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# Household and Kin Provisioning by Hadza Men

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**Abstract** We use data collected among Hadza hunter-gatherers between 2005 and 2009 to examine hypotheses about the causes and consequences of men's foraging and food sharing. We find that Hadza men foraged for a range of food types, including fruit, honey, small animals, and large game. Large game were shared not like common goods, but in ways that significantly advantaged producers' households. Food sharing and consumption data show that men channeled the foods they produced to their wives, children, and their consanguineal and affinal kin living in other households. On average, single men brought food to camp on 28% of days, married men without children at home on 31% of days, and married men with children at home on 42% of days. Married men brought fruit, the least widely shared resource, to camp significantly more often than single men. A model of the relationship between hunting success and household food consumption indicates that the best hunters provided 3–4 times the amount of food to their families than median or poor hunters. These new data fill important gaps in our knowledge of the subsistence economy of the Hadza and uphold predictions derived from the household and kin provisioning hypotheses. Key evidence and assumptions backing prior claims that Hadza hunting is largely a form of status competition were not replicated in our study. In light of this, family provisioning is a more viable explanation for why good hunters are preferred as husbands and have higher fertility than others.

**Keywords** Hadza · Hunter-gatherers · Food sharing · Household provisioning · Costly signaling · Show-off hypothesis

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In the middle of a hot and dry day in late 2009, a tired-looking Hadza man named Lengu walked toward the home he shared with his wife, Moda. He carried over his shoulder a dik-dik he had shot in the surrounding woods. He carefully hung the little antelope on the frame of their grass-covered house, then sat down in the shade and asked Moda for a cup of water. While Lengu drank and rested, one of us chatted with him about his day, and then asked what he planned to do with the dik-dik:

BW: *Are you going to keep all of the dik-dik for your home, or are you going to give some away to others*?

L: Well, if others come and ask for shares, then Moda will share it.

BW: *I've been told that sharing meat is women's work. Is that true?*

L: Yes, that's true. The men's work is to hunt. Women are the ones who share the meat.

BW: *What parts of the animal should the hunter's family keep, and what parts should they give away?*

L: If he kills an impala or zebra, the hunter can keep one back leg and the *salala* [tenderloin].

BW: *What about the skin?*

L: That's okay for him to keep also, because he will use it to sleep on. To keep more is selfish.

BW: *Are there any people around like that*?

L: Yes there are! There are many!

For Lengu and other Hadza, the sharing of food with one's spouse, children, and neighbors is a particularly meaningful daily activity. Even the most successful Hadza foragers must rely on others' work and sharing to get by, especially during days of sickness, rest, or inevitable bad luck experienced when foraging for wild foods. By contributing to and drawing from food sharing networks, the Hadza develop, negotiate, and signify crucial social relationships. For these reasons and others, understanding how and why people do or do not share foods is a long-standing topic of interest to anthropologists and theorists of cooperation (Bowles and Gintis 2004; Boyd and Richerson 1988; Gurven 2004; Mintz and Dubois 2002; Peterson 1993; Sahlins 1972; Tomasello et al. 2012). Human behavioral ecologists have proposed and tested a range of ideas about how food-sharing behavior might be structured by the nutritional and communicative benefits it provides to sharers, their families, and other social partners (Allen-Arave et al. 2008; Bliege Bird et al. 2002; Gurven 2004; Gurven et al. 2001; Hawkes et al. 2001a, b; Blurton Jones 1987; Kaplan and Hill 1985; Nolin 2010; Patton 2005; Winterhalder 1986). Here we retain this general framework and focus on the patterns of male food production and subsequent sharing and consumption that we observed among the Hadza between 2005 and 2009. Our aims are to fill in crucial gaps in our knowledge of the Hadza subsistence economy, and to examine alternative hypotheses about how and why men's foods were produced, shared, and consumed in the seven camps we investigated. Finally, we will discuss linkages between hunting, household provisioning, and reproduction in light of these data.

## The Past and Present of Men's Nuclear Family Provisioning

We define *provisioning* as one individual regularly and selectively providing food to another in a way that benefits the recipient, and *nuclear family provisioning* as that which occurs among spouses and their children. The history and current practices of nuclear family provisioning are subjects of enduring interest in evolutionary anthropology (Chapais 2011; Gurven and Hill 2009; Lovejoy 1981; O'Connell et al. 1999; Quinlan 2008; Washburn and Lancaster 1968). Such research is typically framed within the larger goal of understanding how humans evolved and currently maintain a suite of anatomical and life-history traits that distinguish us from our closest primate relatives. These traits include larger brains, shorter interbirth intervals, higher fertility, lengthier childhoods, and longer lifespans (Hill and Kaplan 1999). Researchers generally agree that shifts in the ancestral hominid diet and new patterns of food sharing and social organization were necessary to support such changes (Flinn 2011). Specific interest in male nuclear family provisioning is one component of this research, understandable given our species' distinctive behavior in this regard.

Although in most birds, many carnivores, and a few genera of New World monkeys, males share foods with their young (Kleiman and Malcolm 1981; Møller and Cuervo 2000), humans are the only species of Old World primate in which it is common for pair-bonded male and female adults to regularly share food with one another, and for fathers to provide food to their offspring (Jaeggi and van Schaik 2011). The antiquity of paternal provisioning is not known, and available anatomical and archaeological evidence from the Plio-Pleistocene supports only tentative inferences about ancient food sharing practices (e.g. Isaac 1978; Ungar et al. 2006). Evolutionary reconstructions have been based on broad considerations of the ecology of extractive foraging in savannah-woodland habitats characteristic of most hominid fossil sites (Cerling et al. 2011) and reasoned speculation about likely antecedents to ethnographically known foraging economies (Marlowe 2005). Data derived from studies of the Hadza have figured prominently in ethnographically informed reconstructions of the past (Bunn 2001; Chapais 2011; Hawkes et al. 2001b; Hildebrandt and McGuire 2002; Kaplan et al. 2000; O'Connell et al. 1999, 2002; Speth et al. 2010).

## The Social Context of Hadza Men's Nuclear Family Provisioning

Although many elements of Hadza society are more fully described elsewhere (see Blurton Jones et al. 1992; Marlowe 2010 and sources therein; Woodburn 1968a, b, 1979), a few summary points about Hadza culture, residential organization, gender roles, and marriage practices are worth noting here to place our study in context.

The pioneering ethnographic work of Woodburn (1968a) describes how Hadza society was organized into an annual subsistence cycle reflecting the seasonal ecology of their woodland-savannah habitats. Woodburn describes how interpersonal relations were guided by a cultural ethos that prized individual freedom and mobility (Woodburn 1968b), and that residential groups (camps) often broke apart or individuals moved between them in order to diffuse social tensions. Although today the locations of camps probably do not change as often as they did during Woodburn's early work, during our observations the Hadza continued to actively "vote with their

feet," joining and departing camps as a way to settle disputes peacefully, to visit relatives and friends, and to seek better foraging opportunities. Woodburn (1979) emphasizes the minimal role of politics, a pervasive emphasis on actions that give immediate returns rather than delayed benefits, and the generally egalitarian nature of Hadza society (Woodburn 1982). Even amidst the rapid economic development occurring in Tanzania, Woodburn's descriptions still fit the Hadza we worked with very well.

Adult Hadza typically live in residential groups with several close consanguineal and affinal kin, marriages are not arranged, monogamous marriage is the norm, with only 4% of men married polygynously, and divorce is quite common (Blurton Jones et al. 2000; Marlowe 2010). The Hadza practice multilocal residence, but among young couples, matrilocal residence is expected, with husbands providing bride-service to their in-laws (Wood and Marlowe 2011). Overall, women are more likely to reside with primary kin than are men (Hill et al. 2011). Matrilineal relationships are especially important in guiding the organization of residential groups and social life in general (Hawkes et al. 1997). Woodburn (1979:256) describes how female autonomy serves to regulate Hadza marriages:

> Women, like men, are usually self-assured and self-dependent. A woman cannot be given in marriage by her male kin nor, when married, can she be compelled to remain married. She is free to break her marriage at any time and is not expected to give any reason unless she chooses to.

To the extent that we can estimate such things, it appears to us that Hadza husbands and wives exercise a great deal of personal freedom and individual autonomy, and couples practice situational leadership rather than following a generally male- or female-dominated form of day-to-day decision-making. In interviews, Hadza tell us that they respect and enjoy living in camps with people who work hard; who do not cause trouble, bickering, or noise; and with whom they share a long history of mutual understanding (Wood 2006 and unpublished data). Both men and women state that in searching for a potential spouse they value physical appearance, character, and foraging abilities (Marlowe 2004). Marlowe (2004) also reports that extramarital affairs were the most commonly stated reason for a divorce.

Although men and women appear similarly endowed with means to express themselves and exert their autonomy, marked gender differences in behavior do exist: in the technologies used, the foods pursued, and even the use of public space for resting and light work, which in Hadza camps is divided into separate areas for men and women. Though varied in its expression and degree, such gendered behaviors are typical of hunter-gatherer societies (Marlowe 2007). Kristen Hawkes, James O'Connell, and Nicholas Blurton Jones were the first anthropologists to address the origins of such gendered differences in foraging behavior among the Hadza.

## Prior Studies of Hadza Male Household Provisioning

Hawkes, O'Connell, and Blurton Jones carried out extensive research on men and women's foraging and food sharing in the Tli'ika area during 1985–1986, 1988, and

1989. A central theme of much of their work, drawing from theories of sexual selection and parental investment (Trivers 1972), is an exploration of how men's and women's foraging goals and behavior may be structured by fundamental differences in reproductive costs, and resulting reproductive strategies (Hawkes et al. 1991, 2001a, b; O'Connell et al. 2002). In particular, their research investigates whether men's foraging strategies, particularly hunting, might best be understood as an outgrowth of male-male status and mating competition, whereas female foraging strategies are more closely fitted to the daily needs of provisioning children and grandchildren. In a series of seminal articles addressing these issues, they report measures of Hadza men and women's activity budgets, men's large game hunting returns, large game meat sharing, and changes in subjects' body weight over their study period (Hawkes et al. 1991, 2001a, b). These data are then used to examine a variety of common assumptions about the form and function of men's foraging efforts.

Nuclear family provisioning is often considered one of the basic economic functions of marriage, wherein two adults cooperatively pool their food resources (Gurven and Hill 2009; Washburn and Lancaster 1968). Although this may or may not be the case, marriage does typically serve another function cross-culturally, as a public acknowledgment of relatively persistent and exclusive sexual relations between adults (Flinn and Low 1986). Under such conditions, spouses who selectively shared foods within their nuclear family (instead of giving to others) would be making a reproductive investment because the foods provided to one's spouse and children would presumably increase their well-being and chances of survival, and may help ensure the continuation of a marriage and future reproduction. Such intrafamilial sharing decisions are of course also influenced by actors' larger social worlds, wherein varying relationships structured by age, affinity, gender, kinship, and religion provide competing social demands and opportunities.

The simple assumption that husbands and wives cooperatively pool their food resources may not reflect the actual food economies of foragers, especially in regard to those foods, such as meat, that are often widely shared beyond the acquirer's household (Hawkes 1990, 1991, 2001). Meat acquisition and sharing is an important feature of Hadza social life: Marlowe (2010) reports that by weight, meat constituted 27% of the total food brought back to 24 Hadza camps observed between 1995 and 2006. The Hadza prefer to eat meat rather than berries or tubers (Berbesque and Marlowe 2009; Woodburn 1968a), understandable given meat's substantial protein and lipid content and its overall high energetic density (Hill 1988).

## The Show-off Hypothesis

Hawkes and colleagues propose that the hunting and meat sharing they observed among the Hadza is best understood as a "show-off" strategy, wherein men foraged not to feed their families but to gain status and deference in the arena of male-male competition for mates (Hawkes et al. 1991, 2001a, b). Below, we describe in detail the data supporting the show-off hypothesis, and then we discuss subsequent research on similar topics with the Hadza.

Hawkes et al. (1991, 2001b) call attention to an important feature of large game hunting: its inconsistent profitability. They report that Hadza hunters specialized in hunting large game and made large game kills at an average rate of only once per 29 hunter-days, and once per 45 hunter-days when only daytime hunting is considered (Hawkes et al. 1991:245, 2001b:686). Using these observed rates, Hawkes and colleagues (2001b) then develop a formal model that examines the household provisioning consequences of exclusive large game hunting, a strategy of hunting both large and small game, or exclusive small game hunting. The expected rates of energetic acquisition, frequencies of acquisition, and sharing patterns included in this model come from their observations of large game hunting and sharing, a small game hunting experiment, and assumptions about how small game would be shared and consumed if acquired.

Hawkes et al.'s (2001a) meat-sharing research found that men who killed large game retained only 5–10% of the total carcass weight for their own households following primary distributions. Successful hunters' shares were seldom (and only in the case of the very largest game) heavier than the average shares received by other nuclear family households. They suggest that defending meat shares from others' demands was too costly, and thus wide-scale sharing was inevitable, as a form of tolerated scrounging (Blurton Jones 1984, 1987; Hawkes et al. 1991). Their analysis of large game meat sharing also indicates that hunters who provided more meat to their residential groups were not reciprocally compensated by receiving more meat from their residential groups (Hawkes et al. 2001a, 2010; cf. Gurven and Hill 2009, 2010).

Based on experiments in which they asked men to snare animals and focus on small game hunting, Hawkes et al. (1991) estimate that if men were to specialize in hunting small game, they would acquire a much lower daily average meat return (0.25–0.75 kg/hunter-day) but would also experience a much lower failure rate; they estimate that small-game specialists could bring home some meat every other day (with snaring) or every three days (with bow hunting) (Hawkes et al. 2001b:686, Table 4).

To model the household incomes after sharing that these different hunting strategies could produce, they couple their observed 5–10% take-home fraction in their study of large game meat sharing with the assumption that if hunters killed small game, the meat so acquired would not be shared, but consumed only within hunter's households.

Hawkes et al. (2001b) estimate that men could potentially supply food to their households at rates of 0.08 kg/hour with exclusive large game hunting and 0.04 kg/hour with exclusive small game hunting. Based on this model, men who were not specialists, but instead chose to hunt *both* large and small game, would provide a more regular supply of food to their households and probably achieve a higher overall foraging return rate (since the estimated post-encounter return rate from small game hunting, >0.23 kg/hour, is greater than the estimated foraging income from exclusive large game hunting). This mixed strategy, wherein hunters pursue both small game and large game, is proposed to be the optimal household provisioning choice, but not the one that Hadza men in fact followed during their observation period.

If men consistently passed up profitable food items, came home empty-handed vastly more often than not, and then widely shared their rare successes, this would surely challenge the common assumption that men's resource choices and sharing patterns are generally guided by the goals of providing a high or steady rate of food to their households. Hawkes et al. (2001b) argue that Hadza men followed this "show-

off" strategy for the status and mating benefits its provided, and that delivering occasional, impressive bonanzas was more valuable to men as a means to gain social attention and status than was providing a regular supply of food to their households. The mating benefits of large game hunting are difficult to assess, but by comparing husbands' hunting successes to their wives' activity budgets, the authors suggest that better large game hunters were able to outcompete other men and marry women who were harder-working and better able to raise and feed children (Hawkes et al. 2001b).

Inspired by Hawkes and colleagues' work, subsequent research has further examined aspects of Hadza men's foraging, paternal care, and household provisioning. Based on fieldwork in 1995–1996, Marlowe (1999) shows that, controlling for men's age, those who had reputations for being good hunters had higher fertility and more surviving children than other men. Analyzing food production data (i.e. rates of bringing food to camp), Marlowe (2003) shows that wives with nursing infants had decreased food production relative to other women, whereas the husbands of such women brought more food back to camp than other men. Based on these observations, Marlowe suggests that husbands were providing their wives with an important flow of calories during the critical period when they were most encumbered by infant care. A later study by Wood (2006) examines whether Hadza men's foraging group preferences appeared driven by a concern for higher status as a hunter or by a desire to provision their households. In interviews, 80% of Hadza men stated a preference for joining foraging groups containing good hunters, where they and their families would expect to eat more meat, rather than groups of poor hunters, where they would have higher status as a hunter relative to the other men.

As the research described above attests, much has already been learned about Hadza male subsistence strategies. At the outset of the current study, however, we still lacked data that are critical to understanding the causes and consequences of men's foraging and food sharing practices: no data describing the sharing of men's foods other than large game were available, and no measures of the consumption of any male-produced foods were available. We were interested in collecting these data in order to construct a more comprehensive account of the food economy of the Hadza, and to further examine ideas about men's foraging, food sharing, and family provisioning.

In what follows, we first describe the hypotheses we will examine, then our methods of data collection, and then the food production and food sharing data sets that resulted. In the "Results" section, we begin our analyses by examining whether the following elements of the show-off hypothesis were evident in our data:

1. Whether Hadza men generally ignored small game and specialized in hunting large game (Hawkes et al. 1991:243, 2001b:684, 686, 702–3).
2. Whether men could not control distributions of the large game they killed, keeping little of the carcasses they had acquired (Hawkes et al. 1991:243, 2001a:124).
3. Whether small game acquired by men was kept and consumed solely within their households (Hawkes et al. 1991:88, 2001b:686, Table 4; O'Connell et al. 1999:464).

After these analyses, we test whether men foraged and shared foods in ways that regularly and selectively benefitted their spouse and offspring, which we call the household provisioning hypothesis. Specifically, we examine the following four predictions:

4. In primary distributions, the shares kept by households of producers should be heavier than those received by other households.
5. In primary distributions, households of successful hunters should be more likely to keep choice cuts and retain high-quality parts—specifically the hind limbs of large ungulates and the skins of impala or kudu.
6. Wives should have increased access to the foods their husbands produce and should be more likely to possess and eat their husbands' foods than other reproductively aged women in camp.
7. Biological children of the producer should eat more of his foods than do other children in camp.

We then test the following prediction of the kin provisioning hypothesis, that men share foods such that their consanguineal and affinal kin living in other households differentially benefit:

8. Consanguineal and affinal kin living in other households should eat more of producers' foods than individuals unrelated to the producer or his wife.

After testing these hypotheses, we explore the food production rates and frequencies of men of different marital status. Throughout, we will explore how camp demographics, food scarcity, seasonality, and food resource characteristics influenced men's food production and sharing.

## Methods

### Data Collection

During the fieldwork carried out for this research, we strived to live in Hadza camps across their entire geographic range, including groups to the east and (the less-well-studied) west of Lake Eyasi. We lived in camps where people were actively foraging for wild foods for the vast majority of their diet. This means we did not carry out work among camps that were engaged in tourism or wage-labor (Table 1).

We collected food production, sharing, and consumption data in seven Hadza camps where the residents were subsisting on wild foods for approximately 95% of their diet. Fieldwork was carried out over three periods: August–September 2005, January 2006–January 2007, and August–September 2009. Basic information about each camp is provided in Table 1. Additional information on the camps, comparisons between camps and seasons, and other statistical analyses are presented in the ESM; Tables labeled S1, S2, S3, and S4 in the text can be accessed online.

**Table 1** Hadza camps in this study

| Camp no. | Year | Months | Season | Households (*N*)[a] | Residents (*N*)[b] | Adult men (*N*) | Notes |
|---|---|---|---|---|---|---|---|
| 1 | 2005 | Aug–Sep | Dry | 20 | 63 | 15 | West of Lake Eyasi, Dunduiya region, many Hadza visitors, meat drying, no tourists |
| 2 | 2006 | Jan–Feb | Wet | 10 | 35 | 10 | East of Lake Eyasi, Tli'ika region, isolated, no tourists |
| 3 | 2006 | Mar–Apr | Wet | 11 | 48 | 11 | East of Lake Eyasi, Tli'ika region, isolated, no tourists |
| 4 | 2006 | May–Jun | Dry | 11 | 26 | 12 | Northeast of Lake Eyasi, Gola region, near Datoga agricultural settlement, honey trading, no tourists |
| 5 | 2006 | Sep–Oct | Dry | 12 | 35 | 12 | East of Lake Eyasi, Tli'ika region, regular Datoga pastoralist and Hadza visitors, no tourists |
| 6 | 2006–2007 | Dec–Jan | Wet | 7 | 21 | 4 | East of Lake Eyasi, Tli'ika region, isolated, no tourists |
| 7 | 2009 | Aug–Sep | Dry | 4 | 23 | 6 | East of Lake Eyasi, Han!abi region, 3 km from small Datoga pastoralist settlement, some meat and maize received from Datoga, no tourists |

[a] The number of households in each camp is a count that includes all the typical household types in Hadza camps: nuclear family households, houses of married couples with no children, houses with only a single occupant (common for elderly men or women), houses that contain a group of unmarried women, and those which contain bachelor males

[b] The number of people residing in Hadza camps fluctuates daily, and the counts presented here are based on the number of people who were present in the camps for more than half of the study period

**Table 2** Counts of the unique men and observation days in the male food production dataset, organized by age and marital status

| Men contributing to food production data | | | | |
|---|---|---|---|---|
| Age Interval | Unmarried | | Married | |
| | Forager days | *N* unique individuals | Forager days | *N* unique individuals |
| 18–20 | 174 | 3 | 58 | 3 |
| 21–25 | 242 | 7 | 196 | 5 |
| 26–30 | 23 | 1 | 83 | 4 |
| 31–35 | 123 | 3 | 325 | 9 |
| 36–40 | 131 | 3 | 153 | 4 |
| 41–45 | 0 | 0 | 180 | 6 |
| 46–50 | 0 | 0 | 220 | 6 |
| 51–55 | 0 | 0 | 100 | 2 |
| 56–60 | 34 | 1 | 135 | 4 |
| 61–65 | 0 | 0 | 13 | 1 |
| 66–70 | 0 | 0 | 23 | 1 |
| >70 | 0 | 0 | 84 | 2 |
| >18 | 727 | 18 | 1570 | 47 |

Two men (aged 25 and 37) appeared in our dataset as married in one camp and single in another, therefore, they are counted twice in the "unique individuals" columns. The total number of unique men in this study is 63

## Men's Food Production Data

Researchers used spring scales to weigh all the foods that Hadza brought back to each camp. Our food production data includes 242 days of observation, 63 unique adult men, and 2,297 person-days of observation. To establish when different individuals were resident in each camp, we used hourly scan samples, food production records, and notes indicating when individuals joined or departed the camps. Table 2 provides the number of unique males and observation days in the male food production dataset by age and marital status.

Food production varied among individuals, but also across camps, owing to differences in the local and seasonal availability of foods (Table S1 and see "Results"). In order to compare men's food production rates and frequencies across camps, we calculated standardized scores of food production (SK: kcal/day standardized by camp) and frequency (SF: frequency of food production standardized by camp) for each man resident in each camp. We have calculated the frequencies and the average daily kcal by which men brought five categories of food to camp: large game, small game, honey, fruit, and all foods. The standardized scores SK and SF are essentially *z*-scores, measuring food production in units of standard deviations from camp means, calculated as follows:

$$\mathrm{SK}_{mtc} = (\mathrm{k_{mtc}} - \mu \mathrm{k_c}) / \sigma \mathrm{k_c}$$

$$SF_{mtc} = (f_{mtc} - \mu f_c)/\sigma f_c$$

where, for each man *m* resident in each camp *c* and each food type *t*:

$k_{mtc}$ individual *m*'s daily average (kcal/day) of bringing food *t* to camp *c*
$f_{mtc}$ percent of observation days individual *m* brought food *t* to camp *c*
$\mu k_c$ mean of *k* of men resident in camp *c*
$\mu f_c$ mean of *f* of men resident in camp *c*
$\sigma k_c$ standard deviation of *k* of men resident in camp *c*, and
$\sigma f_c$ standard deviation of *f* of men resident in camp *c*.

To investigate determinants of men's food production, we have grouped men according to whether they were single or married.[1] Those who were married were further classified by whether or not they had at least one biological child under age 10 living in their household. This age cutoff was used to separate highly dependent from less-dependent children because at around age 10 there is a steep increase in the amount of time Hadza children spend out of camp feeding themselves, and in the amount of food they bring back to camp (Marlowe 2010:122, 129). Analyses of associations between men's production of different food types ("Examining Elements of the Show-off Hypothesis," element 1) are carried out among all men aged 18 and over (the full sample). Analyses of differences in food production between single and married men ("Marriage, Children, and Food Production") are restricted to 40 unique men aged 18–40 (the marital sample), as there was only one man over age 40 in our dataset who was single (see Table 2). For maximum comparability, men's production levels in the marital sample are standardized in reference to other men aged 18–40. Those men who contributed to our food production data in more than one camp ($n$=5) were treated as follows: if they had the same marital status in both camps, their standardized scores computed for each camp were averaged ($n$=3). If men appeared in one camp as single and in another as married, each of their scores were included in the marital sample ($n$=2); therefore, the total number of cases in our marital sample is 42, based on 40 unique men. In the full sample, men's standard scores were averaged across camps regardless of marital status; therefore, this sample comprises 63 cases based on 63 unique men.

## Sharing Data

We collected food-sharing data by conducting randomized household observations, focal individual observations, and focal food resource observations. The food distributions presented here are derived mostly from focal food resource observations. These were undertaken in two contexts: (1) when a man who was already the subject of a focal individual observation entered camp bearing foods or (2) when a man arrived in camp carrying foods, which then triggered a focal food resource observation. Like all foods brought into camp, items were weighed before any in-camp

[1] On marital classifications: Men who were living with a spouse were classified as married, and otherwise, single. Although some men living alone might claim to be married, from a household provisioning standpoint, having a wife who is not co-resident is essentially equivalent to having no wife.

distribution or consumption occurred. The researchers then followed the foods as they were distributed.

Primary distributions are those in which we were able to identify the share sizes received by all households after the initial stage of food sharing in camp was complete. As described in more detail below, Hadza food sharing practices differed by food type. Primary distributions of meat resulted in *household shares* in the terminology of Hawkes et al. (2001a). Further food processing, meal sharing, and consumption followed primary distributions. If we observed all the distribution and consumption of a food item, we call these *complete distributions*. Because it was impossible to observe all the eating that occurred following the sharing of large game, our sample of complete distributions includes only small game, honey, and fruit. In the following sections, we describe how the Hadza shared different types of male-acquired foods, and the corresponding data collection methods we used.

## Descriptions of Hadza Food Sharing Practices

*Large Game* Large game the size of an adult impala (*Aepyceros melampus*, average weight=38 kg) was usually brought back to camp nearly whole. Very large game, such as zebra (*Equus burchelli*), buffalo (*Syncerus caffer*), eland (*Taurotragus oryx*), or greater kudu (*Tragelaphus strepsiceros*), were butchered at or near the kill site and then carried away in pieces. A large animal that was shot with a poisoned arrow would usually run off, and the hunter would assemble a party of helpers to track the wounded animal. If successful, this group would locate the animal after it succumbed to the arrow's poison. In this paper, we call the man whose arrow killed the animal the producer, even though others are often involved in the tracking, butchery, and carrying of meat to camp. During our observations, the hunter whose arrow killed the animal was always in the group making the initial butchery decisions and share allotments. Informants have told us (as Lengu said in the conversation quoted above) that the primary distribution of meat is women's work, but in our observations of large game distributions it was clear that both men and women actively discussed share allotments.

The loads people carried away from the kill site sometimes became the very same shares they eventually kept in their households, but just as often, butchery and sharing continued after the meat arrived in camp. This in-camp butchery and subsequent sharing occurred in public spaces repeatedly used for such work. After this butchery, people carried meat to their households, where they hung it on trees or the frames of their grass huts, laid it on rocks, or placed it inside their houses. Researchers waited until all household shares had been finalized before walking to each home and asking to weigh their shares. The Hadza were comfortable with and always allowed such weighing.

*Small Game* Small game (which here includes all species smaller than adult impala, at 38 kg) was usually brought back to camp whole or minimally butchered. Hunters typically carried entire carcasses to their houses and then handed the animal directly to someone in their household. Butchery was not as public as with larger game. Typically the hunter himself or a designee would butcher the animal and direct the primary distribution of raw shares. The hunter and his wife would often discuss to whom they should give shares, and people in camp would also approach and request them.

The methods used to record household shares varied according to the type of small game in question. For the sharing of animals in the 3–38 kg range, the shares of raw meat received by households were directly weighed using a spring scale, just as in the case with larger game. In the case of smaller animals, such as birds, mongoose, mice, etc., the amounts shared would be estimated by count (e.g., number of birds) or by estimating the share size as a fraction of the known weight of the whole carcass (e.g., half of a 300 g carcass).

*Honey* Men brought honey back to camp inside buckets, cans, and the hollowed-out shells of baobab fruits. Upon arrival at camp, men were usually asked by whoever was nearby whether they had any honey, and if so, they were asked to share it. Not infrequently, the acquirer would claim they had none or hardly any. In the case of an obvious success, a man usually made a division, handing his wife or children their household share and giving what he chose to others. This was often done in front of an eager audience of children and adults. Although there was public demand for shares, such pressure was not insurmountable. Men often handed *all* of the honey they acquired directly to their wife or another member of their household, or brought all their honey directly into their houses, giving none to others. In the case of honey, we coded this initial decision and distribution by the acquirer himself as the primary distribution.

## Measures and Estimates of Sharing and Food Consumption

To estimate amounts of food being shared and consumed, researchers used direct weighing, counting, visual estimation of relative share sizes, and videography. The frequent use of weight scales by the researchers—including the daily weighing of all foods arriving in camp and much of that shared between houses—allowed us to practice and hone our visual estimates and lead us to be confident that our weight estimates are fairly accurate.

Videography was especially convenient whenever weighing shares would have been intrusive. Video footage was recorded using a small digital video camera. The Hadza did the vast majority of their cooking and eating at hearths just outside their homes, where we were invited to join them, and occasionally to enter their homes and film interior eating. When filming, we held the camera at chest height, allowing the researcher to continue to maintain eye contact and interact with others in a regular manner. After a few days of exposure to it, the Hadza became quite comfortable being filmed this way.

To code the food distributions we had filmed, we repeatedly viewed the footage at a slow speed, focusing on only one individual's sharing and eating per viewing. The sequence would then be reviewed to record the sharing and eating done by another individual. To calibrate our visual estimates of amounts eaten and shared, we used graduated cylinders to measure the volume of more than a hundred different food containers used in Hadza camps and took scaled photographs of these containers being held.

## The Food-Sharing Dataset

The food-sharing data were collected on 214 primary distributions of male-acquired foods, including 36 large game, 54 small game, 101 loads of honey, 21 loads of fruit,

1 load of bee brood, and 1 tuber. Forty-four different Hadza males appear as food producers in this dataset. In 98 of these food distributions, all the sharing and consumption that took place was observed, making these complete distributions. Table 3 presents counts of the food-sharing dataset organized by the distribution type, characteristics of the acquirer, and the food type.

In our analyses of food distributions, we considered a person to be a potential food recipient if they were resident in the camp on the day that a food was acquired, even if they were not physically present in camp the moment the food was brought in. We also grouped individuals into households, based on where they slept during our data collection periods. Several types of households were present in Hadza camps: married couples with children; couples without children; young unmarried women; bachelor households; and households containing one or two elderly women. If a visitor from another camp received food during a distribution, that person was recorded as belonging to a visitor household in our records. In the case of large game distributions, such visitors often appeared and requested shares from camp residents after the initial distribution in camp had taken place. This occurred in 15 of our 36 large game primary distributions. When such visitors departed our camps returning home carrying loads of meat, we weighed how much they carried away, asked who in the camp had given them the shares (if we did not already know), and adjusted the household shares of those donors accordingly. In distributions of large game, it is customary in Hadza culture to reserve certain parts of the carcass known as *epeme*, or God's meat, for consumption by older initiated men in seclusion (Woodburn 1968a). These shares were not included in our analyses of relative household share weights.

**Table 3** The food sharing dataset, organized by distribution type, food type, producer age, and marital status

| | Primary distributions | | | | Complete distributions | | | |
|---|---|---|---|---|---|---|---|---|
| | Producer's age and marital status | | | | | | | |
| | <18 years old | | ≥18 years old | | <18 years old | | ≥18 years old | |
| Food | Married | Single | Married | Single | Married | Single | Married | Single |
| Large Game | 0 | 0 | 33[a] | 3 | 0 | 0 | 0 | 0 |
| Small Game | 0 | 5 | 36 | 13 | 0 | 5 | 14 | 6 |
| Honey | 0 | 29 | 61 | 11 | 0 | 25 | 33 | 10 |
| Fruit | 0 | 0 | 19 | 2 | 0 | 0 | 4 | 0 |
| Insect | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Tuber | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Subtotal | 0 | 34 | 151 | 29 | 0 | 30 | 52 | 16 |
| Subtotal | 34 | | 180 | | 30 | | 68 | |
| Total | 214 | | | | 98 | | | |

[a] In two large game distributions, we were able to record the shares kept by the producer but not those of other receiving households (both by married adult men). For this reason, our sample size of large game producer share sizes is 36 whereas that of average non-producers is 34 (see Figs. 2 and 3)

As Table 3 indicates, our food sharing dataset includes 52 complete distributions of foods acquired by married adult men. We use these cases to analyze how marriage, household membership, and kinship relations of both the acquirer and his wife influenced food distributions and consumption. In 26 complete distributions, the producer had at least one biological child under the age of 10 living within his household; this sample consists of 7 different men and 16 different children.

### Statistics

Statistical analyses were conducted using R (www.R-project.org). All statistical tests are conducted in a two-tailed fashion unless noted otherwise. Owing to the non-normal distributions of most dependent variables, non-parametric Wilcoxon rank sum and chi-square tests are used for most group comparisons, and the resulting W and $\chi^2$ statistics are reported. In those cases where dependent variables were normally distributed, *t*-tests are used for group comparisons. We use multiple linear regression to examine influences on *sharing breadth*—the number of households who received shares in a distribution—and *sharing depth*—the weight or caloric value of the share kept by the producer (sensu Gurven et al. 2001). In order to make the data suitable for linear regression, $\log_{10}$ -transformations of predictor variables (carcass weight and food kcal value) and outcome variables (producer's share weight and producer's share kcal value) were necessary because of heteroscedasticity in these measures. All dependent variables were incremented by +1 (corresponding to 1 g or 1 kcal) prior to log-transformation because of the problem of log-transforming zero values. The single case in which a large game hunter kept nothing for his household is interesting, and its significance is discussed separately below (Household Provisioning Hypotheses). All the statistics reported in the text are also summarized in Tables S2 and S3.

## Results

### Examining Elements of the Show-off Hypothesis

1. *Did Hadza hunters generally ignore small game and specialize in hunting large game?* To test whether this strategy of prey selection was evident in our data, in Table 4 we list the foods that Hadza men (aged 18 and older) acquired and brought back to camp, aggregated by season, during 242 days of observation.

During 2,297 person-days of observation, Hadza men brought back to camp small game, honey, and fruit 853 times, 18 times more frequently than large game were brought to camp. During the wet season, men brought back meat, honey, or fruit once per 1.8 person-days, and in the dry season, once per 3.6 person-days. These food production data show that resident men were not large game specialists, and they frequently brought back small game, honey, and fruit; they thereby greatly reduced their chance of returning to camp empty-handed.

Because of its size, large game is a major source of energy for the Hadza, but by count, large game constituted only 5% of the foods men brought to camp. During our

**Table 4** Foods men brought to camp, by season

| Season | Camps | Food | Instances brought to camp | Total weight: kg | Total kcal | Percent of kcal | Avg. package weight: kg (SD) | Person- days | Person-days per acquisition | Avg. kg per man per day | Avg. kcal per man per day |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wet | 2,3,6 | Large Game | 4 | 142.7 | 212,618 | 12% | 35.7 (16.6) | 991 | 247.8 | 0.1 | 215 |
| | | Small Game | 68 | 70.1 | 127,158 | 7% | 1.0 (2.5) | 991 | 14.6 | 0.1 | 128 |
| | | Honey | 371 | 326.7 | 1,135,010 | 63% | 0.9 (0.9) | 991 | 2.7 | 0.3 | 1,145 |
| | | Fruit | 94 | 254.9 | 312,680 | 17% | 2.7 (2.0) | 991 | 10.5 | 0.3 | 316 |
| | | All | 537 (Sum) | 794.4 (Sum) | 1,787,466 (Sum) | 100% (Sum) | | | 1.8 (991/537) | 0.9 (Sum) | 1,803 (Sum) |
| Dry | 1,4,5,7 | Large Game | 42 | 3,849.1 | 593,0445 | 80% | 91.6 (131.4) | 1,306 | 31.1 | 3.0 | 4,541 |
| | | Small Game | 115 | 175.4 | 318,023 | 4% | 1.5 (2.2) | 1,306 | 11.4 | 0.1 | 244 |
| | | Honey | 141 | 282.3 | 1,017,282 | 14% | 2.0 (2.5) | 1,306 | 9.3 | 0.2 | 779 |
| | | Fruit | 64 | 120.0 | 144,908 | 2% | 1.9 (1.7) | 1,306 | 20.4 | 0.2 | 111 |
| | | All | 362 (Sum) | 4,426.9 (Sum) | 7,410,658 (Sum) | 100% (Sum) | | | 3.6 (1,306/362) | 3.5 (Sum) | 5,674 (Sum) |

Only foods produced by camp residents are included in these totals. These data represent 94 dry season and 146 wet season observation days. If a man brought to camp a package that contained multiple items of one food type, such as three baobab pods or two birds, this was coded as a single instance of bringing such foods to camp

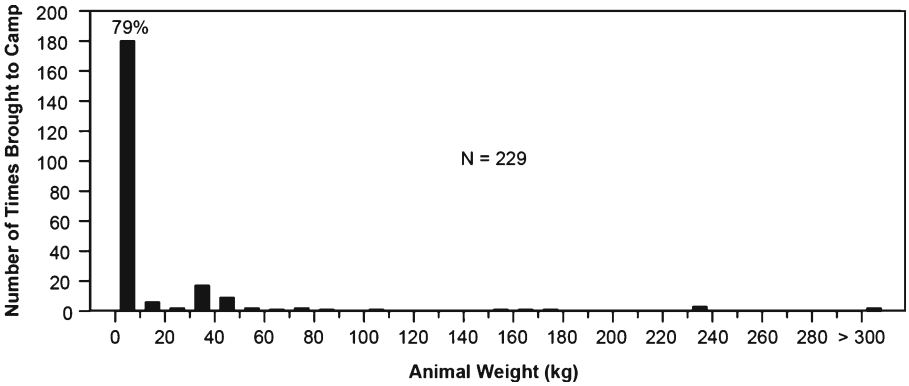


**Fig. 1** Counts of the number of instances Hadza men brought to camp animals of different weights over 2,297 person-days

observations, small animals were killed and brought back to camp four times as often as large game.

To get a sense of how much small-game-hunting men did, we can compare what we observed to the results of the small game hunting experiment carried out by Hawkes and colleagues (1991). Men in that experiment were asked to take as great a mass as small animals as possible (1991:246) and subsequently made kills every 2–3 days; during our observations, men actually brought small game back to camp once every 14.8 hunter-days in the wet season and every 11.3 hunter-days in the dry. The lower rate of acquisition that we observed relative to the small game hunting experiment is expected since the men we observed were not induced to hunt as much small game as possible. Figure 1 shows the frequencies with which Hadza men brought animals of different sizes to camp.

At least 79% (180/229) of the animals Hadza men killed and brought to camp weighed less than 10 kg. This is an underestimate of the number of small animals men brought to camp, because on many occasions men brought in several small animals at once, but for the sake of the current analyses, such events are counted as a single instance.

In our food production sample, 54 unique men lived in camps where large game was acquired (all but camp 2). We found no association between individual men's success at hunting large game and their success at hunting small game in terms of kcal/day or frequency (SF $r$=0.08, $p$=0.52, $n$=54; SK $r$=−0.12, $p$=0.35, $n$=54). Among adults, age appears to explain very little of the variance in men's production of small or large game—men aged 50–60 were as successful at hunting both large and small game as younger men, though men 65 and older experienced a noticeable decline in these measures.

2. *Did hunters only keep a small fraction of their large game kills, or were men able to control distributions of the large game they killed to their household's advantage?* Our data show that shares of large game retained by producer households were much larger than those received by other households in camp. This pattern is shown in Fig. 2, a histogram of the share weights that producer and average non-producer households retained. Producers retained 42% of the carcass weight on average, while non-producers who received shares retained on average 11%.

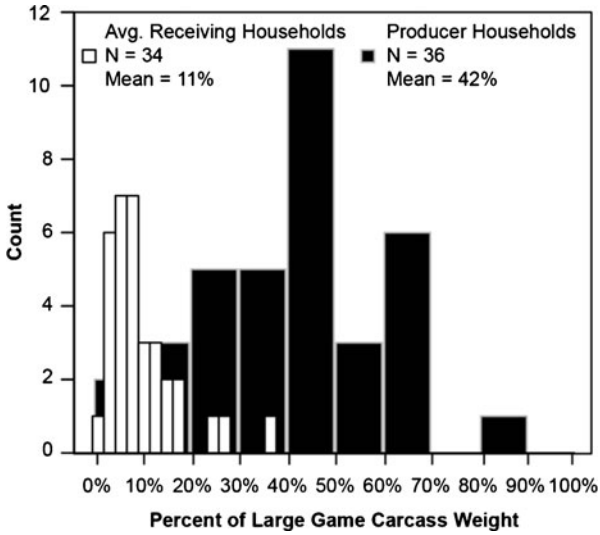


**Fig. 2** Producer and receiving non-producer household share sizes in 36 large game primary distributions

The hunters we observed clearly exerted some control over distributions, and in so doing they significantly advantaged their own households, keeping shares 3.8 times heavier than other receiving households in primary distributions ($W$=1,144, $p$<0.001, $n_1$=36, $n_2$=34). Not surprisingly, the absolute weight of the shares retained by producers and others in primary distributions was strongly influenced by the total carcass weight of prey animals. In Fig. 3, we plot the weight of producer and non-producer household shares against the weight of large game carcasses.

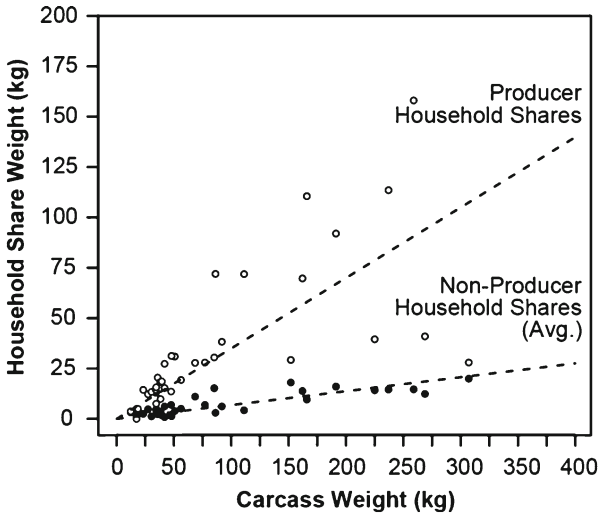


**Fig. 3** Producer and non-producer household share weights in relation to carcass weights in large game primary distributions. Note: white dots represent the producer household share sizes ($n$=36), and black dots the average share sizes of non-producer households in camp that received any share ($n$=34). The two dotted lines are ordinary least squares regressions through producer (estimate=0.35, adjusted $R^2$=0.72, $p$<0.001) and average non-producer (estimate=0.07, adjusted $R^2$=0.84, $p$<0.001) shares

The average weight of producer household shares in our sample of large game distributions is 35.5 kg (SD=35.3 kg), 28 kg heavier than average non-producer household shares (average=7.6 kg, SD=5.6 kg).

A bivariate correlation test shows that carcass weight is strongly associated with the number of households that received shares in primary distributions (Pearson's $r$=0.62, df=32, $p$<0.001). To examine demographic influences on sharing breadth (noting that greater sharing may be demanded in larger camps), we performed multiple linear regression, using the number of resident households in the camp and the $\log_{10}$ of carcass weight in kg as predictor variables on the number of non-producer households that received shares. Results (summarized in Table S3) show that both camp size (partial estimate=0.23, $p$<0.001) and carcass weight (partial estimate=0.03, $p$<0.001) had significant effects on sharing breadth (model 4 in Table S3, adjusted $R^2$=0.86, df=32, $p$<0.001).

If, as proposed by Hawkes et al. (1991), large game were shared like common goods, it would be expected that producer households would retain smaller shares in camps containing more people. We tested this idea using multiple linear regression, using the number of resident households in a camp and the log-transformed carcass weight as predictor variables and the log-transformed share weight retained by producers as the outcome variable. Regression analysis shows that carcass weight was positively associated with the share weight retained by the producer (partial estimate =0.79, $p$<0.001), and that the number of resident households had no effect (partial estimate=0.00, $p$<0.52) (model 5, adjusted $R^2$=0.86, df=34, $p$<0.001).

It is surprising that producers were not giving away larger fractions of carcasses in larger camps, as would be expected if sharing was largely driven by social pressure. Before investigating this matter further, it is important to note that the largest camp in our dataset (camp 1) also experienced the most successful large game hunting (one large game kill per 12.8 person days, shown in Table S1). Perhaps because more meat arrived in this camp than others, the social demands on producers to share were reduced, allowing them to retain more meat for their own households. We tested whether food scarcity influenced sharing depth of large game with multiple linear regression, using the per capita food kcal brought into camp in the 24 h prior to each large game distribution ("recent") and the log-transformed carcass weight as predictor variables and the log-transformed weight of the share retained by the producer as the outcome variable. This measure of food scarcity had no effect on sharing depth (partial estimate=0.00, $p$=0.11, model 6, adjusted $R^2$=0.86, df=32, $p$<0.001). Similarly, the recent per capita supply of just meat-derived calories had no effect on large game sharing depth (model 7). These results suggest that variation in meat supply to camps did not account for variation in sharing depth. Even in camps where large game hunting was relatively successful, meat scarcity was the prevailing condition when kills were made. The per-capita supply of meat in the 24 h prior to each large game distribution in our sample only ranged from 1 to 329 kcal/person/day (median=49).

The size of camps, therefore, had a discernible effect on the sharing breadth, but not on the sharing depth, of large game. This means that in larger camps, producers did not give away a larger fraction of the meat they produced, but what was distributed was divided into more recipient shares. From the share recipient's standpoint, being in a larger camp meant receiving a smaller fraction of what was made

available through others' production and sharing, while from the producer's standpoint, it meant exerting control among an increasing number of potential recipients. These data attest to an obvious source of social tension, which indeed seems to arise more often in larger camps in the context of food sharing (Marlowe 2010).

3. *Were small game kept and consumed wholly within hunter's households?* The data we presented above show that men were hunting both large and small game, which is in accordance with Hawkes et al.'s (1991) general prediction for household-provisioning-oriented foraging. However, their model also assumed that small game would not be shared but consumed wholly within hunters' households, in stark contrast to the wider-scale sharing of large game. We investigate the provisioning consequences of small game hunting by inspecting our dataset's 14 complete distributions of small game by married adult men. In this sample, producer's households consumed 47% of the carcass weight on average. Since even small game were shared, this makes exclusive small game hunting even less profitable than modeled by Hawkes et al., and it helps explain why Hadza men are motivated to kill large game. In future work we plan to calculate the post-encounter return rates of different foods that men and women pursued and model the payoff structures of different resource sets. Based on our large and small game sharing data, we provisionally suggest that the pursuit of large game is not likely to entail a collective action problem since successful hunters receive larger shares than others, and even small game is shared, both of which increase the individual benefits of large game production relative to scrounging (Vickery et al. 1991; Winterhalder 1996).

## Household Provisioning Hypothesis

4. *Prediction: In primary distributions, shares kept by the household of the producer should be heavier than those received by other households.*

A married adult hunter with whom we spoke in camp 1 told us, "The person who kills the animal keeps a bigger piece than the others." In the previous section we showed that, indeed, large game sharing clearly advantaged hunters' households during primary distributions. Here we analyze primary distributions of all the major food types, as listed in Table 3. These data, presented in Fig. 4 and Table 5, show that men shared all their foods in ways that advantaged their households.

Across all food types, share sizes kept by producers' households were much heavier than those of other households. For example, producer households kept shares of honey that were on average four times heavier than those of other receiving households, and in the case of large game, four times heavier than other receiving households and seven times heavier than the average share retained by all non-producer households in camp. Fruit is the food that afforded the greatest producer advantage, at 43:1. Below we give special attention to the rates and frequencies of men bringing fruit to camp.

Using multiple linear regression, we explored possible influences upon sharing depth and breadth across the set of primary distributions (Table S3, models 8–14). Similar to our results from the analysis of large game presented above, we find that the amount producers kept in primary distributions was strongly determined by the total caloric value of the food (model 8) but was not influenced by the number of

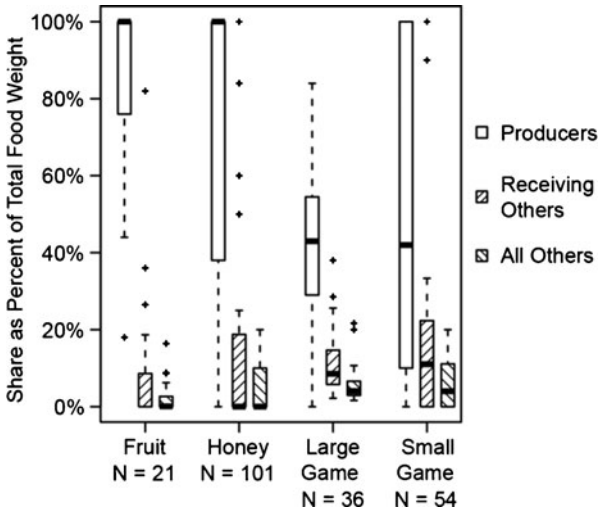


**Fig. 4** Primary distributions of male-acquired foods. This figure shows the share fractions kept in the household of the producer compared with (1) the average shares given to receiving households and (2) the average share fractions received by all households, including those who received nothing. In this boxplot and others in this article, rectangles enclose the data's interquartile range (IQR), midlines represent median values, and whiskers enclose the range of the data excluding outliers more than 1.5 IQR from the first or third quartiles (shown as crosses)

households in camps (model 9). We examined the influence of marriage on sharing breadth using those 180 primary distributions by adult men. Controlling for food kcal value, we find that married men kept significantly more for their households than did single men (marriage partial estimate=0.93, $p<0.001$, adjusted $R^2=0.94$, model 10). With regard to sharing breadth, we find that the caloric value of food items before sharing (model 11) and the number of households in camp (model 12) are both significantly associated with the number of households who received shares in

**Table 5** Summary of primary food distributions across resource types acquired by males

| Food type | *N* | Avg. fractions to producers' households (SD) | Avg. fractions to receiving households (SD)[a] | Avg. fractions to all non-producer households (SD)[b] | Producers' advantages[c] |
|---|---|---|---|---|---|
| Fruit | 21 | .85 (.24) | .10 (.19).** | .02 (.04).** | 43:1 |
| Honey | 101 | .69 (.40) | .17 (.30).** | .05 (.07).** | 14:1 |
| Small Game | 54 | .53 (.42) | .26 (.38).** | .06 (.06).** | 9:1 |
| Large Game | 36 | .42 (.18) | .10 (.08).** | .06 (.04).** | 7:1 |

[a] *Average fractions to receiving households* is derived by taking the average of *N* values, each value derived from (total portion given/number of receiving households) in a particular primary distribution

[b] *Average fractions to all non-producer households* is similar to *a* but includes non-receiving households in the denominator: [total portion given/(number of households in camp −1)]

[c] *Producers' advantages* are derived from (Avg. fractions to producers' households/Avg. fractions to all non-producer households)

**$p<.01$ in comparison to Avg. fractions to producers' households

primary distributions. As with sharing depth, married men's sharing breadth also differed; controlling for a food item's total caloric value and the number of households in camps, married men were found to share with 2 fewer households during primary distributions than single men (partial estimate=−2.2, $p<0.001$, adjusted $R^2=0.56$, model 13).

We continue these analyses by examining complete distributions. Figure 5 displays data from complete distributions, showing the fractions of food packages that were eventually eaten by members of producers' households compared with fractions eaten by other households in camp. These 98 complete distributions (see Table 3) represent distributions of meat, honey, fruit, and one tuber. On average, members of producer households ate 49% (median=42%, SD 37%) of the total food weight, while average other households ate 7% (median=7%, SD 6%).

Focusing on the 52 complete distributions in which the acquirer was at least 18 years of age and married, we find that producers' households ate on average 55% of the total food weight (median=50%), while average other households in camp ate only 4% (median=0%) of the total food weight ($W$=6,269.5; $n_1$=52, $n_2$=500; $p<0.001$). To ensure unbalanced sampling of individuals was not driving these results, we aggregated these 52 distributions by food producer. For each of the 13 different producers in this sample, we calculated the average of the consumption in that producer's household and the average consumption in other households. In this aggregated data set, producer households consumed on average 51% of the total food weight (median=50%) while non-producer households ate 4% on average (median=5%), a significant difference ($W$=163.5, $n_1=n_2=13$, $p<0.001$).

Based on these sharing and consumption data, it is clear that husbands' food production differentially benefited members of their own households, both at the primary distribution stage and ultimately in the amounts of food their spouse and children consumed.

**Fig. 5** The relative consumption of male-acquired foods by members of producers' households and other households in camp. This sample includes 98 complete distributions. The two distributions are significantly different ($W$=7,858, $p<0.001$)

5. *Prediction: In primary distributions, the households of successful hunters should be more likely to keep choice cuts and retain high-quality parts—specifically, the hind legs of large ungulates and the skins of impala or kudu.*

The weight of a share of meat is a useful metric of its food value, but the practical and nutritional values of animal parts vary in other ways. Here we test the hypothesis that men kept choice cuts for their households. We identified two high-quality parts of animal carcasses based on both objective criteria and Hadza perceptions. The Hadza particularly desire the skins of impala and kudu because they make ideal sleeping and working surfaces, and their leather is particularly good for clothing or other tool manufacture. The skins of other large animals are not as highly regarded. We therefore investigated our dataset's 20 impala (*Aepyceros melampus*) and 6 greater and lesser kudu (*Tragelaphus strepsiceros*, *T. imberbis*) primary distributions. In this sample, the skins of 1 impala and 1 greater kudu were damaged beyond use because hyenas partially ate the carcasses before the Hadza located them. Also, in three instances, our field notes indicate that impala skins were not brought back to camp. In one of these instances, we know that the hunter decided to leave the skin at the kill site (this successful hunter already had several skins at home), but we don't know why the two other impala skins were not brought to camp.

Summing across the 21 distributions in which the skin of a kudu or an impala was brought back to camp, there were 21 producer households and 275 non-producer households that could have received the skin. If producers had an equal chance of retaining the skins as non-producers, they would have had a 7% chance of retaining a skin in a single distribution, and therefore would be expected to have retained the skin 1 or 2 times in 21 distributions (21*[21/(21+275)]=1.5). In fact, producers' households retained the skin of a kudu or an impala 15 times (71%), confirming that they were significantly more likely to retain this choice carcass portion ($\chi^2$= 132, df=1, $p$<0.0005).

Different carcass elements also vary in the fraction of their weight that is edible meat or marrow. Ethnoarchaeologists (Binford 1978; Burger et al. 2005; Madrigal and Holt 2002; Metcalfe and Jones 1988) have calculated food utility values (typically, total raw weight minus the weight of inedible bone) of large ungulate carcass elements. This work indicates that the femur is the skeletal element with the highest corresponding food utility value. Hind limbs are especially choice cuts because of large ungulates' heavy quadriceps and hamstring muscles, and because femurs contain large stores of marrow. When the Hadza butchered ungulates less than 100 kg in weight, the hind limbs were typically separated from the rest of the carcass (for more details on butchery see Bunn et al. 1988; O'Connell et al. 1988), and when those portions were shared, households retained whole limbs. In the case of the larger ungulates (eland and buffalo), many household shares resulted from a single hind limb.

We investigated the primary distributions of the 20 impala, 6 kudu, 5 zebra (*Equus quagga*), 3 buffalo (*Syncerus caffer*), and 1 eland (*Taurotragus oryx*) in our dataset. Hyenas had eaten the hind limbs of 2 impala and 1 kudu before the animals were located. The buffalo and eland hind limbs were butchered into steaks at the kill site and subsequently shared among households. We excluded these cases when testing this prediction because no single household kept an entire hind limb. In the 28 other distributions (Table 6), the hind limbs were shared whole during the primary

**Table 6** Producers' retention of the hind limbs of large ungulates

| Species | Carcasses | Hind limbs | Kept by producer (*N*/%) | Kept by non-producer households (*N*/%) |
|---|---|---|---|---|
| Impala | 18 | 36 | 24/67% | 12/33% |
| Zebra | 5 | 10 | 5/50% | 5/50% |
| Kudu | 5 | 10 | 7/70% | 3/30% |
| Total | 28 | 56 | 36/64% | 20/36% |

distribution, such that a single household retained either one or both of them. If the 28 producer households had the same chance of retaining one of these whole 56 hind limbs as did the 375 non-producer households that were resident in the camps during these distributions, we would expect producers to have retained 4 limbs in total (56*[28/(28+375)]=3.9). Our data show that producers' households actually retained 36 hind limbs, 64% of those that that were shared whole in primary distributions, confirming that producers were significantly more likely to retain this choice carcass element ($\chi^2$=285, df=1, $p$<0.001).

6. *Prediction: Wives should have increased access to the foods their husbands produce.*

As mentioned in the introduction, there are several plausible reasons why men might benefit by sharing food with their wives—such sharing can increase the well-being of their wives; increase the amount of energy they have available for other tasks, such as foraging or parenting; and might help keep a marriage intact. For these reasons, men should direct shares of food they acquire toward their spouses, and wives should therefore be observed eating their husbands' foods more often than other women in camp.

We therefore used our dataset of 52 complete food distributions by married men to test whether wives ate more of their husbands' foods than other reproductively aged women in camp who were unrelated to their husband. We scored women in camp as reproductively aged if they were between 18 and 50 years old. Those women who were related to the acquirer by $r$<0.125 (more distant than first cousins, based on genealogies) were considered unrelated to the producer.

Our dataset of 52 complete distributions by married men consists of 13 married couples in 5 different camps. Forty-six other women of reproductive age were living in the same camps as these couples. In these 52 complete distributions, wives ate on average 18% (median=11%) of the food package that their husbands brought to camp, while unrelated women of reproductive age in the same camp ate an average of 2% (median=0.4%), a significant difference ($W$=1,859, $p$=0.001). These data confirm that wives had increased access to the foods their husbands produced.

We also find that wives ate a larger fraction of foods men brought back to camp than their husbands themselves did (Fig. 6). While wives ate 18% of the food package on average, husbands ate an average of 8% (median=0%) ($W$=1,047, $p$=0.036). When men are out of camp foraging, they often feed themselves on fruit, honey, and small game, and this helps explain why they were observed eating less of the foods they brought back to camp than their wives (and children). We aggregated our data by couple and similarly confirmed that wives ate more of the foods their husbands

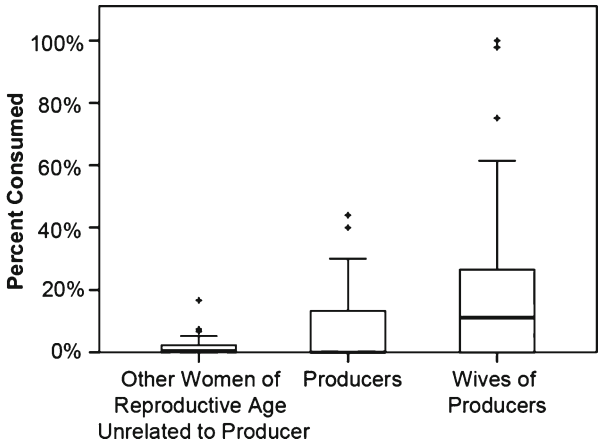


**Fig. 6** A comparison of the fraction of food weight consumed by reproductive-age women in camp unrelated to the food producer, the producer himself, and the producer's wife. This box plot is based on 52 complete food distributions by married adult men, with the amount consumed by women other than the producer's wife was averaged for each distribution, resulting in equal sample sizes for all three categories, $N$=52

procured than other reproductively aged women in camp ($W$=165, $p$=<0.001) and, at least in a one-tailed test, more than their husbands ($W$=123, two-tailed $p$=0.051; one-tailed $p$=0.026).

As mentioned above, when men returned to camp with foods, they often handed the entire package directly to their wives. We observed this 29 times (56%) in our sample of 52 complete food distributions by married men. In 8 (15%) additional instances, men gave the total package to one of their children or distributed it all among children in their household. Although men did play a significant role in shaping these food distributions, mothers oversaw most of the feeding of their children. Our sample of 52 complete distributions comprises 320 individual food transfers. Wives of producers were the donors in 159 (50%) of these transfers; husbands were donors in 109 (31%). These data illustrate that wives had increased access to and strongly influenced the distribution of the foods their husbands acquired.

7. *Prediction: Biological children of the producer should eat more of his foods than do other children in camp.*

Men's direct provisioning of their children can increase their nutritional status and, by extension, their survival prospects, enhancing their own fitness and that of their wives. Such benefits are more likely if men selectively share foods with their own offspring instead of others. We were therefore interested in testing whether the average biological child in men's households ate more of his foods than did other children in camp. For this analysis we define children as a biological child of the producer aged 10 years or younger.

Our food-sharing sample includes 25 complete food distributions where the acquirer had at least one child aged 10 or younger living in his house. This sample consists of 7 unique male acquirers and 15 of their children. In the camps where these men lived, there were 63 children in other resident households, who we classify as potential recipients of his food. Our data confirm that men's children ate more of their foods than did other children in camp.

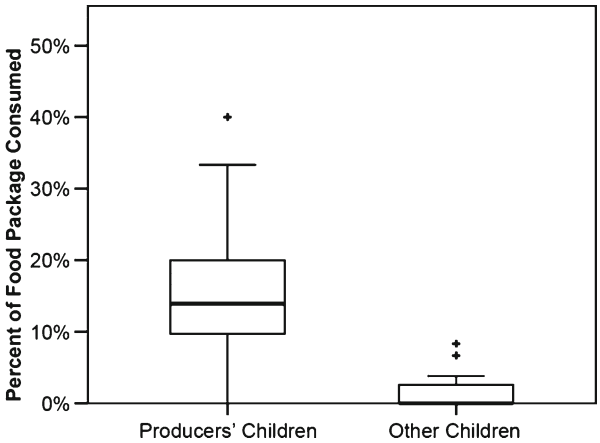


**Fig. 7** Food consumption by children of producers compared to other children in camp, in 25 complete distributions by men with at least one biological child in their household

Figure 7 shows that biological children of the producer ate 16% of the weight of food packages brought to camp by their fathers on average (median=14%), while other children in the camp ate on average 2% (median=1%; $W$=576, $p$<0.001). When we aggregate these 25 distributions by food producer, we reduce our sample to only 7 cases, but we find the same result, that producers' children ate more of their food on average than did other children in camp ($W$=49, $p$=0.002). These data are evidence that males were sharing foods in ways that directly benefited their children.

Some of the other children in camp were relatives of the food producer or his wife. In the next section we consider the influence of kinship on the food distributions we observed.

## Kin Provisioning Hypothesis

8. *Prediction: Consanguineal and affinal kin living in other households should eat more of producers' foods than individuals unrelated to the producer or his wife.*

Many ethnographers have highlighted how important extended families are in the residential and economic organization of forager societies (e.g., Damas 1972; Helm 1968; Wenzel 1995). Hadza residential groups often contain multigenerational families, including several adult siblings, each with their own nuclear families. Matrilineal relationships are especially important (Hawkes et al. 1997; Hill et al. 2011). Extended kin are vital in the Hadza's everyday tasks of finding food, caring for children, sharing information, and receiving comfort and protection when needed (Crittenden and Marlowe 2008; Marlowe 2010; Wood and Marlowe 2011). Interviews indicate that Hadza prefer to share foods with kin (Wood and Marlowe 2010). In evolutionary terms, sharing with kin beyond the nuclear family may be beneficial for a variety of reasons. Kin-selection theory proposes that a tendency to help relatives could evolve because of the positive effect on the inclusive fitness of helpers (Hamilton 1964). Several studies of food sharing have shown a positive bias in sharing toward consanguineal kin (Betzig and Turke 1986; Gurven et al. 2001; Koster 2011; Ziker and Schnegg 2005). Among the Hadza and other foraging

societies that practice bride-service, men are also compelled to share foods with their wives' parents as a fulfillment of marital expectations.

We address the kin provisioning hypothesis by comparing the probability of consanguineal kin, affinal kin, and non-kin living outside producers' households eating *any amount* of the foods that men brought to camp. For this analysis, we investigate our 52 complete distributions by married men and score all camp residents with a binary variable, as either eating or not eating. Individuals who were related to the producer by $r \geq 0.0625$ (second cousins and closer) were considered the producer's consanguineal kin and those of such relatedness to the producers' wives were considered affinal kin. All other individuals in camp were categorized as non-kin. We then compared the probabilities of eating a producer's food by individuals who lived outside his household. In each of the 52 complete distributions by married adult Hadza, we used residence data to calculate that there were 1,469 opportunities for non-kin to have eaten producers' foods, 127 opportunities for the husbands' kin, and 155 opportunities for his affinal kin. Our results indicate that producers' consanguineal kin were observed eating in 46% of these instances, affinal kin in 17%, and non-kin in 10%. Both the producers' consanguineal and affinal kin ate his foods at significantly higher frequencies than non-kin (consanguineal vs. non-kin $\chi^2=138.1$, $p<0.001$; affinal vs. non-kin $\chi^2=7.6$, $p<0.01$).[2] These data show that men shared the foods they acquired in ways that benefitted their own households and their kin living in other households.

## Marriage, Children, and Food Production

Marlowe (2003) found that men with nursing children at home brought food back to camps at a greater rate than men without nursing children, and that much of the increased production of such men was in the form of honey. Here, using the marital subsample of our food production data (see "Methods"), we similarly investigate men's food production (average rates, frequencies, and constituent food types) in relation to men's marital status and the presence of children (Fig. 8).

We find that married men ($n=25$) brought more food to camp than single men ($n=17$), as measured both in unstandardized caloric values and standardized measures: married men brought an average of 7,133 kcal/day to camp, whereas single men brought 1,854 kcal/day (SK=0.36 vs. −0.54, $W=351$, $p<0.001$).

Two men who contributed to our food production data were single in one camp and married in another, and in both cases, they brought more food to the camp at which they were married (case 1, single in camp 6, SK=−0.18, married in camp 5, SK=−0.10; case 2, single in camp 4, SK=0.01, married in camps 5 and 6, SK=0.08, 0.23, respectively). Those married men with at least one biological child under age 10 at home had an average SK from all foods of 0.50; married men without such children at home a lower SK of 0.19, though the two samples are not significantly different ($W=94$, $p=0.37$). Married men's higher rates of food production did not lead to greater variance in their food production (average CV of kcal/day: married=2.6, single=2.5; $W=178$, $p=0.71$).

[2] On kinship: Using a more restrictive definition of kin, considering only individuals related by $r>0.125$ to the food producer or his wife, corroborates this evidence for kin-biases in consumption (consanguineal vs. non-kin: $\chi^2=106.0$, $p<0.0005$; affinal vs. non-kin: $\chi^2=6.2$, $p=0.01$).

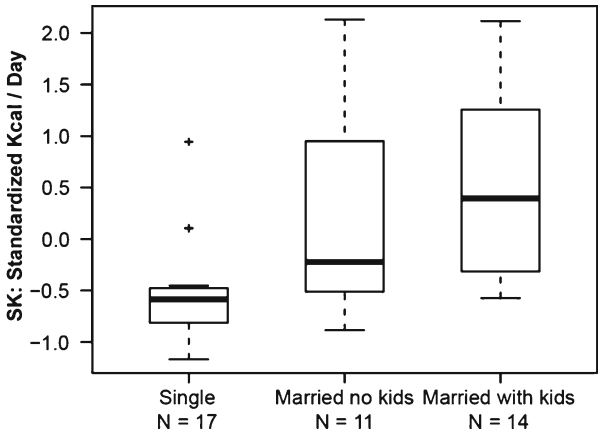


**Fig. 8** Rates of food production by men aged 18–40 who were single, married without children in their households, and married with at least one child 10 or younger in their household

We also examined the frequencies with which men brought food to camp. Overall, men aged 18 and older brought some amount of food to camp on 720 of 2,297 person-days of observation—that is, once per 3.2 days. In the marital subsample of men aged 18–40, men brought some amount of food to camp on 482 of 1,508 (32%) person-days of observation (i.e., once every 3.1 days). For comparison purposes, our preliminary analyses indicate that women (aged 18+) brought some amount of food to camp on 1,322 of 2,716 (49%) person-days of observation—that is, once every 2.1 days. Thus men brought food to camp less often, but not vastly less often, than women. Among all observation days of men aged 18–40, we find that single men brought food to camp on 27% (189/693) of days, significantly less frequently than married men, who brought food to camp on 40% of days (293/815) ($\chi^2$=12.6, df =1, $p$<0.001). Comparing unstandardized measures among men, we find that on average, single men brought food to camp on 28% of days; married men without children at home, 31% of days; and married men with children at home, 42% of days. Standardized measures of the frequency of bringing food to camp (SF) are shown in Fig. 9.

Noting that married men brought food back to camp at higher rates than single men, and those with children at home more frequently than single men, we then explored our data to find what specific foods men were acquiring that contributed to these patterns. We found that gathering, rather than hunting, defined the clearest difference between married and single men's food production. While married men only trended toward higher production of large game (Fig. 10, average SK=0.22 vs. −0.48, $W$=188, $p$=0.18), they clearly brought fruit to camp at higher rates (Fig. 11, average SK=0.21 vs. −0.27, $W$=241, $p$<0.05) and more frequently (average SF=0.29 vs. −0.34, $W$=91, $p$ <0.05). This pattern of fruit provisioning by married men is notable since our sharing data indicate that fruit advantaged producers' households the most in primary distributions (Fig. 4, Table 5).

To summarize, married men brought foods to camp at a greater daily rate than single men; and married men with children, at a greater frequency than single men and men without children at home. In terms of the constituent food types, married men trended toward greater production of large game, and they clearly brought fruit to camp more often. Although our sample sizes are generally too small to detect statistical differences between the production of married men with children at home

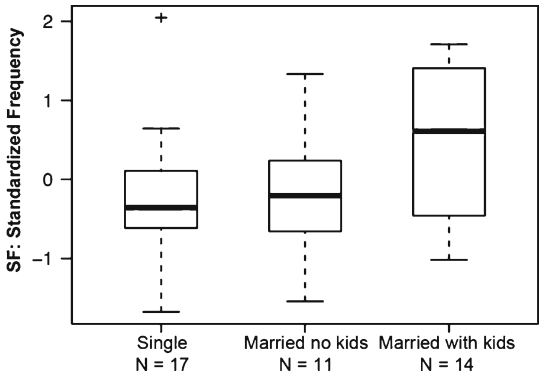


**Fig. 9** Standardized frequencies of bringing food to camp by men who were single, married without children at home, and married with at least one child at home. These data are normally distributed, so *t*-tests are used to examine differences. Married men and single men do not differ ($t=-1.5$, $p=0.15$), while married men with children at home brought food to camp more frequently than single men ($t=-2.08$, $p<0.5$) and, at least in a one-tailed test, more often than married men with no children at home ($t=-1.76$, $p<0.5$)

**Fig. 10** Standardized rates of large game production by 28 men living in camps where large game was acquired by men aged 18–40

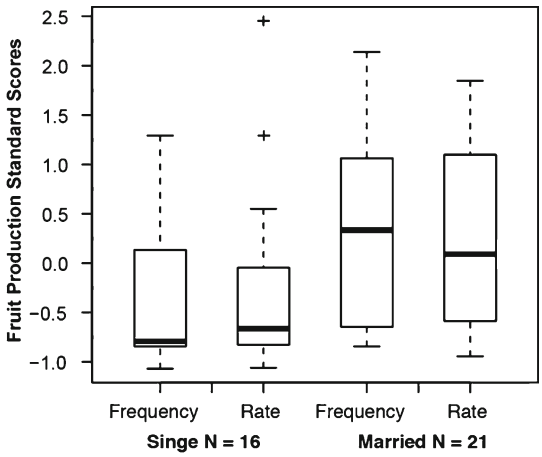


**Fig. 11** Fruit production by single and married men

and that of married men without children at home, trends in these measures are all as one would expect if men with children at home were either more motivated or more able to provision—men with children at home had the highest daily rates of food production and brought food back to camp the most frequently.

## Discussion

### Why the Differences between Studies of Hadza Foraging and Food Sharing?

Our results differ from earlier descriptions of Hadza foraging and food sharing (Hawkes et al. 2001a, b) in that we found the Hadza not to be engaged in specialized large game hunting, and our data show that men shared large game in ways that clearly advantaged their households. Our study is the first to report on the sharing of foods other than large game, the sharing of choice carcass elements, patterns in food consumption, and the influences of marriage, parentage, and kinship therein. We therefore focus this discussion on the points upon which our studies differ—men's production of small game and patterns of large game distributions. Such differences could be due to methodological differences, changes in behavior in the time between our two studies, or differences in the subsets of the Hadza population we studied. Below we explore these possibilities.

Regarding methodological differences, Hawkes et al. (1991) characterize men's small game acquisitions using 45 individual follows covering 75 hunter-days,[3] whereas our characterization is based on records of all the foods men brought back to camp over 249 days of observation, covering 2,296 hunter-days (Table 4). Both methods can be used to accurately describe how often men bring small game to camp, but ours produced a much larger and more representative sample. A bias of our methodology is that it *underestimates* the amount of small game killed because hunters sometimes ate such prey before returning to camp.

An important possibility to consider is whether a recent decrease in the abundance of large game is responsible for shifts in men's foraging. As prey choice models would suggest (e.g., Broughton 2002; Hill et al. 1987), perhaps an increase in small game hunting has occurred owing to a decrease in the profitability of large game hunting. To explore this possibility, we calculated the success rates of large game hunting during the wet and dry season components of our study (Table 4) and examined whether small game hunting increased when large game hunting had lower yields.

If depletion of large game was the reason why the Hadza with whom we lived hunted small game, we might expect them to engage in less small game hunting during the dry season, when large game hunting is most successful. Our data show that during the wet season, resident men killed large game on average only once per 248 hunter-days, but during the dry season, once per 31 hunter-days (a value similar to the once per 27 hunter-days reported in Hawkes et al. 1991). The small game

[3] On focal follows: Hawkes et al. (1991) report data derived from 45 follows conducted in 1985–1986 covering 75 hunter-days (average=1.6 hunters per follow). In these follows, 14 small game animals were killed.

acquisition rate during the wet season was one kill per 15 hunter-days; during the dry season it was higher—1 kill per 11 hunter-days (Table 4). This indicates that when large game hunting was more successful, small game hunting was also more active, or at least more successful. This rough measure suggests that large game depletion since the 1980s might not explain why we observed Hadza men regularly hunting small game. However, there is a notable difference between our two studies in the species of large game killed—namely, no giraffe were killed during our observations. Because of this, the average daily returns from large game hunting were lower during our study, even during the dry season: 2.9 kg of large game meat/hunter-day during our observations (Table 4), and 4.6 kg/hunter day in the 1980s (Hawkes et al. 1991). So a decrease in the profitability of large game hunting due to a lack of giraffe kills could well have led to an increase in small game hunting during our observations. We are currently analyzing a large set of focal follow data covering men's behavior out of camp, and we plan to use these data to examine differences in ecology and possible shifts in prey choice between our studies. Likewise, a direct comparison with our records of the amount of small game, honey, and fruit men brought back to camp would be useful if such records are available from the 1980s.

Our study's differences in observed patterns of large-game sharing are challenging to interpret. Because sample sizes are small, even minor methodological, regional, or individual differences could have had a pronounced effect on the general patterns we report. Our sample of large game distributions includes the primary distributions of 36 large game acquired by 23 different men, in which we know the producer's share sizes, while theirs had 12 such cases, derived from 7 men.[4] There are many factors that might have led to the differences we report in producers' advantages. The mean carcass weight of large game in our sharing sample is 90 kg ($n$=36), whereas it is 192 kg ($n$=12) in Hawkes et al. (2001a)—this size difference is largely attributable again to the lack of giraffe kills during our study. It is quite probable that it would be more difficult for men to control distributions and retain a sizable producer advantage in the 1980's with such very large game. However, Hawkes et al. (2001a) found that it was only in their subsample of the very largest game (>200 kg), that producer's households were keeping more than other households.

In the 12 comparable distributions reported in Hawkes et al (2001a), there is some evidence of a general producer advantage: households of the producer retained an average of 11% of the edible carcass weight, while non-producers retained an average of 7%, but the difference between producer and non-producer household fractions is not significant ($W$=48, $p$=0.175).

In this paper, we have compared the weight of meat shares kept by households of producers to those of all other households in camp (see "The Food-Sharing Dataset"). In Hawkes et al. (2001a), only the shares of meat retained by producer households and other *nuclear family* households are reported. To make our analyses more comparable, we sampled from our primary distributions of large game only those animals killed by married men who were living with their spouse and at least one child (under age 10), whether his own or his wife's. In this sample of 18 large game

[4] On Hawkes et al. (2001a) sharing data: Case numbers 22, 23, 24, 30, 35, 37, 42, 44, 46, 47, 49, and 65 as reported in Hawkes et al. (2001a:138). In the remaining cases, some or all of the producer household shares were not reported.

distributions, producer households retained an average of 40% of the carcass weight, whereas other nuclear family households in the same camps retained 5% on average, a significant difference ($W$=2,366, $n_1$=18, $n_2$=145; $p$<0.001).

With regard to individual or regional differences, we conducted our research with more individuals and in more areas within the total range of the Hadza. We worked in the areas of Tli'ika, Dunduiya, Gola, and in Han!abi; the meat sharing data reported in Hawkes et al. (2001a) was gathered from one core group of families in the Tli'ika region. Perhaps the hunters observed in the 1980s were above average in their skill at hunting large game, or lived in an area with particularly abundant large game. Since a major focus of their team's research was patterns of large game butchery and bone transport (O'Connell et al. 1988, 1990), it seems reasonable that they would focus their data collection on camps of accomplished large game hunters.

Another possibility to consider is a changing sense of private ownership, something that might be brought on by an increased trade in bush meat. During our study, we observed two cases in which resident hunters left our camp to sell meat from animals they had killed—both events occurred in camp 6 (Table 1). On December 25, 2006, a hunter and his wife left camp with just over half an impala, which they planned to sell at a Christmas Day celebration in a village. In the earlier primary distribution of this animal, the producer kept 62% of the total body weight in his household, 1.1 standard deviations more than the average amount kept for large game. Removing this single case from our dataset does not substantively alter our results, however. Another (failed) instance of bush-meat trading occurred after a man killed a hyena that had been disturbing our camp. He filleted the meat and tried to sell it in a nearby village, but later he told us that nobody would buy the meat. Since none of the Hadza in camp ate the hyena meat (which the Hadza normally avoid), this distribution was not included in our dataset. If tolerated theft were largely determining the balance of household meat shares, it is unclear why meat drying or trading should alter the ability of producers to control primary distributions because any potential changes in the marginal utility of meat shares would apply equally to producers and scroungers. An increase in bush-meat trading doesn't seem to empirically or theoretically account for our studies' differences.

## Hunting, Status, and Marriage

Certainly, successful hunting and subsequent sharing can bring Hadza men respect and prestige. Hunting plays an important role in how Hadza men establish their reputations as skilled and mature social actors within their communities. Hadza men are expected to kill at least one large animal before joining the ritually initiated group of elder men. Joining this group has certain nutritional benefits—only initiated men are permitted to eat sacred parts of large animals, some of which are exceedingly fatty (see Woodburn 1979 for a discussion of *epeme* meat). This ritual context explains the single case in our large-game sharing sample in which the producer gave away an entire carcass in a primary distribution. In this case, a hunter who was single and uninitiated killed an impala, and subsequently gave the carcass to an older, initiated man, who butchered and shared the meat with the other households. Religious activities occurred after this kill in which the young man received public, ritual recognition for his hunting and sharing. Woodburn (1968a) writes that successful

large game hunting helps Hadza men find and keep wives. We have no way of knowing in this case, but the memorable experience described here could only have helped the young man socially.

Marlowe (2004) reported that 85% of Hadza women stated that being a good hunter is a desired trait in a husband. Hawkes et al. (2001b:688, Fig. 1) found that the children of better hunters gained more weight than other children, and similarly that the wives of better hunters gained more weight than other women (2001b:690, Fig. 4). Based on their food production and sharing data, Hawkes et al. suggested not that men's family provisioning explained the better condition of good hunters' wives and children, but instead that their greater weight gain was attributable to successful hunters being married to harder-working women who were better able to provide for themselves and their children. Here, we examine the relationship between hunting success and household provisioning by modeling the amount of food that the best hunters, median hunters, and poorest hunters provided to their households in our seven camps. To do so, we first identify, among the married men (aged 18–65) in each camp, those men whose hunting produced the highest, the median, and the lowest daily rates (kcal/day from hunting).[5] We then examine how much large game, small game, fruit, and honey each of these men brought back to camp. Finally, we couple these food production measures with estimates of how much each one of these foods would have been consumed in the producers' households, based on our sharing data. The results are shown in Fig. 12.

In terms of gross food production before sharing, the best hunters brought 12.3 times (16,818/1,367) as many calories as the poorest hunters to camp per day. The sharing of large game reduced the differential benefit to hunter's households, but it still remained significant: after sharing, we estimate that the best hunters' households could have consumed 4.2 times the amount of male-produced calories as the poorest hunters (3,447/814). Interestingly, better hunters brought honey to camp at a lower rate than median or poor hunters—perhaps this indicates that men who are less successful at hunting compensated by bringing in more honey. In terms of food production frequency, the best, the median, and the poorest hunters brought food to camp at similar frequencies—on 38%, 44%, and 40% of all observation days, respectively ($\chi^2$=1.1, df=2, $p$=0.57).

One might expect, if men's hunting and sharing were largely a form of intrasexual mate competition, that unmarried men would be those most driven to hunt and share foods with others. On the contrary, our food production data show that single men had far lower daily rates of food production and trended toward lower rates of hunting success. How did this relationship between men's marital status and foraging rates arise? We suggest that female mate choice plays a significant role, wherein self-assured Hadza women have chosen better hunters as husbands, and married men have

[5] On selecting the max, the median, and the minimum hunters: Selecting the maximum-producing hunter in each camp is straightforward. Selecting the median hunter is straightforward in camps with an odd number of hunters. In camps with an even number, we first removed the best hunter from the sample and then identified the median hunter from among those men who remained. Since the distribution of hunting success among men is usually right-skewed (a few hunters with very high success), this is a better estimate of central tendency. Selecting the minimum hunter was a little tricky in two camps, where more than one man produced zero large game or small game. In these instances, we randomly selected one of the men.

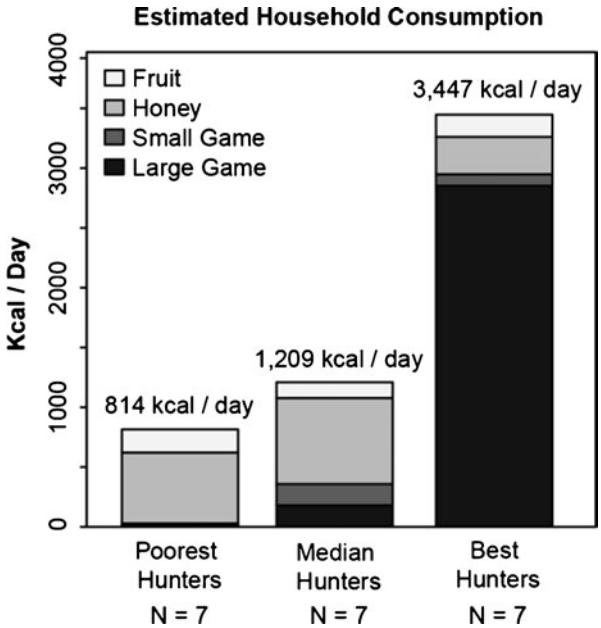


**Fig. 12** Household-consumed calories produced by poor, median, and best hunters. See Table S4 for exact values and how they were calculated

facultatively increased their food production in the context of marital and familial obligations.

## Conclusion

Our interest in the foraging and food sharing behavior of Hadza men has been rooted in two main objectives: to provide basic data describing their foraging economy while it is still observable, and to test hypotheses about the production, sharing, and consumption of men's foods. Where our findings differ from earlier anthropological studies of the Hadza, we have provided what we hope is a constructive examination of possible reasons for such differences, and to have plotted a course for continued work on these issues.

Our research shows that while large game continues to be an important component of the Hadza diet, men were not large game specialists; they also acquired significant amounts of small game, honey, and fruit. In distributions of large game, households of producers retained much larger shares than other households in camp, and the shares they kept included higher-quality parts, including hind limbs and skins. These patterns were observed just as clearly in small camps as in larger camps, where the social pressure to share would be expected to be greater. Food consumption data show that distributions of meat, honey, and fruit clearly advantaged the producers' own households and their kin living in other households. Our data show that wives had enhanced access to the foods their husbands produced, and considerable influence over how such foods were distributed. Men who were married brought foods back to camp at a greater average rate, and more frequently, than single men, and married men brought the least-shared resource, fruit, back to camp more often and at

a greater rate than single men. In terms of sharing depth and breadth, married men kept a greater fraction of their food production for their own households, and shared with fewer other households, than did single men. Our model of the relationship between hunting success and household food consumption indicates that better hunters provided 3–4 times the amount of calories to their households, after sharing, than median or poor hunters. Based on these new data, and other studies of Hadza behavioral ecology, we suggest that family provisioning benefits provide a plausible reason for why Hadza women prefer good hunters as husbands and why successful hunters have higher fertility than others.

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