# Is Bigger Better? Evaluating The Relationship Between Prey Body Size and Fat Composition in Eastern African Mammals

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## Introduction

- Fat is hypothesized to have been critical to hominin brain evolution, since larger, energetically costly brains required more fat-heavy diets[1, 6, 11, 13]
- Reconstructions of hominin diets often assume a positive relationship between body size and relative body fat in prey species, an assumption fundamental to understanding early hunting strategies and metabolic requirements (e.g., avoiding "rabbit starvation," protein poisoning from a diet too lean in fat < 35-45%) [2, 3, 4, 8, 9, 20, 21]
- This assumption is largely based on estimates from non-African and/or domesticated species used as proxies for wild African fauna [2, 3, 8, 9]
- **We test whether body size positively predicts absolute (not proportional) total body fat, which requires an exponent greater than 1**
- **We then compare this relationship to N. American mammals to test whether the pattern long assumed in non-African proxies holds for wild African fauna**
- **We also test how total fat scales relative to muscle mass, since this ratio is central to avoiding protein toxicity**

## Methods

- Compiled mean body mass, total body fat, and intramuscular fat data of contemporary E. African mammals (and N. American mammals[5, 12, 15, 18]
- Estimated intramuscular fat ~ body mass and total fat ~ body mass scaling relationships to mathematically convert intramuscular fat to total fat, this assumes the estimated total fat ~ body mass scaling relationships are the same for all species within the dataset
- Conducted an ANCOVA comparing the slopes and intercepts in log-log space for the total fat ~ body mass relationship between E. African mammals (Ledger/Malaisse[12, 16]) and N. American mammals (Bosch/Pitts & Bullard[5, 18])
- Assumed muscle mass scales linearly with body mass, at a constant 45% muscle-to-body-mass ratio[17], for comparison against the empirical total fat scaling relationships

## Results

- Analysis included 35 eastern African and 47 North American species spanning roughly five orders of magnitude in body mass (0.01–4,000 kg)
- Total fat scales superlinearly with body mass in both groups, with the E. Africa slope = 1.28 and N. America slope = 1.19 (slope offset p = 0.277)
- **North American mammals had a significantly higher intercept (p < 0.001), indicating they are on average fatter than Eastern African mammals of similar body size (carrying ~ 5.3x more total fat)**
- Muscle mass exceeds total fat mass across all body sizes and continents with the gap narrowing in larger animals, as fat scales more steeply (1.19–1.28) than the assumed constant muscle-to-body-mass ratio[17]

## Discussion

- **Body size positively and strongly predicts total fat in Eastern African mammals when using absolute total fat, which is a better metric for hominin dietary studies since foragers consume a fixed quantity of tissue**
- Difference between N. American and Eastern African mammals may reflect latitudinal influences, such as increased seasonality and colder temperatures at higher latitudes
- These findings suggest African mammals may offer a more suitable proxy than non-African or domesticated species for body composition analysis and dietary reconstruction in hominin contexts
- Because muscle is primarily protein, and avoiding protein toxicity requires roughly equal fat and protein intake, the muscle-to-fat scaling relationship shown here (Fig. 1) is critical for assessing whether prey of a given body size can meet dietary fat requirements[21, 21, 22]
- **Given that carcasses typically contain more muscle than fat (Fig. 1), hominins may have needed to (1) selectively target fat-rich depots within a carcass, particularly in larger mammals where the entire animal would not be consumed, (2) prioritize marrow or brain tissue, or (3) supplement with fat from plant foods to avoid protein toxicity**
- It is important to revisit the hypothetical diets of early hominins with an adjusted framework that considers the data presented here

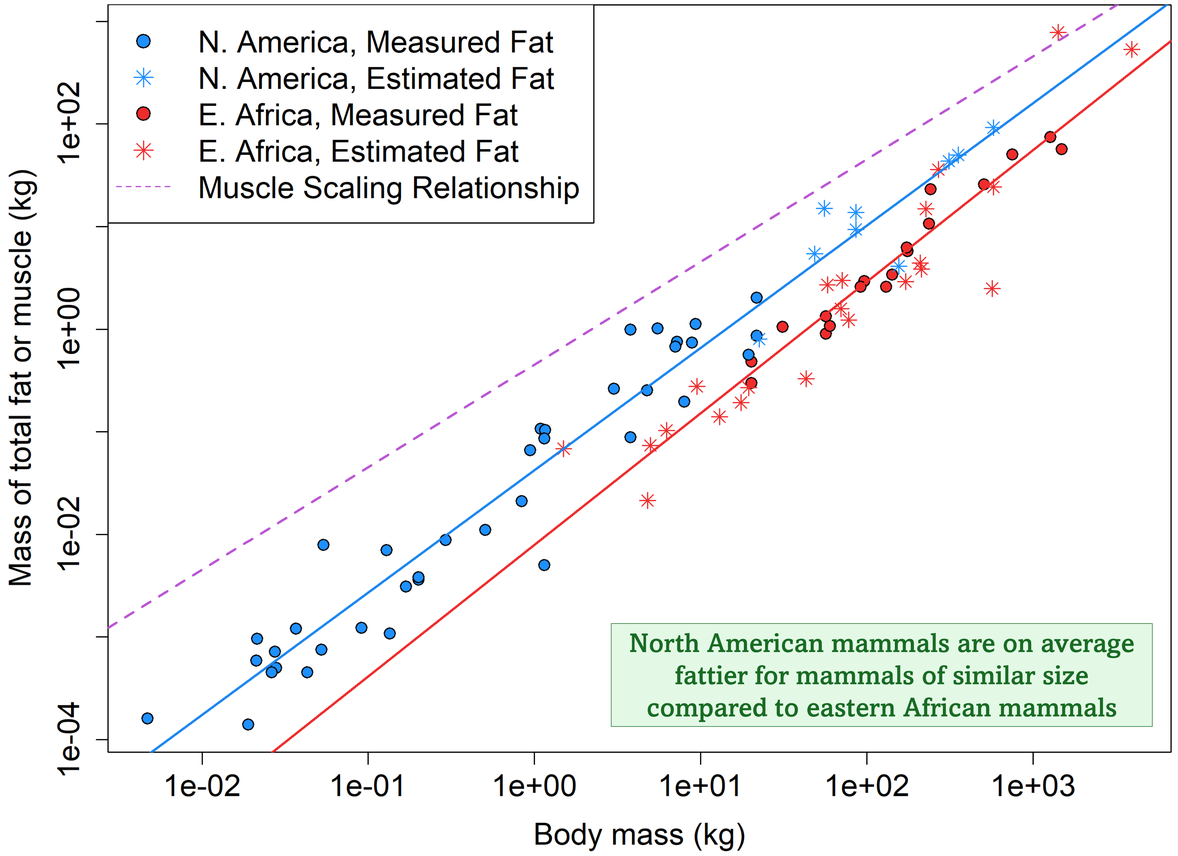
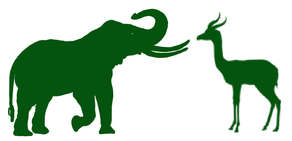



**Figure 1:** Scaling of total body fat with body mass across eastern African and North American mammals (log-log axes). Circles show directly measured total fat (Ledger 1968; Pitts & Bullard 1968); asterisks show total fat estimated by combining intramuscular fat and total fat power functions (Malaisse 2010/Ledger 1968; Bosch 2015/Pitts & Bullard 1968). Dashed line shows the expected scaling of muscle mass with body size assuming a constant 45% muscle-to-body-mass ratio (Munro 1969), for comparison against the empirical total fat scaling relationships

| Term | Estimate | 2.5% CI | 97.5% CI |
|---|---|---|---|
| E. Africa Intercept | -2.102 | -2.407 | -1.798 |
| E. Africa Slope | 1.282 | 1.137 | 1.426 |
| N. America Intercept Offset | 0.724 | 0.404 | 1.045 |
| N. America Slope Offset | -0.09 | -0.253 | 0.073 |

**Table 1**: Coefficient estimates and 95% confidence intervals from the ANCOVA testing whether total body fat scaling with body mass differs between eastern African and North American mammals. Eastern African values (Ledger 1968, Malaisse 2010) are the reference level; North American offsets (Bosch 2016/Pitts & Bullard 1968) indicate the difference relative to eastern African fauna. The data is on log 10 transformed independent and dependent variables



References & Supplementary Information