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6 **The Ecological and Social Context of Women's**
7 **Hunting in Small-Scale Societies**
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14 Jordie Hoffman¹, Kyle Farquharson¹, Vivek V. Venkataraman^{1,*}

15 ¹Department of Anthropology and Archeology, University of Calgary
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18 *To whom correspondence may be addressed: vivek.venkataraman@ucalgary.ca
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Abstract

Women participate in hunting in some societies but not in others. To examine the socioecological factors that are conducive to women's hunting, we conducted an ethnographic survey using the Human Relations Area Files and other selected sources. Based on life history theory and behavioral ecology, we predicted that women should engage in hunting when: i) it poses few conflicts with childcare, ii) it is associated with few cultural restrictions around the use of hunting technology, iii) it involves low-risk game within range of camp, with the aid of dogs, and/or in groups, and, iv) women fulfill key logistical or informational roles. We systematically reviewed ethnographic documents across 64 societies and coded 242 paragraphs for the above variables. The data largely support theoretical expectations. When women hunted, they did so in a fundamentally different manner than men, focusing on smaller game and hunting in large groups near camp, often with the aid of dogs. There was little evidence to suggest that women only participated in hunting during non-reproductive years; instead, allocate networks were a prominent strategy for mitigating tradeoffs between hunting and childcare responsibilities. Women commonly fulfilled crucial informational, logistical, and ritualistic roles. Cultural restrictions limited women's participation in hunting, but not to the extent commonly assumed. These data offer a cross-cultural framework for making inferences about whether and how women's hunting occurred in the past.

Keywords: women; hunting; foraging; hunter-gatherers; dogs; division of labour

Introduction

The emergence of gendered divisions of foraging labour represented a critical shift in human evolution, improving foraging efficiency and transforming social organization, and contributing to humans' ecological success (Bird 1999; Kuhn & Stiner 2006; Kraft et al 2021). Whereas foraging behaviour in the closely-related great apes is similar between the sexes, modern hunter-gatherer societies evince relatively stable and dichotomous, yet flexible, divisions of foraging labour: men engage in riskier activities like hunting and women perform lower-risk tasks like gathering (Bird 1999; Marlowe 2007). As part of this gendered division of labour, it is rare for women to hunt. One estimate (Gurven & Hill 2009) places the frequency of modern hunter-gatherer societies in which women hunt at 7.3% (13/179). A more recent estimate places the value at ~80% (Anderson et al 2023), but there are significant methodological issues with this estimate that render it unreliable (Venkataraman 2023).

Though the timing of the origins of the gendered division of labour is unclear, prevailing theories lie at two extremes. Some scholars suggest that this feature of human socioecology emerged relatively recently in human evolution, perhaps less than 300 kya (Kuhn & Stiner 2006). If labour was relatively undifferentiated prior to the emergence of modern *Homo sapiens*, females may have regularly participated in hunting. In contrast, others believe that sexual divisions of labour may extend as far back as 2 mya, to *Homo erectus* (Aiello & Key 2002), as indicated by elevated brain sizes and increased energy budgets associated with humans' cooperative economy of food (Kraft et al 2021). These changes are plausibly related to the emergence of cooking, which enabled more time-intensive and risky foraging by males (Wrangham 2009). An early emergence of a sexual division of labour would suggest that *Homo* females would have engaged in hunting relatively infrequently, as seen in the modern ethnographic record.

Questions about the origins of gendered divisions of labour have re-emerged recently, with a focus on the potential contribution of women to hunting. Haas et al (2020) recently described a 9000-year-old skeleton (WMP6) attributed to a female hunter-gatherer from southern Peru who was buried alongside a hunter's toolkit. The toolkit contained a full suite of big-game procurement and processing tools such as projectile points, scrapers, and a backed knife (Haas et al. 2020). Haas et al (2020) argue that these populations were likely hunting groups of vicuña with atlatls, or spear throwers, and that women would have been frequent participants. Haas et

al (2020) also reviewed burials in the Americas during the Late Pleistocene and Early Holocene. They identified 27 individuals from 18 sites associated with big-game hunting tools. Of those, 11 were identified as females based on sexing of the skeletal elements. Combining these lines of evidence, the authors argue that 30-50% of big-game hunters in these populations were female. If true, this value would exceed levels of female hunting observed in any known modern hunter-gatherer society.

Haas et al (2020) offer a salutary correction to the circular logic that can plague sex assignment of skeletons and assumptions about divisions of labour. Within burial contexts, gender and division of labour are often inferred based on preconceived notions of contemporary gender roles and have little to do with past cultures (Doucette 2001). For example, when archaeologists discover hunting tools alongside the remains of women, they are often hesitant to conclude that the women were hunters (Gilchrist 2012); and in cases of ambiguous sexual assignment, an association with hunting implements can lead to a sex assignment as male (Doucette 2001). For obvious reasons, this circularity should be avoided; gender roles must be demonstrated, not assumed.

Nevertheless, there are some problematic inferences made by Haas et al (2020). The sample sizes were very small, and, aside from WMP6, none of the burials were unambiguously female hunters (Haas et al 2020). One site contained female infants who could not have been hunters. At one site, only two individuals possess secure stratigraphic association with big-game hunting tools and were confidently sexed using biomolecular methods (Peacock 1991). When considering only the unambiguous sex assignments, Kelly (2020) argues that it is more likely that roughly ten percent of hunters were females. Finally, Haas et al (2020) did not consider alternative explanations for the grave goods being associated with young women (WMP6 was 17-19 y.o. at time of death). For example, the observed grave goods could have been associated with a system of bride wealth or child growth payments (Pleger 2000).

To evaluate the possibility of women's hunting in the deep past, it is important not to rely solely on archaeological deposits that are subject to *post-hoc* interpretation; it is also crucial to understand the broader patterns of costs and benefits that structure behaviour (O'Connell 1995). From the behavioural ecology perspective, it is expected that under certain conditions, women should, in fact, hunt. Divisions of labour documented among foragers are statistical patterns, not prescriptive guides to behaviour. Though it may be rare compared to men's

135 hunting, there are nevertheless a number of reports of female hunting (Goodman et al 1985;
136 Reyes-García et al 2020; Anderson et al. 2023). To aid in the development of a broader
137 framework for making inferences about women's hunting in the deep past, here we consider the
138 shared socioecological similarities of the societies in which women hunt.

139
140 Women's hunting is generally thought to be uncommon due to a host of proximate and ultimate
141 factors, including reproductive constraints and proximate logistical constraints on the ability to
142 hunt (Brown 1970). Humans have an energetically demanding life history (Kraft et al 2021):
143 short interbirth intervals, high fertility, and long periods of childhood dependence require multiple
144 dependents to be simultaneously cared and provided for (Brown 1970). This often means that
145 women face trade-offs between childcare and subsistence work during their prime years of life
146 (Meyer-Rochow 2009). Among foragers, maternal subsistence behaviours decrease during the
147 early postnatal period and during lactation (Hames 1988; Hill and Magdalena Hurtado 1996;
148 Ivey 2000; Peregrine 2001). Women's subsistence behaviours are more compatible with
149 childrearing than men's (Brown 1970; Peregrine 2001). Big-game hunting is thought to be
150 especially incompatible with childcare. Noisy children can interfere with ambush hunting. Fast
151 movement can be difficult, if not dangerous, with children. The same is true for close-range
152 killing. Hunting often requires long-distance travel and time away from home, not to mention the
153 physical threat of danger from prey animals to mother and child (Wood 2006). To avoid these
154 costs, when women do participate in hunting, they appear to occupy different roles than men.
155 For instance, women may observe tracking signs spotted while gathering and relay these to
156 hunters, carry meat home from hunts, or help to drive game into confined spaces or nets, or
157 over cliffs (Biesele & Barclay 2001; Nitsch et al 2014; Prall & Scelza 2017).

158
159 From an evolutionary perspective, the extended human life history pattern, which has its roots in
160 the human foraging niche (Kaplan et al 2000; Koster et al 2020; Kraft et al 2021), may also
161 militate against women's hunting. The human foraging niche emphasizes the acquisition of
162 large-package and nutrient-dense food items that are skill-intensive (Kaplan et al 2000).
163 Humans acquire greater amounts of energy compared to nonhuman primates, overproducing
164 for several decades in midlife in order to subsidize non-producing dependents and the elderly
165 (Kraft et al 2021). Developing such skills, however, requires a long juvenile period (Kaplan et al
166 2000). In this context, the concept of comparative advantage becomes relevant (Gurven & Hill
167 2009). Because individuals cannot devote time and energy to multiple skill-demanding tasks, it
168 pays to specialize in one domain.

169

170 It is important to clarify that gendered divisions of labour can emerge even when skill or ability at
171 a given task differs little between the genders (Gurven & Hill 2009). For instance, even modest
172 sex differences in strength and speed can affect the comparative advantage of each sex in
173 terms of hunting. Men, on average, have significantly greater lean muscle mass compared to
174 women, resulting in greater overall strength and speed (Lassek & Gaulin 2009; Puts 2010), all
175 of which would be assets in hunting. On the other hand, success in human hunting is perhaps
176 better facilitated by cooperation and skill (Kaplan et al 2000) than raw strength *per se*. Sex
177 differences in strength help to explain, but do not fully explain, why it is uncommon for women to
178 hunt.

179

180 Finally, social norms may negatively impact optimal female strategies. Discouragement from
181 hunting may begin in early development, when children begin to learn about subsistence tasks
182 that they will perform in later life (Lew-Levy et al 2017). Taboos against women eating meat are
183 very common, and may discourage women from hunting since they would not directly gain
184 nutritional benefits (Murdock et al 1961; Spielmann 1989). Additionally, hunting taboos generally
185 focus on preventing women from using specialized big game hunting weapons (White et al
186 1977). Such taboos may bias young women from taking up hunting. It is important to
187 understand whether such norms result in full exclusion from hunting, or whether women
188 participate in more subtle ways.

189

190 Taken together, the differential costs of hunting for men and women at both proximate and
191 ultimate scales militate against hunting as a frequent behaviour for women (Venkataraman
192 2021). When hunting requires particularly high levels of skill, it may be expected that women are
193 less likely to participate due to the principle of comparative advantage (Gurven & Hill 2009).
194 When hunting is easily mastered at a young age, or involves technological or logistical features
195 that mitigate tradeoffs with childcare, women's hunting is more likely to occur. Perhaps the most
196 famous case of women's hunting is that of the Agta hunter-gatherers of the Philippines, who
197 broadly participate in hunting (Goodman 1985). This pattern was attributable to several factors.
198 Childcare constraints were alleviated by low ratios of dependent children to adults, reducing the
199 burden on mothers. Hunts tended to take place close to camps, and with the aid of dogs. Sterile
200 or post-reproductive women instead took up hunting when carbohydrate roots were sparse and
201 unprofitable. In other prominent cases of women hunting, such as among the Martu of Australia,
202 women pursue relatively immobile prey such as lizards (Bird & Bird 2008).

To obtain a broader ethnographic perspective on the issue of women's hunting, we conducted a survey using the Human Relations Area Files (eHRAF) and complemented the resulting dataset with other select sources. Based on prevailing models of life history and behavioral ecology, and similar to the approach of Noss & Hewlett (2001), we generated four hypotheses about the context in which women's hunting should occur. These are relevant to five domains: conflict with childcare, life history, cultural restrictions, hunting behaviour, and logistical roles. More specifically, women's hunting should:

(H1) Pose few conflicts with childcare (i.e. performed by pre- or post-reproductive women and/or opportunities for allocare);

(H2) Be associated with few cultural restrictions around the use of hunting technology;

(H3) Involve the pursuit of low-risk game (i.e. smaller, more reliable game) within range of camp, with the aid of dogs, and/or in groups;

(H4) Involve women fulfilling key logistical or informational roles

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For each hypothesis, we created several variables corresponding to specific aspects of hunting behaviour. In total, we produced 21 variables (Table 1).

Methods

Modern ethnographic data

We conducted a cross-cultural analysis of women's hunting using the Human Relations Area Files (HRAF), a comprehensive digital collection of ethnographic documents that serve as an essential repository of human diversity in traditional, subsistence-level societies. The Standard Cross-Cultural Sample (SCCS), a subset of the HRAF, uses a systematic sampling method to control for historical intercultural relationships (Meyer 1994). The SCCS consists of 186 societies with varying social organization, subsistence patterns, and cultural, economic, linguistic, and geographical backgrounds. We also complemented these data with reports of women's hunting that we found independently or were referenced in Anderson et al (2023).

Societies were categorized by their predominant subsistence style. Hunter-gatherers obtained their food by hunting wild animals, fishing, and gathering wild plant resources. Horticulturalists cultivated crops in small garden plots using simple tools and also gather wild plant resources. Agriculturalists farmed using more advanced techniques such as plows, irrigation, and domesticated animals for labor. Pastoralists raised domesticated animals for food, clothing, and transportation, and move their herds to different grazing areas depending on the season. Some societies have a mix of subsistence strategies. Societies labeled as 'primarily hunter-gatherers' obtain the majority of their food through hunting and gathering but may also engage in other subsistence strategies such as horticulture or fishing.

Our search of HRAF focused on five Outline of Cultural Materials (OCM) codes ("division of labor by gender", "gender roles and issues", "child care", "infancy and childhood", and "food quest") and three keywords (hunt*, women, and beater*) related to women's hunting in the SCCS subset of the eHRAF (Kraft et al 2021). There were 1,116 paragraphs returned in this search. Due to the general nature of OCM topics (e.g., "gender roles and issues"), most returned paragraphs did not address women's hunting specifically. Consequently, we examined each paragraph for information specific to women's hunting. Information relevant to women's hunting was found in 242 paragraphs ("text records") from 69 documents and 40 journal publications, across 64 societies, published between 1829 and 2020; the mean year of publication for our ethnographic sources was 1972 (Figure S1). Out of the 139 total authors contributing to the examined documents, we found that 94 (67.6%) of authors identified as male, while 45 (32.4%) of authors identified as female. We did document some differences in the ways that male and female authors reported aspects of women's hunting (Figure S2 & S3).

Our 21 variables consisted of unambiguous propositions (Table 1). For each of these variables, each text record was read and coded by the first author (JH) and verified by the second author (KF) and senior author (VV). A variable was coded as 1 when there was evidence for its corresponding proposition, -1 if there was evidence against its corresponding proposition, and 0 if there was no evidence at all. We considered the occurrence (1) and nonoccurrence (-1) of traits in relation to the total number of societies that had any evidence for a given prediction (i.e. data coded as zero were not included in the denominator of the calculated percentages). To arrive at a society-level coding for each variable, we analyzed the coding decisions within the relevant paragraphs and identified the most frequent coding outcome (either 1 or -1). We then reported the majority outcome in our overall calculations. In instances where the coding

decisions were evenly split between positive and negative for a variable, we regarded this as positive evidence for both.

Data used in the analysis may be accessed at the following website:

https://github.com/vivekvasi/womens_hunting.

Results

The geographic distribution of societies with women's hunting is shown in Figure 1, with societies labeled by circles whose sizes are proportional to the number of documents from that society. In total, our sample comprised 64 cultures. The majority of the sample is comprised of hunter-gatherers (n=54). There was a far smaller sample of horticulturalists (n=4), agriculturalists (n=3), pastoralists (n=1), and primarily hunter-gatherer (n=2) societies represented in the sample. Additionally, the representation of various subsistence categories differs by the number of paragraphs referenced. Paragraph extracts ("n") were categorized by subsistence type: hunter-gatherers (n=221), horticulturalists (n=5), agriculturalists (n=8), pastoralists (n=3), and primarily hunter-gatherers (n=5). Figure 2 shows for each variable the extent to which the data were consistent with our predictions. The most commonly-mentioned aspects of women's hunting were the following: var3.4: women hunting small game (<15 kg), var1.1: children coming on hunts, var2.3: women using different hunting technology than men, var3.2: women hunting in a group, var3.6: collective hunting of medium-large game, var4.1: participation in game drives and var4.2: carrying the hunted game (Table 1). In the following, we discuss our findings regarding each prediction falling under the four main hypotheses (Figure 2).

H1. Conflicts with childcare

We found that it was common for children to attend hunts, typically communal hunts of small game (var1.1; 26/28 societies). In such instances, they either participated in hunting or were carried by hunters. For example, among the Mbuti, net hunters used a special skin that formed a sling for carrying babies on their backs (Turnbull 1965). In some cases, older children may help out with logistical tasks related to hunting. For instance, Slavey children assist women in collecting small game when they go out to hunt (Asch 1986). Additionally, since most land animals in the Tiwi islands of Australia could be caught with minimal strength, skill, and equipment, children were often taught to aid women in collecting these foods (Goodale 1971).

It was also common for children to be left at home with other family members (var1.2; 9/10 societies). !Kung women left all children except nursing infants and toddlers at the base camp while mothers gathered or hunted (Kent 1993). Due to the collaborative nature of collective hunting, women in Mbuti net-hunting bands practiced more cooperative strategies than women in archer bands, such as leaving their children with sisters or close friends for short periods of time (Turnbull 1965).

Nulliparous women accompanied men, often their husbands, on hunting trips (var1.4; 4/8 societies); we also found evidence of post-child-bearing women (var1.3; 4/8 societies) doing so. The Slavey of Canada exhibited both of these behaviours. Slavey women would accompany their husbands to assist on hunting and trapping trips prior to the birth of their first child. Slavey widows, because they lacked a regular supply of meat, took it upon themselves to learn to shoot rifles to hunt rabbits for subsistence (Helm 1961).

H2. There are few cultural restrictions on access to hunting technology

Cultural restrictions on women's hunting were found in roughly half of the societies for which evidence was available (var2.1; 12/28 societies). Restrictions typically took the form of exclusion from using certain hunting tools or pursuing certain prey animals (Ohnuki-Tierney 1984; Lye 2004). However, restricting women's access to hunting technology such as bows, nets, and guns (var2.2; 9/18 societies) did not necessarily mean women do not hunt, as women could instead use a different hunting technology that was not proscribed (var2.3; 21/26 societies). In terms of technology used by women, snares were the most common (Figure S4). The second most common was the digging stick, which is typically used to exploit underground storage organs (Figure S4). Among the !Kung, women employ their digging sticks, traditionally utilized for excavating the ground to uncover roots, as makeshift clubs to strike small animals (Kent 1993). In line with religious beliefs, Ainu women are only allowed to hunt nondeified animals with instruments separate from the male use of bows and arrows (Nitsch et al 2014). However, restrictions were not always tool based. Tiwi women were not allowed to hunt turtles or geese, and while they may accompany men during turtle hunts or goose-killing expeditions, they did not take part in the actual hunt (Goodale 1971)1971:154). However, when they hunted non-tabooed small game animals such as opossums and bandicoots, both men and women made and used ground steel axes (Goodale 1971) 1971:154).

Women's hunting practices were often mundane rather than prized within their communities (var2.4; 5/7 societies). For instance, among the Ojibwa of Ontario, myths or ceremonies, male activities and leadership were glorified, and women's roles were considered inferior and thus, not celebrated. Unlike Ojibwa boys, girls did not receive a feast after their first hunting kill (Vecsey 1983). However, women's efforts in hunting were sometimes commended. Among the Ju/'hoansi (!Kung) people recognize women's skill, judgment, and strength on hunting trips, and their contributions are genuinely appreciated (Bieseke 1978; Bieseke & Barclay 2001).

Finally, women were believed to contribute positively to hunting indirectly through various ceremonies, institutions, or rituals (var2.5; 4/4 societies). In Iñupiaq culture, it was thought that women's involvement in such rituals contributes to improved hunting success (Bodenhorn 1990). According to this belief system, the respect shown by women towards the animals killed during hunting trips, as well as their meticulous care during the butchering process, was thought vital in ensuring future successful hunts. In contrast, evidence suggesting that women are believed to have a negative impact on hunting success was reported in certain cultural contexts (var2.6; 7/8 societies). Among the Northern Paiute, men, women, and children participated in antelope-drives. However, women who were pregnant or menstruating were excluded from participating because it is believed that the presence of a woman in either of these conditions would cause the antelope to break through the corral fence and escape (Park, 1938).

H3. Women pursue low-risk game within range of camp with the aid of dogs and/or in groups
Women often participated in game drives (var3.6; 26/28 societies). These game drives are characterized by a hunting strategy in which one type of game is targeted and herded into confined or precarious place where it can be more easily killed. The methods employed to guide the game differ, ranging from individuals acting as beaters who employ sound or tools to initiate game movement, to utilizing environmental elements like fire. For Ovimbundu women of central Angola, involvement in hunting is typically limited to assisting in peripheral tasks during communal fire hunts. Communal hunts occur during the dry season when the grass can be trodden down, after which fires are started, and animals are killed as they flee (Hambly 1934).

Women's hunting also commonly involved the pursuit of low-risk game which was relatively reliably acquired (var3.4; 38/38 societies). These hunts were usually composed of groups of women (var3.2; 26/30 societies) and took place close to camp (var3.7; 7/7 societies).

368 Additionally, dogs were shown to be valued hunting companions for women as they would be
369 used to locate and drive game or pull sleds (var3.1; 10/11 societies). Tiwi women had well-
370 trained hunting dogs that are given unique names and referred to using the same kinship terms
371 women use for their own children. After these dogs passed away, they were buried and
372 mourned by their Tiwi family (Goodale 1971).

374 *H4. Women fulfill key logistical or informational roles during hunting*

375 We found that carrying meat back to camp was the most common logistical role of women
376 during hunting (var4.2; 18/20 societies). This load-bearing behaviour presented in various ways.
377 In some cases, women would carry game into camp from the kill site, such as among the
378 Kimam, where the possibility of surprise attacks from neighbouring villages made it necessary
379 for women to transport the slain game to camp, allowing men to focus on external threats. In
380 other cases, men would bring the meat closer to camp, and women would carry it the rest of the
381 way. Warao men would carry the slain game from the kill site and leave it some distance from
382 the house for women to collect and bring home (Kirchhoff 1948). This behavior is believed to
383 stem from the general cultural expectation that women were responsible for carrying loads,
384 even when it may have been more convenient for men to do it themselves (White et al 1977).

386 There were also instances where women would assist in hunting by rowing boats while men
387 searched for and pursued medium-large game, such as seals. Ainu women were forbidden from
388 directly participating in sea mammal hunting, as the sea was considered sacred residence of the
389 sea deities, and it is believed that the smell of menstrual and parturient blood is offensive to the
390 deities. However, Ainu women would still attend hunts to help men by rowing boats and
391 transporting killed game (Nitsch et al 2014).

393 Women commonly served as beaters during collective hunting (var4.1; 17/20 societies). In
394 Central Africa, Mbuti women made beaters from twigs and branches and spread out in a
395 semicircle in the forest. Men set up nets across from them to complete the circle. The women
396 would beat the ground and shout to drive game toward the nets. Slow game was caught by
397 women with their hands and placed in baskets while men remained motionless, waiting to seize
398 any animals captured in their nets. Once caught, the net owner killed the animal with a knife or
399 spear, signaling success to his companions by clapping his armpit. The women's shouting and
400 the men's arm-clapping indicated not only when and where game is caught but also the type of
401 game (Turnbull 1965).

Women were also crucial in providing information about prey animals to male hunters (var4.3; 8/9 societies). Among the Ju/'hoansi (!Kung), women accompany their husbands on about half of their hunting trips. Some women brought nursing infants along while hunting, as they did when gathering. While gathering, women often discovered prime hunting tracks which they relayed to male hunting parties. Sometimes women would lead the hunt, tracking or stalking the game until it was close, or using baby animals to lure in larger prey, at which point men took over. Bieseles & Barclay (2001) report that while the women were skilled trackers and shared signals, the men ultimately carried the weapons and were considered to be in control. However, cross-culturally, women's contributions via spotting and chasing game, retrieving arrows, carrying water to flood holes to flush prey, encouraging hunting dogs, striking animals with sticks or machetes, guiding the party, and carrying meat home, are culturally well-respected and considered vital to hunting success (Bieseles & Barclay 2001).

Discussion

We sought to understand the conditions that promote women's hunting in small-scale societies. In making inferences about past populations of foragers, the goal is not to identify specific populations of modern foragers that most resemble some ancestral condition. Rather, the goal is to identify the general set of conditions under which women hunt, and to investigate how reproductive and other logistical constraints - which, it stands to reason, would have also been important in the past - are overcome. Overall, our results aligned well with our predictions, which were derived from theory in behavioral ecology and life history, indicating that women's hunting is determined by a dynamic profile of costs and benefits throughout the life course (Kaplan et al 2000; Noss & Hewlett 2001; Gurven & Hill 2009). Below we discuss our findings for each hypothesis.

H1. Women's hunting poses few conflicts with childcare

The demands of childcare are considered to militate against women's hunting (Brown 1970). Our results suggest this is the case in the sense that lone big-game hunting, which poses numerous incompatibilities with parenting, is not performed by women. But our analysis also

reveals that women's hunting can be facilitated in diverse ways by allocate networks, whether at the hunting site or back at camp. Sometimes children do attend hunts and provide important labour. For instance, Jang et al (2022) showed that girls in early childhood (ages 4-7) facilitated adult women's foraging by attending to young children. Although it may not be necessarily beneficial to have children present from the foraging perspective, there may be longer-term benefits. For example, participation in hunting could be an important opportunity for vertical transmission of social learning from parent to child (Hewlett et al 2011). Social learning and gender play a significant role in understanding cultural practices related to big game hunting. Generally speaking, social learning by children in hunter-gatherer societies reflects adult divisions of labour (Gallois et al 2015; Lew-Levy et al 2018). As part of communal hunting, children can act as beaters or capture small game, tasks that encourage child interest in subsistence strategies and teach them skills that can be built upon as they grow older. For instance, Nisa, a !Kung woman, described a role-playing game related to hunting she participated in as a child (Shostak 1976; Shostak 1981). She and her friends followed tracks and shot pretend arrows at prey when they spotted them. They then carried back to the village leaves on sticks, pretending they were meat. For the Tiwi, all land animals except wallabies were easy to hunt with minimal physical strength, skill, and equipment. This allowed women and even children to contribute to the daily food supply. Children could learn the necessary techniques early, and since physical strength and energy were not major requirements for these prey types, children could contribute to the larder early on (Goodale 1971). Finally, the hypothesis that women engage in hunting during pre- or post-reproductive stages received limited evidence compared to other hypotheses, suggesting that age-related limitations on women's hunting may be overstated in the literature.

H2. Women's hunting is associated with few cultural restrictions around the use of hunting technology.

Although it is commonly stated that social factors determine whether or not women hunt (Brightman 1996), we found that social norms restrict women's hunting in half of the reports for which evidence was available. Therefore, explanations such as patriarchy or male dominance do not fully capture the complexity of the factors that influence women's hunting decisions. Women were rarely completely excluded from hunting practices; even when they were, they found ways to be involved in hunting. Frequently, they fulfilled alternative roles that contributed

importantly to hunting success. Whether women hunt or not is not primarily imposed on them by others, though sometimes it is. More generally, the decision is shaped by the experiences and tradeoffs faced by women themselves. However, we did find evidence that women's hunting was very rare in non-hunter-gatherer societies. This may be linked to the gender inequality that generally accompanies increases in sociopolitical complexity; further work is needed to examine this possibility.

We suggest that future research should focus on how social norms and belief systems influence women's role in hunting. In our review, we came across few instances in which female hunters were asked about how they made the decision to hunt or not. However, a unique case was observed among the Kutse, among whom both men and women were questioned about why women did not participate in hunting with bows and poison arrows, as men did. In response, both genders stated that women were unable to hunt with bows and poison arrows due to their lack of knowledge and skill in shooting arrows and safely extracting poison without risking harm or fatality to themselves. Some individuals said that if women possessed the knowledge and ability to safely handle poison and use it effectively, there would be no reason to prevent them from using bows and arrows. Future research would benefit from consideration of emic viewpoints, such as the interviews employed among the Kutse or among the Hadza by Stibbard-Hawkes et al. (2022), to better understand why women choose to hunt or not.

H3. Women's hunting involve the pursuit of low-risk game (i.e. smaller game) within range of camp, with the aid of dogs, and/or in groups

Our study confirmed that women's hunting in foraging societies tends to focus on relatively small-sized game; big-game hunting by women is uncommon and only done in groups (Figure S5). We found two societies in which solo big-game hunting was described for women: the Alyawara, in which women hunted kangaroos (with guns), and the Woodland Cree, in which certain women pursued moose, caribou, and bear (with guns) (Devitt 1989; Brightman 1996). Bugir et al (2021) surveyed 161 study sites associated with hunter-gatherer populations to assess which kinds of fauna hunter-gatherers prefer as prey. They found that foragers' preferred species ranged in body mass from 17.4 kg to 535 kg, with a mean of 128.5 kg. The

authors suggest that hunter-gatherers prefer larger, more threatening herbivores, largely within the order Artiodactyla. Based on their preference index, they also suggest that, at a global level, animals less than 2.5 kg are generally avoided, likely because acquisition costs outweigh energetic gain. Combining these results with ours, the consensus view is supported that women's hunting focuses on smaller prey compared to men's hunting.

Our results confirmed that women's hunting was often associated with game being close to camp. Less time spent traveling may reduce tradeoffs with childcare. Women's hunting typically occurred in large groups, with women serving prominent roles as beaters and helping to carry game back to camp. This may be a way of not only increasing hunting efficiency through cooperative gains, but also pooling labour to facilitate childcare, as noted above. Moreover, the use of dogs is often crucial to women's hunting. Dogs help to haul objects and items, reducing transport costs (Lupo 2019; Lupo 2021). And in the case of direct involvement with hunting, dogs lower search and handling costs of prey items (Lupo 2017). Dogs therefore increase the efficiency and ease of women's work and decrease the costs of women's participation in hunting. It is important to note, however, that there are many societies with dogs in which women do not hunt. Dogs should be considered a contributing, but not sufficient, condition for women's regular participation in hunting.

H4. Women fulfill key logistical or informational roles

Much work of hauling and carrying falls to women when they are involved in hunting. This can be energetically costly, with potentially negative fitness consequences (Lupo 2021). It is curious that the highly physical task of carrying so often falls to women across cultures, even though they are sometimes said to be excluded from hunting due to strength limitations. A potential cultural explanation for this comes from Róheim (1933:217), who, writing of Australian Aborigines, noted that "woman bears the child and carries him in her womb, and then on her body. By extension, therefore, it is a natural tendency to make her carry things."

Even when women did not directly participate in hunting, they were observed to play important roles in providing information to hunters. Unsurprisingly, women in hunter-gatherer societies appear to have rich knowledge of animal behaviour that may influence hunting success (Biesele & Barclay 2001). In considering these contributions by women, we call attention to the rich cultural texture behind hunting behaviour, including that of women. As in any element of hunter-

gatherer life, hunting is nested within the broader spheres of competition and cooperation. In highlighting the diverse roles in hunting served by women, any interpretation of women's hunting - and, indeed, men's hunting - must be viewed through the lens of gendered interdependence. As (Burch & Ellanna 1994) write: *"In a few societies, females have hunted big game, in others they have cooperated with males in the pursuit of big game, and in quite a few they have hunted small game and have fished, with or without male assistance. Even where they have not actively participated in hunting, females often have played a major part in the rituals that have helped to ensure hunting success...One cannot really make sense of the division of labor along gender lines in a given society without reference to the allocation of power and responsibility, ritual, symbolism, communication, and emotional expression. The straightforward focus of many early gender studies on the amount of time males and females spent in different activities is no longer sufficient."* (Burch & Ellanna 1994:12)

Summary of women's hunting

Taken together, our results show that women's participation in hunting is not a static feature of a society. Instead, it is a dynamic behaviour shaped by a complex calculus of costs and benefits at proximate and ultimate scales. Agta hunter-gatherers, a canonical example of a society in which women hunt (Goodman et al 1985), offer an illustration of this dynamism. Kuhn & Stiner (2006) write that 'there is no widely accepted explanation' for why Agta women hunt, but it is quite clear from Goodman et al (1985) that the socioecological conditions faced by the Agta in the 1970s and 1980s incentivized this behaviour. But things appear to have changed over the past decades. As documented by Hagen et al (2016), Agta informants in recent years stated that increased logging in the area had detrimentally affected the forest vegetation and reduced animal populations. Additionally, fewer hunting dogs were available. With these changes, it became harder for women to hunt. Hagen et al (2016) mentions that two older women had claimed they had hunted when they were younger but state that no Agta women under the age of 45 have ever participated in hunting. Two recent ethnographers of the Agta note they had never seen women hunters or heard people talk about them, and they believe women's hunting is no longer practiced (D Smith, M Dyble, *pers comm*). In light of increasing levels of market integration, it seems that women's hunting has been increasingly disincentivized among the Agta.

Estimating the frequency of women's hunting among modern foragers

Although our primary goal was not to estimate the frequency of women's hunting, our results do enable an estimate that can be compared with those of Gurven & Hill (2009) and Anderson et al (2023). Before doing so, it is important to acknowledge at least two pitfalls of attempting such an estimate. First, whether hunting occurs by women sometimes or rarely is different from the question of whether it occurs frequently enough to constitute a female foraging strategy. For example, in the western Australian desert Martu women do hunt kangaroos on rare occasions, but this behaviour is typically performed by male hunters (Bird & Bird 2008). Despite the presence of occasional kangaroo hunting by women, it would be a stretch to say that kangaroo hunting is a female foraging strategy among the Martu (Bird & Bird 2008). With HRAF reports, it is generally difficult to assess the frequency of women's hunting within a population. In most cases, rare events of women hunting are coded the same as habitual women's hunting. This is a shortcoming of virtually all studies of women's hunting, including our own.

Second, there is a common assumption that male ethnographers will tend to overlook instances of women's hunting, resulting in systematic underestimates of the frequency of the behaviour. This is an important consideration, as male ethnographers often face challenges interacting with women during fieldwork, and the vast majority of traditional ethnographers were men. However, our results do not necessarily support this idea, as over two-thirds of the ethnographic documents used in our analysis came from male authors. This does not mean that there are no biases. Ethnographers commonly assumed hunting was a male activity. For example, in his ethnography of the Slavey, Honigmann stated: "Hunting was of course the work of men although women trapped for smaller mammals such as rabbits" (Honigmann 1946). Ethnographies should be scrutinized for such biases, and inferences adjusted accordingly.

With this in mind, our HRAF survey showed that reports of women's hunting were uncommon. Our analysis uncovered only 125 paragraphs across 26 societies in the SCCS database; we arrived at a total of 64 societies after including other sources, some of which were derived from Anderson et al (2023). If we consider only our SCCS sample, the estimated frequency of societies in which women participate in hunting is 15.5% (26/186). We also conducted a search on the D-PLACE database, focusing on the "Sex Difference: Hunting" variable. Out of 965 societies, 14 (1.4%) were coded for the presence of women's hunting. Of those 14 groups, 12 of

them were hunter-gatherers, and the other two were agriculturalists. If we treat 965 as a reasonable denominator for the number of societies, this gives an estimate for the frequency of women's hunting as 6.6% (64/965). If we consider only hunter-gatherers, the frequency would be 16.4% (64/391). Finally, Koster et al (2020) synthesized data on hunting across 40 small-scale societies. The dataset contained little data on hunting by women. Though the authors caution against generalizing about sex differences based on low female sample sizes, many data came from very well-studied populations (e.g. Ache, Batek, Pume), suggesting the behaviour is indeed uncommon. Our findings of the rarity of female hunting in modern ethnographic contexts confirms previous cross-cultural work on the topic (Gurven & Hill 2009) and contrast starkly with the 80% estimate of Anderson et al (2023). However, as noted previously, there is reason to be skeptical about the majority of findings presented in Anderson et al (2023) (Venkataraman 2023).

Women's hunting in the Pleistocene

Among modern foragers, whether women hunt or not is largely a function of specific socioecological conditions. This should have been true in the past as well. In light of our results, we now return to consideration of the possibility of women's hunting in the Pleistocene. A full account of the possibility of female hunting across human evolution is complicated by complex ecological and technological change across great timescales. Nevertheless, some generalizations are possible.

Prey size, type, and abundance changed over the past several hundred thousand years, which would have influenced female participation in hunting. By the Late Quaternary period, due in part to hominin influence, 90 genera of animals >44 kg went extinct globally (Ben-Dor & Barkai 2021). As a result, subsequent human ancestors subsisted on smaller prey than their predecessors, necessitating a broadening of diet breadth (Ben-Dor & Barkai 2021; Dembitzer et al 2022). These macroevolutionary trends suggest that human ancestors were quite successful in killing big game for hundreds of thousands of years. Such hunting sometimes required large-scale cooperation to drive, corner, and run prey, and may have led to the formation of large groups on a temporary basis (Boyd & Richerson 2022). We expect such large-game communal hunting to result in widespread female participation, an inference supported by the review of Boyd & Richerson (2022). If we extrapolate from ethnographic trends, women would have participated primarily in terms of providing logistical support, including carrying and processing

game, and serving in ritualistic and symbolic roles; women also likely participated in finding game and acting as beaters.

Any consideration of women's hunting in the past must consider the technologies available at a given time period, as any given technology is associated with unique profiles of failure probability and danger, as well as requirements of cooperation with others. Broadly speaking, and admittedly oversimplifying, technological evolution throughout the human lineage is thought to have progressed from hand-wielded spears to throwing spears, followed by spear throwers and bows and arrows (O'Driscoll & Thompson 2018; Milks 2020). As stated by O'Driscoll & Thompson (2018: 34; Lombard 2016), although these technologies appear to increase in complexity over time, the adaptation of these technologies should be understood as "independent solutions that each operated within its own environmental and cultural contexts." Based on the evidence of early points, throwing and thrusting spears were first used ~500 kya, with earliest evidence being found in South Africa (O'Driscoll & Thompson 2018). Some of the earliest and direct evidence for the emergence of spear throwers are found in Europe at ~17.5 kya (O'Driscoll & Thompson 2018). Possible fragments of a bow have been recovered from sites in Europe, dating back to ~18 kya. However, the earliest evidence of complete armatures dates back to ~8 kya in Denmark (O'Driscoll & Thompson 2018). It is important to consider that wooden clubs and throwing sticks also make for potent weapons but are challenging to detect archaeologically (Hrnčič 2023). On the whole, it seems that relatively complex technologies emerged rather recently in human evolution.

We first consider hand-wielded spears, which would have necessitated close-range killing. Archaeological evidence suggests this may have been the most common type of hunting, up to 500 kya. Our ethnographic review revealed spears to be the fourth-most common type of weapon used by women during hunting. Extrapolating from these reports, we suspect hunting large game at close range may have posed unacceptably dangerous risks to female participants. It is unlikely that children would be brought into close range of large and dangerous animals. But, on the other hand, if communal hunting necessitates large gatherings (Boyd & Richerson 2022), numerous opportunities for allocare would also be available. We suggest that women would likely have participated in this kind of hunting in the same way it is observed among modern foragers: not necessarily close-range killing, but by serving as beaters and being involved in ritualistic practices, butchery, sharing, and serving other key logistical roles.

With the advent of direct spear-throwing and spear-throwing technology such as atlatls, killing at a distance became possible. It has been theorized that atlatls were used for hunting large terrestrial mammals, though this would have varied by geographic location (Lombard & Shea 2021). This is the kind of hunting inferred by Haas et al (2020) to have occurred in the case of the Peruvian female hunters. Spear-throwing technologies are notable for their potential use by a wide demographic of people during group hunting (Bettinger 2013; Grund 2017). Grund (2017) constructed learning curves for self-bows and atlatls based on modern amateur practitioners, concluding that spear throwers are relatively easy to learn compared to archery (but see Whittaker 2013; Whittaker et al 2017). Though the atlatl is considered to have relatively low accuracy, this may be offset by marginal gains in overall success rates due to larger group size (Grund 2017). Given the cooperative structure of atlatl hunts, the reduced danger of hunting-at-a-distance, and the relative ease of use of this technology, it is quite possible that women regularly participated in atlatl hunting in diverse ways.

With the emergence of bow and arrow technology at ~18 kya (at the latest), foragers would have realized several benefits: a greater maximum striking range, higher accuracy, and a faster reload rate (Bettinger 2013). These technological differences have led scholars to conclude that bows are more conducive to more individualistic or small-group hunting compared to atlatls, and that they potentially downgraded the scale of cooperation in Western North America after their introduction (Bettinger 2013). There is little evidence from the modern ethnographic record to suggest that women would have regularly engaged in hunting with the bow in the past, particularly if this form of hunting is individualistic and necessitates long periods of time away from camp.

Finally, we consider the antiquity of dogs' involvement in women's hunting. Dogs are considered to be one of the first species to enter a domesticate relationship with humans (Chambers et al 2020; Perri et al 2021). Researchers debate the timing(s) of dog domestication. Some scholars place dog domestication as early as ~20-40 kya (e.g. Galibert et al 2011 and their discussion on proto-domestication), however these cases of earlier "Pleistocene dogs" have been met with skepticism (Irving-Pease et al 2019; Thalmann & Perri 2018). Currently, strong evidence of domestication has been found for dates ranging ~13.5-15 kya (Chambers et al 2020; Irving-Pease et al 2019; Lupo 2017; Thalmann & Perri 2018). If we conservatively accept these more recent estimates, this leaves a long period of time during which dogs were not available to aid modern *Homo sapiens* women in hunting. For most of the Pleistocene, involvement in game

697 drives and other forms of collective hunting were probably the most common kinds of
698 participation by women in hunting.
699

700 Revisiting the origins of divisions of labour in foragers

701 Our study may shed some light on the emergence of gendered divisions of labour among
702 foragers. As noted in the Introduction, one prominent theory (Kuhn & Stiner 2006) suggests that
703 gendered divisions of labour characteristic of modern foragers ‘did not appear in Eurasia until
704 the beginning of the Upper Paleolithic.’ According to this view, the undifferentiated economies of
705 Middle Paleolithic populations were at a competitive disadvantage due to lower foraging
706 efficiency compared to the differentiated economies of Upper Paleolithic populations that
707 eventually replaced them. This hypothesis is based on the principle of comparative advantage,
708 from which it follows that complementary gender roles yield foraging benefits (Bird 1999).

709
710 However, it is important to be specific about what is meant by undifferentiated economies.
711 Women’s participation in hunting need not imply undifferentiated economies. As we see in
712 modern foragers, divisions of labour can still exist and yet be flexible according to circumstance,
713 being undifferentiated in some seasons or contexts but stricter in others. For example,
714 Indigenous hunting behaviour at buffalo jumps in the Northern Plains of North America was
715 highly seasonal due to the grouping patterns and reproductive patterns of buffalo, with the
716 largest drives occurring only in the autumn, when buffalo fat reserves were at high levels (Brink
717 2008; Lee et al 2022). Women in these societies would have participated in hunting, but large
718 buffalo drives likely only happened every few years. Women may have participated in hunting
719 frequently on a seasonal basis, but this doesn’t necessarily imply frequent hunting on larger
720 timescales, nor specialization on hunting. Given that atlatl and spear use are relatively easy to
721 learn (Grund 2017) and the fact that big-game cooperative hunting was seasonal, ancient
722 women may have experienced minimal tradeoffs between involvement in hunting and acquiring
723 skills that are more typically in the female domain, such as plant foraging. This idea is supported
724 by the fact that digging sticks are one of the most commonly used hunting weapons by modern
725 female foragers. The idea of undifferentiated economies may need revision in light of these
726 points.

Conclusion

Our ethnographic analysis identified several socioecological similarities observed in modern foraging societies in which women participate in hunting. Based on contemporary ethnography it seems probable that the following factors would have promoted women's involvement in hunting in the past: opportunity to collectively hunt abundant small game; mitigation of tradeoffs with childcare through allocare networks; opportunities to act as beaters and drivers of game; opportunities to serve logistical, informational, and ritualistic roles; and the use of hunting technology requiring low expertise. The extent to which women's hunting occurred would have been a result of these various factors interacting in complex ways. In the case of Middle Paleolithic modern humans, prevailing technologies and socioecological settings suggest that female hunting may have been relatively common under the right circumstances.

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Tables

Table 1. Hypotheses and corresponding predictions about the socioecological context of women's hunting.

Hypothesis	Prediction	Proposition
1. There is minimal conflict with childcare	1.1 Children attend hunts	Evidence that children attend hunting excursions along with women
	1.2 Allocarers attend to children at camp	Evidence that children stay at camp with other care takers when women go on hunting excursions

	1.3 Post-child bearing women hunt (or hunt more often)	Evidence that women hunt post-child bearing
	1.4 Nulliparous (pre-child bearing) women hunt (or hunt more often)	Evidence that women hunt before they reach reproductive age
2. There are few cultural restrictions on access to hunting technology	2.1 Exclusion or taboo on women's hunting	Evidence that women are socially forbidden from hunting-related practices
	2.2 Women have limited access to hunting technology	Evidence that women are socially forbidden from using certain hunting technology
	2.3 Women use different technology than men	Evidence that women use a different technology than men when they hunt
	2.4 Women's hunting unceremonious compared to men's	Evidence that women are not celebrated when they hunt successfully
	2.5 Ritualistic role	Evidence that women are involved in rituals believed to improve hunting success
	2.6 Negative impact on hunting	Evidence that women are believed to negatively impact hunting success in some way

3. Women pursue low-risk game within range of camp, with the aid of dogs, and/or in groups	3.1 Use of dogs by women	Evidence that women are aided by dogs when they hunt
	3.2 Women hunt in a group	Evidence that women hunt in association with other adults
	3.3 Women hunt alone	Evidence that women hunt unaided by other adults
	3.4 Women hunt small game (<15 kg)	Evidence that women hunt game <15 kg
	3.5 Women hunt medium-large game (≥15kg)	Evidence that women hunt game ≥ 15 kg
	3.6 Participation in game drives	Evidence that women communally hunt medium-large game in drives
	3.7 Close to camp	Evidence that women hunt game close to camp
	3.8 Far from camp	Evidence that women hunt game far from camp
4. Women fulfill key logistical or informational roles	4.1 Women act in collective hunt as beaters	Evidence that women act as beaters to drive game during communal drives

	4.2 Carrying role	Evidence that women carry meat back to camp or aid male hunters with the hunting load
	4.3 Information role	Evidence that women track and relay information about hunting opportunities to male hunters

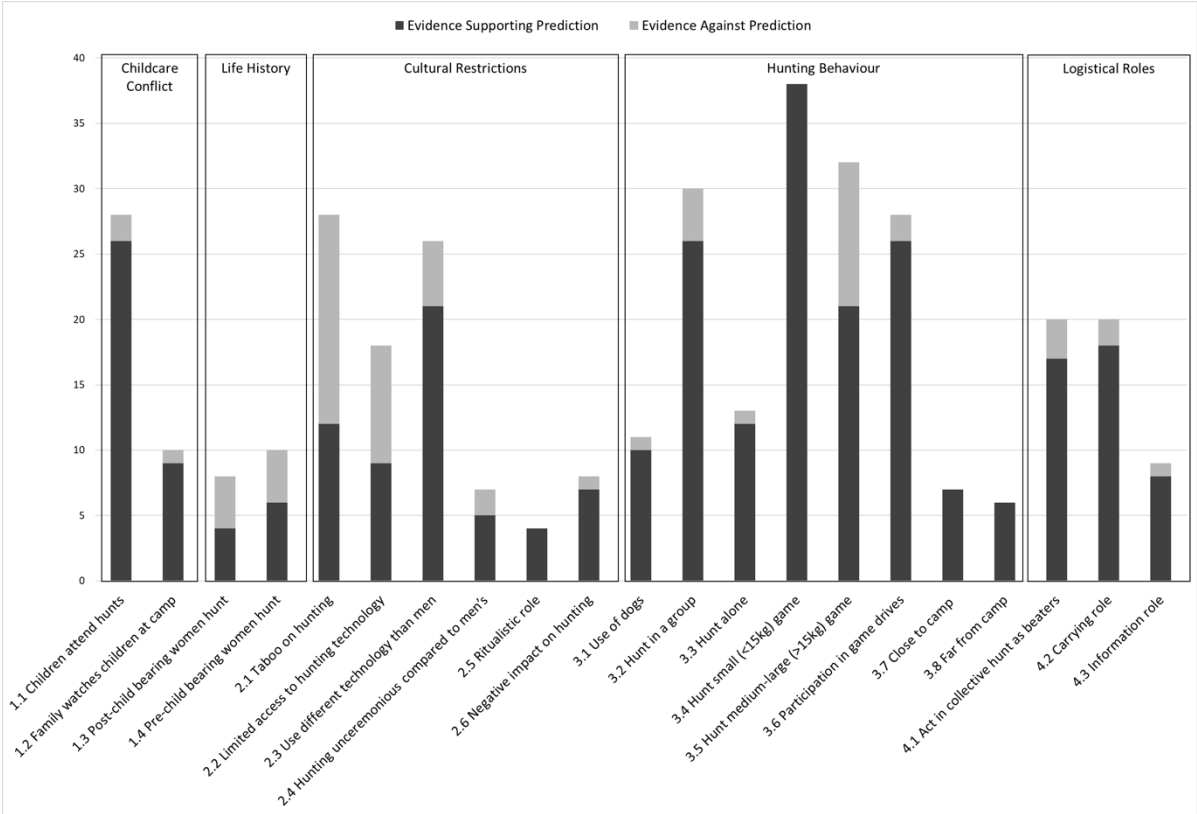
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Figures

Figure 1. Geographic locations of ethnographic instances of women’s hunting. Circle sizes are proportional to the number of relevant documents from each society. Subsistence strategy is denoted by symbol type.



Figure 2. Bar graphs displaying evidence for (black) and against (grey) predictions regarding the socioecological context of women’s hunting across five domains.



Supplemental Information

Figure S1. Bar graph of weights (kg) of medium-large game hunted by women.

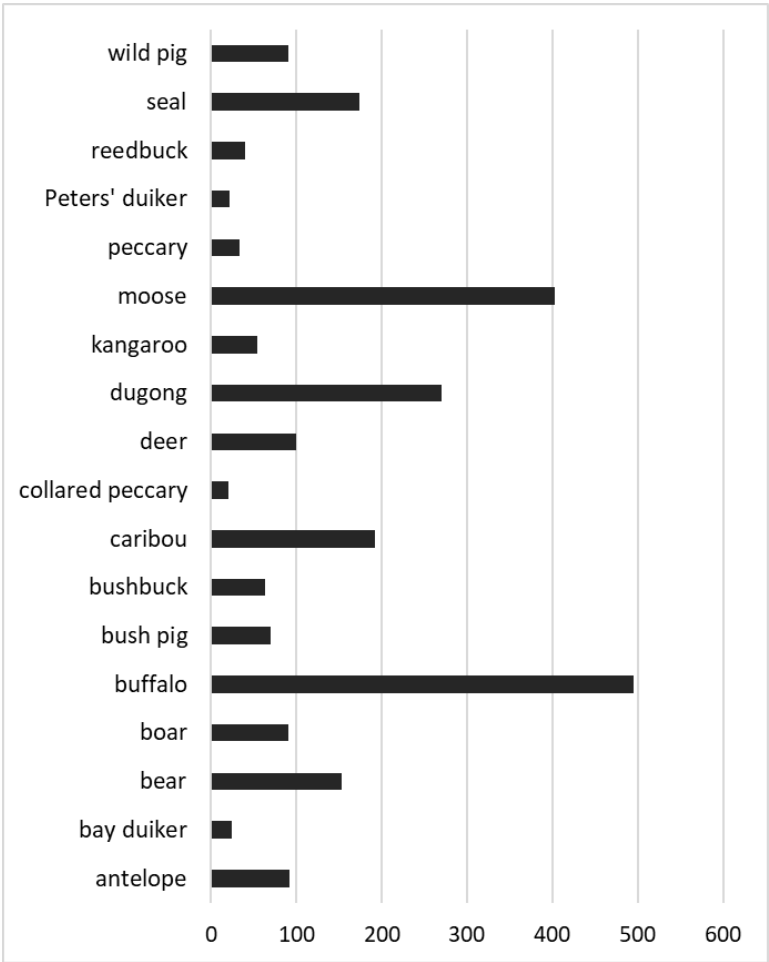


Figure S2. Clustered bar chart of behaviours as recorded in male versus female authored ethnographies.

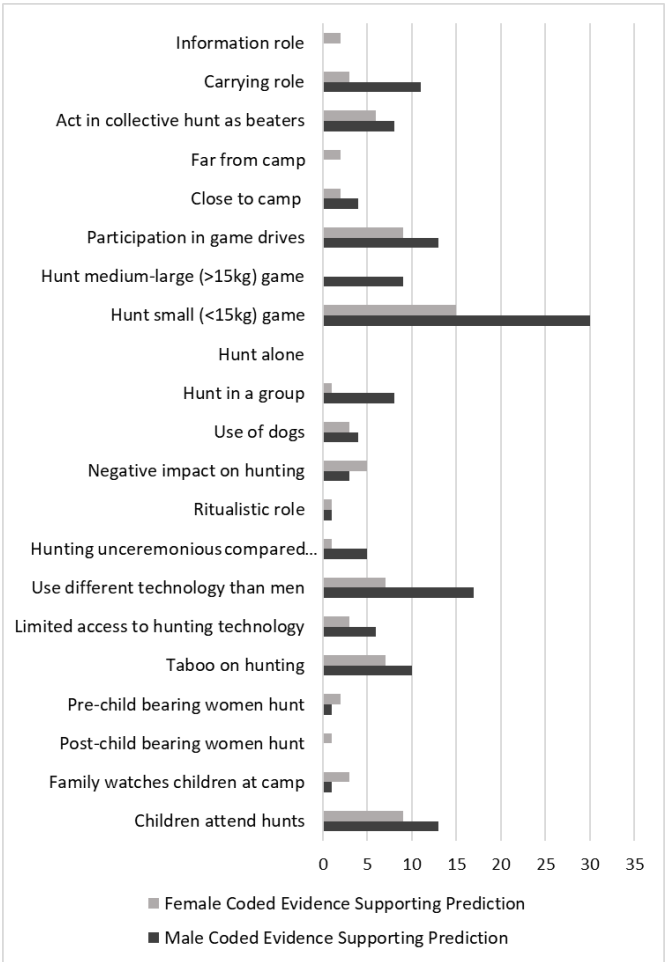


Figure S3. Clustered bar chart of behaviours as rejected in male versus female authored ethnographies.

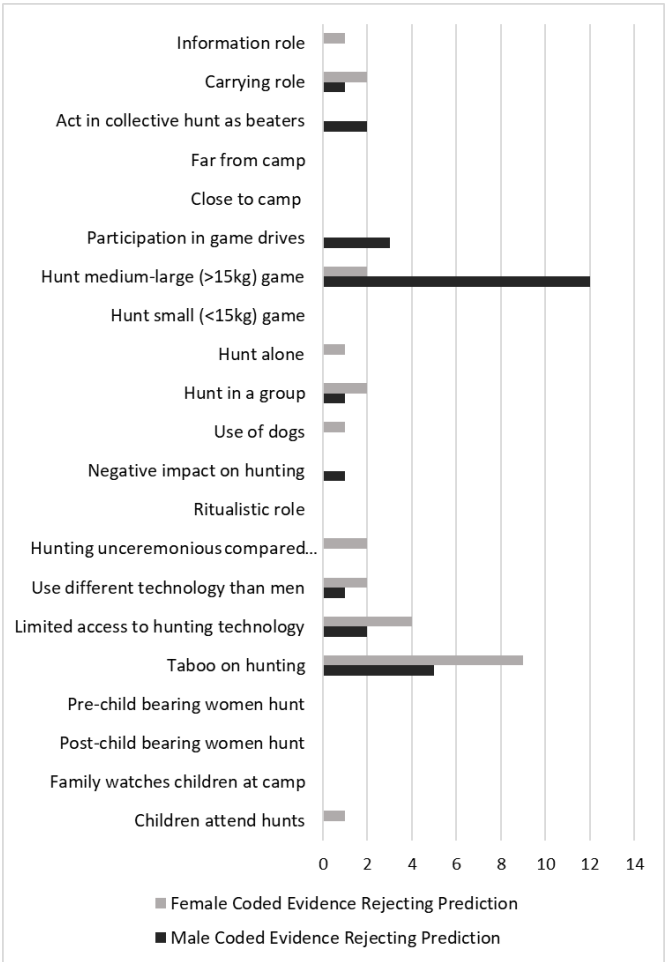
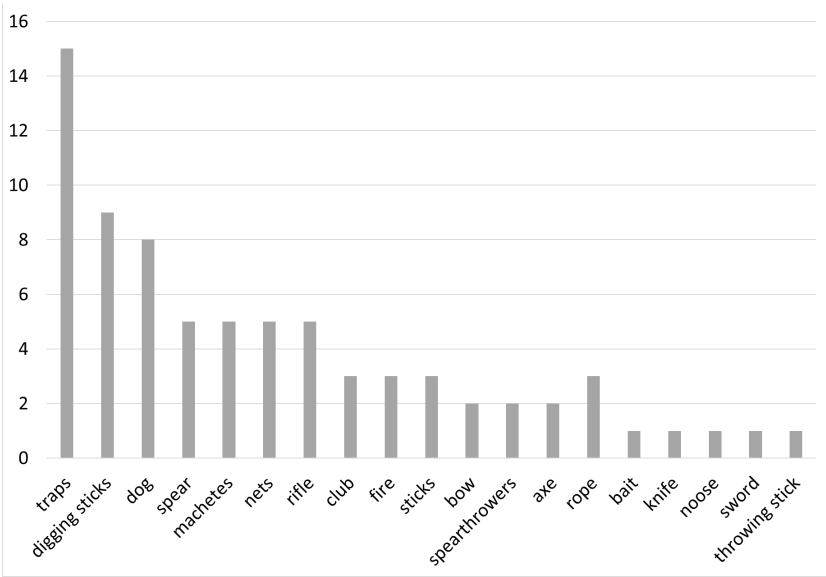
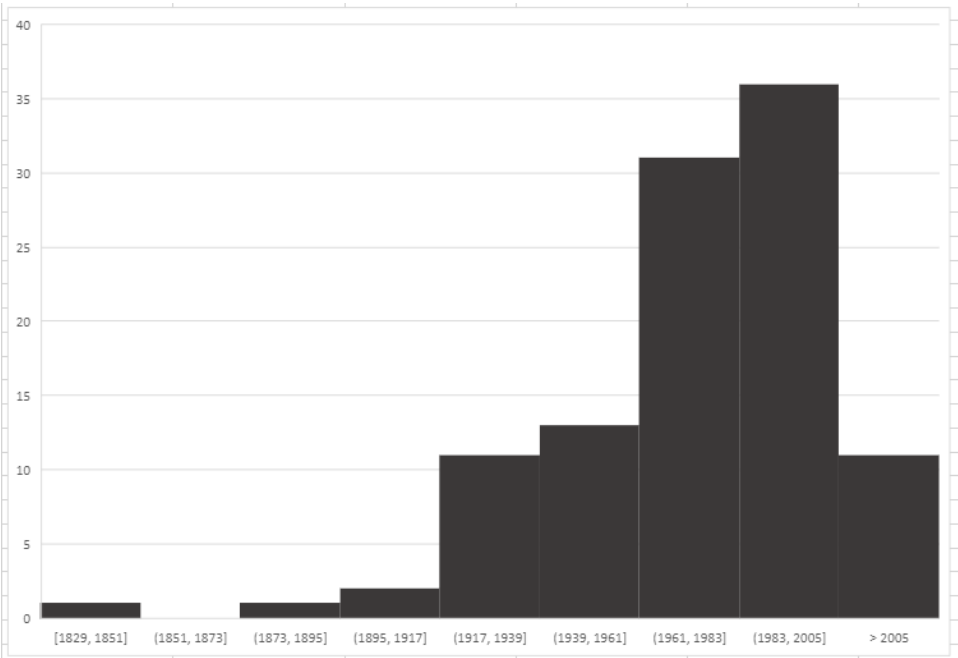


Figure S4. Bar graph of ethnographic reports of women’s hunting technology use.



1074 **Figure S5.** Histogram of ethnographic reports of women’s hunting across time.



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