

Despite such theoretical considerations, some scholars have been reluctant to ascribe hunting functionality to tools associated with female burials (*20*–*22*). Concerning the Paleoindian Gordon Creek burial, Breternitz *et al.* (*23*) grappled, "Since the burial has been determined to be a female, the inclusion of a projectile point preform has been difficult to explain. However, if the artifact had been used as a knife or scraper, typically women's tools, then its inclusion with the burial is a more consistent association." Nelson (*24*) challenged a DNA-based sex determination at Toca dos Coqueiros (*25*) partially on the grounds that "…[t]he presence of inferred funerary offerings in the form of chipped stone points and other tools and flakes appear to support [male estimation]…." On the one hand, such reluctance may reflect a degree of contemporary gender bias (*20*) or ethnographic bias (*26*). On the other hand, ethnographically informed models of gendered subsistence labor remain plausible as quantitative phenomena or given the multiple pathways by which objects can come to be spuriously associated in the archeological record (*27*). Toward resolving the question of gendered big-game hunting practices among early hunter-gatherer populations in the Americas, we report the discovery of two Early Holocene [pre–8 thousand years (ka)] hunter-gatherer burials in association with big-game hunting paraphernalia and place these findings in the context of Early Holocene and Late Pleistocene burial practices throughout the Americas.

RESULTS

The archeological site of Wilamaya Patjxa was recorded in 2013 when local Aymara collaborator, A. Pilco Quispe, reported an artifact scatter near his natal community of Mulla Fasiri. The scatter covers 1.6 ha and is located at 16.2° south latitude, 70.8° west longitude, 3925 m in elevation in the Puno district of southern Peru. In 2018, in collaboration with members of the Mulla Fasiri community, excavations were initiated to understand the adaptive process of early human populations in the interior high Andes. The excavations covered 36.5 m^2, resulting in the discovery of more than 20,000 artifacts, principally flaked stone debitage, and 15 cultural pit features including five human burial pits with six individuals (Fig. 1). Two of the individuals—Wilamaya Patjxa individual 6 (WMP6) and WMP1—were associated with Early Holocene projectile points. None of the other burials were associated with hunting tools, and preliminary assessments suggest mid-Holocene dates for those burials.

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Wilamaya Patjxa individual 6

Individual 6 (WMP6) is an adult inhumation occurring in a burial pit near the center of the site and extending 55 cm below the agricultural plow zone, approximately 85 cm below the ground surface (Fig. 2, A and B). Preservation of the osteological materials is poor, consisting of a fragmentary cranium, teeth, portions of the femoral diaphyses, and tibia and fibula fragments. The individual was interred in a semiflexed position on their left side with head oriented west/northwest. Twenty-four stone artifacts were located on the floor of the burial pit (Fig. 2C and fig. S2). Six eared projectile points of 1B style suggest an Early Archaic Period burial date sometime between 11 and 9 cal. ka (*28*). Two radiocarbon dates taken on bone collagen average to 8008 ± 16 ^{14}C before the present (B.P.), or 8.98 to 8.73 cal. ka.

Twenty of the artifacts were tightly concentrated and partially stacked in a pile just above the femora. At the base of the stacked artifacts was a large igneous river cobble with a unidirectionally flaked working edge. Piled on the cobble were four complete 1B-style chert projectile points, two chert thumbnail end scrapers, two large igneous scrapers/choppers, a possible backed knife, two retouched chert flakes, three unmodified chert lithic flakes, and a red ocher nodule. Adjacent to the stacked artifacts were two small, well-rounded river cobbles and two red ocher nodules. The large river cobble and one of the small cobbles show ocher staining on the acute ends (fig. S3). The spatial co-occurrence of projectile points, scrapers, and ocher along with the ocher staining on the cobbles converge to suggest that the ocher was related hide processing (*29*).

The stacking and topological integrity of the artifact cluster indicate that the artifacts were likely interred as an integrated toolkit in a perishable container such as a leather bag. The kit includes a full suite of big-game procurement and processing tools including a flaked stone component that is notably similar to the mobile toolkit theorized by Kuhn from basic geometric principles (*30*). The stone projectile points would have been used to dispatch big game (*31*), the backed knife and lithic flakes to field dress harvested game, the large scrapers/choppers to extract bone marrow or process hides, the small scrapers for detailed hide work, and the cobbles and ocher to tan hides. In addition to the toolkit artifacts, isolated artifacts were found on the burial pit floor including a complete 1B-style projectile point, projectile point midsection, projectile point tip, and retouched laminar flake.

Age at death for WMP6 is estimated at 17 to 19 years based on dental development (*32*–*35*). Apart from the third molars, which were still developing, the remaining 14 permanent teeth are fully formed, in occlusion, and exhibit some wear. The qualitatively gracile nature of the femoral diaphyses is consistent with a female individual. Proteomic analysis of sexually dimorphic amelogenin peptides in tooth enamel (*36*, *37*) confirms this assessment. Male-diagnostic AMELY_HUMAN peptides are entirely absent. The cumulative signal intensity for female-diagnostic AMELX_HUMAN peptides is 3.47×10^9 and includes 336 unique AMELX_HUMAN peptides, indicating a female individual [Pr(F) = 0.81] (fig. S4).

Bone isotope chemistry and faunal data further indicate the importance of hunting to the WMP6 individual. A δ^{15}N value of 8.1 ± 0.1 per mil (‰), a $\delta^{13}C_{col}$ value of −18.9 ± 0.1‰, and a $\delta^{13}C_{ap}$ value of −12.8 ± 0.1‰ are all consistent with a mixed terrestrial plant and animal diet (fig. S7). Four large terrestrial mammal bone fragments were recovered from the burial fill, one of which is identifiable as a lumbar vertebra of a taruca (*Hippocamelus antisensis*) or Andean deer (table S4). Large-bodied mammal bone dominates the site assemblage, which includes 17 camelid (Camelidae), 5 deer, and 106 indeterminate large terrestrial mammal bone fragments and 1 bird element. The camelid and deer elements are likely from endemic species, vicuña (*Vicugna vicugna*) and taruca, respectively, but the fragmentary remains preclude further taxonomic specificity. Neither small-bodied mammal nor fish elements were recovered despite flotation processing of feature sediment.

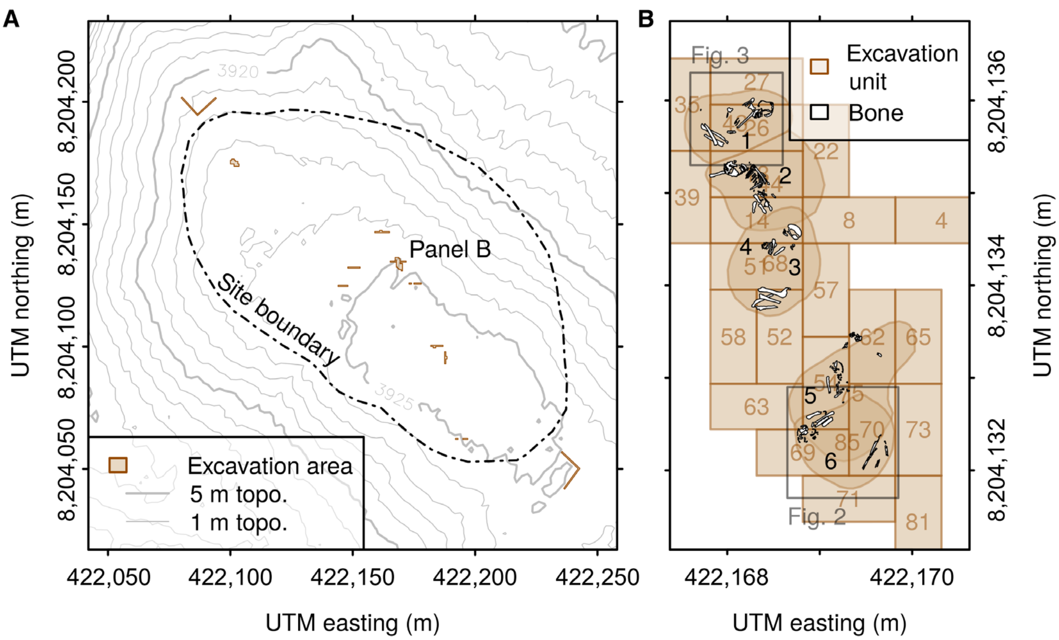

Fig. 1. Geography of Wilamaya Patjxa. (**A**) Site topography and excavation locations. UTM, Universal Transverse Mercator, Word Geodetic System 1984 (WGS84); topo., topographic contour. (**B**) Location of five burials including six individuals. Only individuals 1 and 6 are Early Holocene in age and associated with big-game hunting tools.

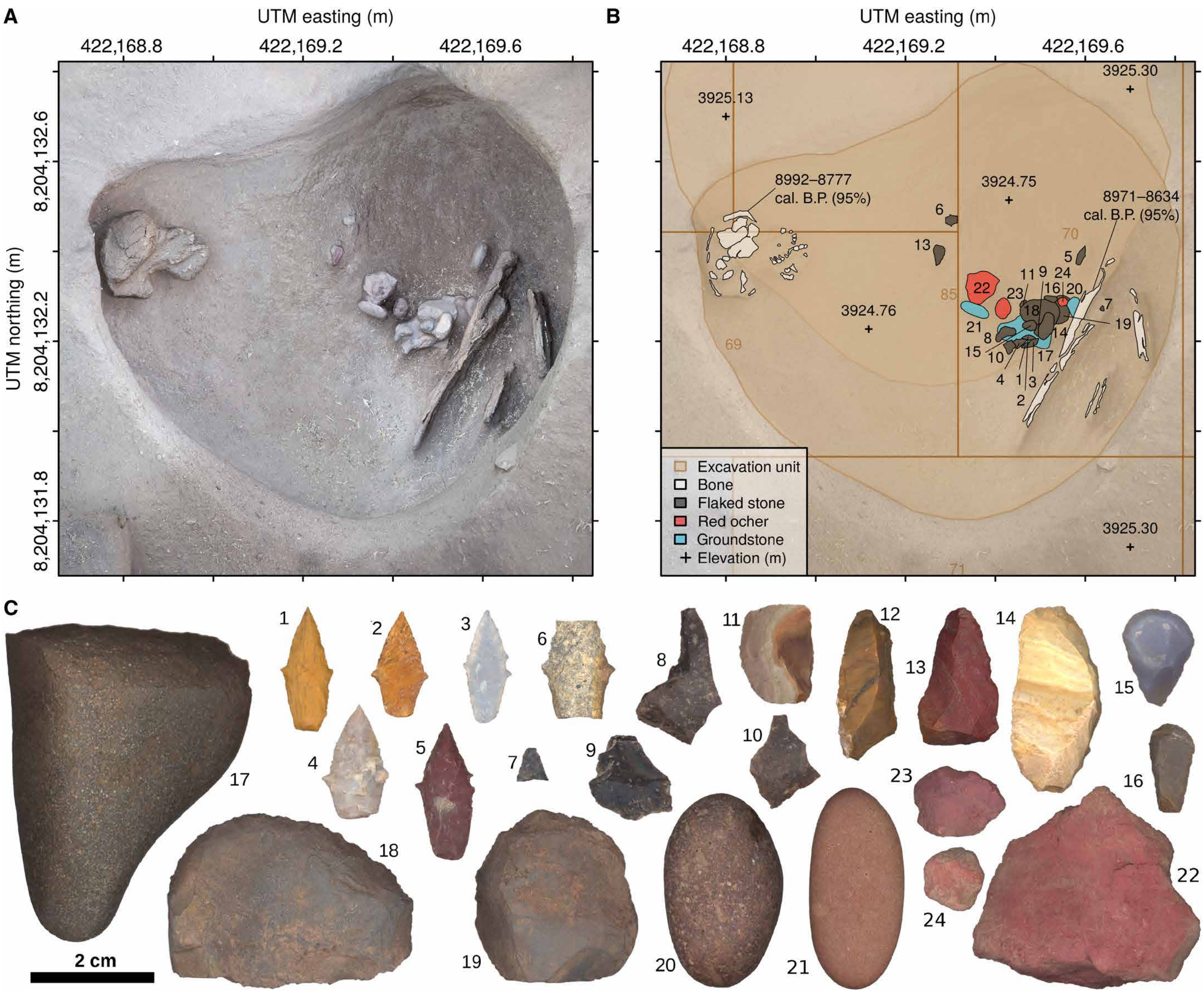

Fig. 2. WMP6, a 17- to 19-year-old female with hunting toolkit in situ dating to 9 cal. ka. (**A**) Orthorectified, georeferenced photograph. (**B**) Vector map showing positions of skeletal materials and associated grave goods. (**C**) In situ artifacts from burial pit floor including projectile points (1 to 7), unmodified flakes (8 to 10), retouched flakes (11 to 13), a possible backed knife (14), thumbnail scrapers (15 and 16), scrapers/choppers (17 to 19), burnishing stones (17, 20, and 21), and red ocher nodules (22 to 24). Photo credit: Randall Haas, University of California, Davis.

The individual appears to have been a permanent resident of the high-altitude landscape as opposed to a logistical or seasonal visitor from the lowlands. The interior geography of the site suggests that its occupants were at least seasonal highlanders (*34*). A $\delta^{18}O_{MW}$ value of −16.8 ± 0.2‰ taken on bone bioapatite is consistent with intake of high-altitude surface waters, which tend to range from −25 to −8‰ (*34*, *38*). The $\delta^{13}C$ observations reported above are furthermore consistent with a high-altitude home range (*34*, *39*).

Wllamaya Patjxa individual 1

Individual 1 (WMP1) is a shallow adult burial extending 9 cm below the plow zone, approximately 40 cm below ground surface (Fig. 3). Osteological remains consist primarily of fragmentary cranial bones and postcranial long bones. The individual was interred in a flexed position on their left side with head oriented east. A flaked stone projectile point was located under and in contact with a proximal fragment of the right radius or ulna. The artifact is a large, well-made stemmed form with serrated blade margins made from white chert. A second projectile point—a black igneous bipoint form—was located in the pelvic area. Klink and Aldenderfer (*28*) classify these forms as 3B and 3E types, respectively, both of which date to the Early/Middle Holocene, 9 to 7 cal. ka. Whether the artifacts are grave offerings or a result of impalement is indeterminate. An attempt at direct dating an ultrafiltered sample of collagen from the right petrous portion was unsuccessful.

Dental wear patterns suggest an age at death of 25 to 30 years (*32*–*35*). Robust cranial and mandibular features indicate a male individual, which is confirmed by a strong AMELY_HUMAN cumulative

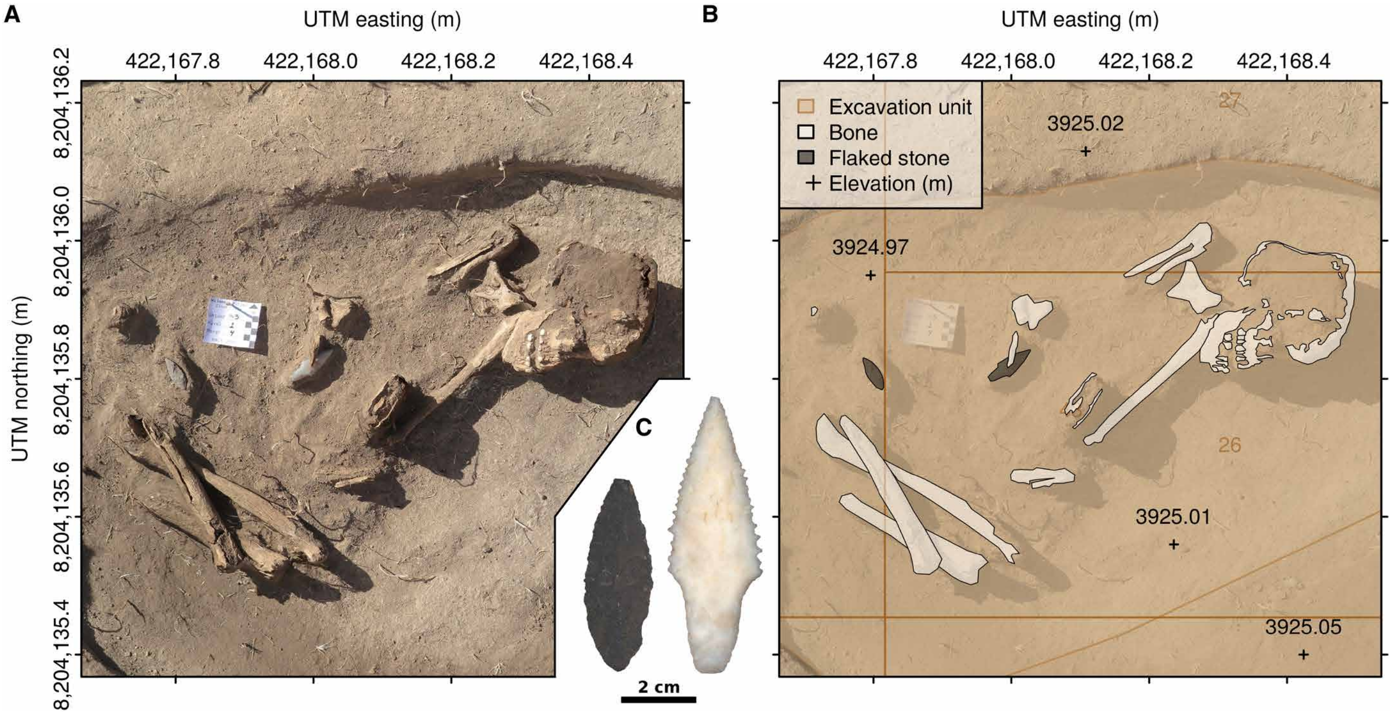

Fig. 3. WMP1, a 25- to 30-year-old male with associated projectile points in situ. (**A**) Map with orthorectified photograph. (**B**) Vector map showing positions of skeletal materials and artifacts. (**C**) In situ projectile points including a black igneous 3E point and white chert 3B point. Photo credit: Randall Haas, University of California, Davis.

signal intensity of 6.5×10^8, including 368 unique peptides on a fragment of dental enamel [Pr(F) = 0.00] (figs. S5 and S6). Substantial bowing of the femoral diaphyses along with pronounced linea aspera suggests a highly mobile individual. Stable isotope determinations on bone bioapatite suggest that, despite a high degree of mobility, the individual was a permanent resident of the highlands. A $\delta^{18}O_{MW}$ value of −14.5 ± 0.2‰ is consistent with intake of high-altitude surface waters (*34*, *38*). A $\delta^{13}C_{ap}$ value of −12.1 ± 0.1‰ is consistent with a high-altitude home range (*34*, *39*) and a mixed diet of plants and animals (see fig. S7). However, the lack of collagen may indicate compromised structural integrity, which warrants interpretive caution. Faunal remains were not present in the feature fill.

Early hunter burials of the Americas

The observation of an Early Holocene adult female burial in association with a big-game hunting toolkit raises the question of the extent to which WMP6 is an isolated incident or part of a broader behavioral pattern. Our review of Late Pleistocene and Early Holocene burials in the Americas resulted in the identification of 429 individuals from 107 sites (table S6). Of those, 27 sexed individuals from 18 sites are associated with big-game hunting tools (Fig. 4). Including WMP6, 11 of the individuals from 10 sites are identified as female. Sixteen individuals from 15 sites, including WMP1, are identified as male.

The sample is sufficient to warrant the conclusion that female participation in early big-game hunting was likely nontrivial—greater than the trace levels of participation observed among ethnographic hunter-gatherers and contemporary societies. The statistical robustness of this claim can be shown by solving for the probability mass of a binomial distribution given 11 female hunters (successes), 27 total hunters (trials), and some probability of female participation, *p*, as follows

$$\Pr(11;27,p) = \binom{27}{11} p^{11} (1-p)^{27-11}$$

The results for $p = 0,10,20, \ldots 100\%$ show that the empirically observed counts are highly unlikely to have come from a population of individuals in which average female participation in big-game hunting was less than 30%. Rather, plausible models range between 30 and 50% female participation, suggesting that early big-game hunting was likely gender neutral or nearly so (Fig. 5).

Unfortunately, the quality of artifact association, sex estimation, and date estimation varies among the archeological samples. Only three individuals from two sites—two individuals from Upward Sun River and the WMP6 individual—are considered secure insofar as they are (i) well documented in secure stratigraphic association with big-game hunting tools, (ii) securely sexed using biomolecular methods, and (iii) directly dated by radiocarbon on bone collagen. The Upward Sun River females are both infants and, thus, were not hunters per se, although they appear to have been gendered in a way that recognized females as associated with big-game hunting. WMP6 is the only individual securely identified as a big-game hunter burial in a sample of 27 tentative Late Pleistocene or Early Holocene New World individuals in association with big-game hunting tools. Regardless of whether the most conservative or liberal criteria are used for identifying hunter burials, when the criteria for acceptance are applied uniformly

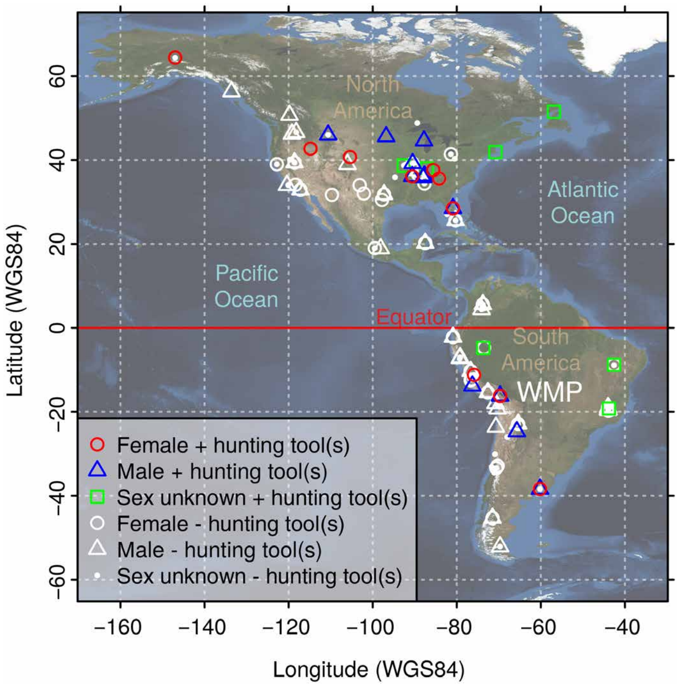

Fig. 4. Geography of Wilamaya Patjxa and early burials of the Americas. Female and male burials with (+) and without (−) big-game hunting tools are indicated. WGS84, World Geodetic System 1984.

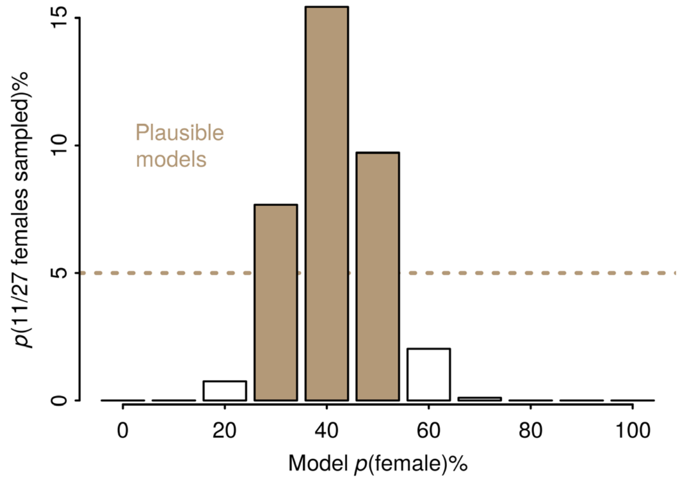

Fig. 5. Probability of observing 11 female hunters in a random sample of 27 hunters given 0 to 100% probability of female big-game hunting. Plausible models range from 30 to 50% female participation, indicating that big-game hunting was likely gender neutral or nearly so among Late Pleistocene/Early Holocene populations.

across the sample, both female- and male-hunter burials occur in statistical parity (Materials and Methods, burial meta-analysis).

DISCUSSION

Although burial treatment is complex and contingent (*40*–*42*), the objects that accompany people in death tend to be those that accompanied them in life (*1*, *43*). Scholars generally accept that projectile points associated with male burials are hunting tools, but have been less willing to concede that projectile points associated with female burials are hunting tools. WMP6 presents an unusually robust empirical test case for evaluating competing models of gendered subsistence labor. Although burial-associated projectile points can result from homicide, hunting accident, or stratigraphic mixing, the topological integrity of the WMP6 assemblage renders such interpretations unlikely. Projectile points can serve as knives, but it seems more likely that the backed knife and flakes in the WMP6 kit served that purpose. Error-prone osteological sex determinations can be spurious, but our coupling of osteology and amelogenin protein analysis renders such error highly unlikely (*37*). It is possible that the WMP6 burial represents a rare instance of a female hunter in a male-dominated subsistence field, but such an outlier explanation diminishes with the observation of 11 female burials in association with hunting tools from 10 Late Pleistocene or Early Holocene sites throughout the Americas, including Upward Sun River (*44*), Buhl (*45*), Gordon Creek (*23*), Ashworth Rockshelter (*46*), Sloan (*47*), Icehouse Bottom (*48*), Windover (*49*), Telarmachay (*50*), Wilamaya Patjxa, and Arroyo Seco 2 (*51*). These results are consistent with a model of relatively undifferentiated subsistence labor among early populations in the Americas.

Nonetheless, hunter-gatherer ethnography and contemporary hunting practices make clear that subsistence labor ultimately differentiated along sex lines, with females taking a role as gatherers or processors and males as hunters (*1*–*4*, *6*). Middle Holocene females and males at the Indian Knoll site in Kentucky were buried with *atlatls* in a respective ratio of 17:63, suggesting that big-game hunting was a male-biased activity at that time (*21*). Thirty percent of bifaces, including projectile points, are associated with females in a sample of 44 Late Holocene burials from seven sites in southern California (*52*). A similar trajectory may be observed in the European Paleolithic, where meat-heavy diets and absence of plant-processing or hide-working tools among Middle Paleolithic Neandertals would seem to minimize potential for sexually differentiated labor practices (*5*, *53*, *54*). Economies diversified in the Upper Paleolithic sometime after 48 ka, with increasing emphasis on plant processing and manufacturing of tailored clothing and hide tents creating new contexts for labor division. When and how such differentiated labor practices emerged from evidently undifferentiated ones require further exploration. Comparative analysis of burial associations with hunting tools and ground stone artifacts (*55*) in other times and places would be particularly valuable toward understanding how labor division evolved among hunter-gatherer societies.

Scholars have long grappled with understanding the extent to which contemporary gender behavior existed in our species' evolutionary past. A number of studies support the contention that modern gender constructs often do not reflect past ones (*7*–*10*, *12*, *13*, *56*). Dyble *et al.* (*57*) show that both women and men in ethnographic hunter-gatherer societies govern residence decisions. The discovery of a Viking woman warrior further highlights uncritical assumptions about past gender roles (*58*). Theoretical insights suggest that the ecological conditions experienced by early hunter-gatherer populations would have favored big-game hunting economies with broad participation from both females and males. Such models align with epistemological critiques that reduce seemingly paradoxical tool associations to cultural or ethnographic biases. WMP6 and the sum of previous archaeological observations on early hunter-gatherer burials support this hypothesis, revealing that early females in the Americas were big-game hunters.

MATERIALS AND METHODS

Standard surface reconnaissance and hand excavation techniques were used to discover and excavate cultural features at Wilamaya Patjxa. Burials were excavated in natural units and exposed to maintain topological integrity of in situ artifacts. Terrestrial photogrammetry was used to document burial condition and structure. Age and sex of the individuals were estimated using standard osteological (*32*, *59*) and dental enamel protein methods (*36*, *37*). Flaked stone artifacts were visually classified according to functional forms (*60*), and projectile points were classified according to the regional typology (*28*). Chronometric assignment is based on artifact seriation and radiocarbon dating of human bone collagen by accelerator mass spectrometry applying the 2013 Southern Hemisphere calibration curve (*61*). Faunal remains were recovered from feature fill using water flotation and dry screening with 1-mm mesh. Plow zone sediment was screened through 6-mm mesh. Faunal taxa were identified on the basis of visible morphology and comparison to reference collections. Additional analytical details are presented in the Supplementary Materials.

The burial meta-analysis is designed to assess the extent to which the WMP6 burial represents a rare or common instance of female-associated hunting tools in early burial contexts in the Americas. Regional reviews of early burial practices throughout North and South America are consulted to identify burials dating to the Late Pleistocene or Early Holocene, defined here as pre–8 ka. Where possible, primary references are consulted to record sex estimations and the presence or absence of big-game hunting tools including projectile points or *atlatl* parts. All dates, sex, and tool associations are assessed as secure or tentative. The resultant data are tabulated to quantify the proportions of early female and male burials with and without hunting tools. The contingency table is tested against sexual division of labor models ranging from 0 to 100% female participation using binomial probability analysis. The analysis is repeated for all possible combinations of secure and tentative assessments of dates, sex, and tool associations. Analytical procedures, error analysis, and raw data are elaborated in the Supplementary Materials.

SUPPLEMENTARY MATERIALS

Supplementary material for this article is available at http://advances.sciencemag.org/cgi/content/full/6/45/eabd0310/DC1

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