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RESEARCH ARTICLE

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Energy expenditure and obesity across the economic spectrum

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Affiliations are included on p. 7.

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Global economic development has been associated with an increased prevalence of obesity and related health problems. Increased caloric intake and reduced energy expenditure are both cited as development-related contributors to the obesity crisis, but their relative importance remains unresolved. Here, we examine energy expenditure and two measures of obesity (body fat percentage and body mass index, BMI) for 4,213 adults from 34 populations across six continents and a wide range of lifestyles and economies, including hunter-gatherer, pastoralist, farming, and industrialized populations. Economic development was positively associated with greater body mass, BMI, and body fat, but also with greater total, basal, and activity energy expenditure. Body size–adjusted total and basal energy expenditures both decreased approximately 6 to 11% with increasing economic development, but were highly variable among populations and did not corre-

Significance

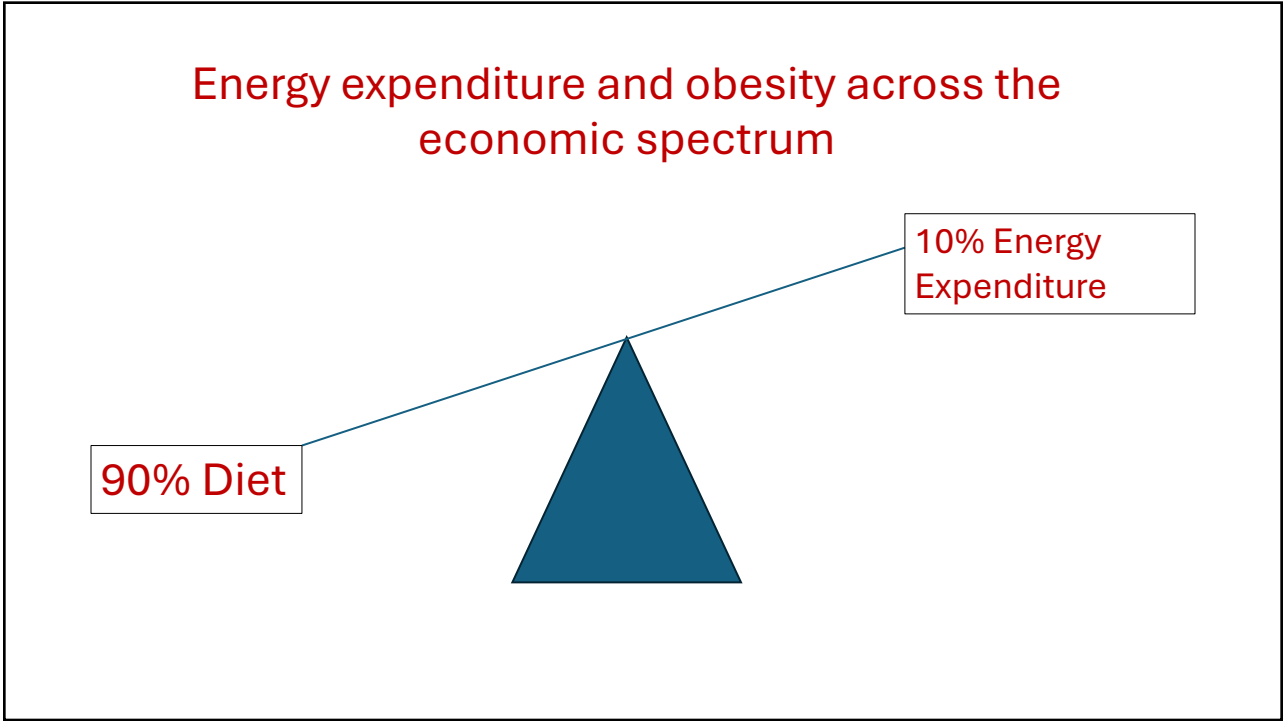
Economic development is associated with increased prevalence of obesity and related health problems, but the relative importance of increased caloric intake and reduced energy expenditure remains unresolved. We show that daily energy

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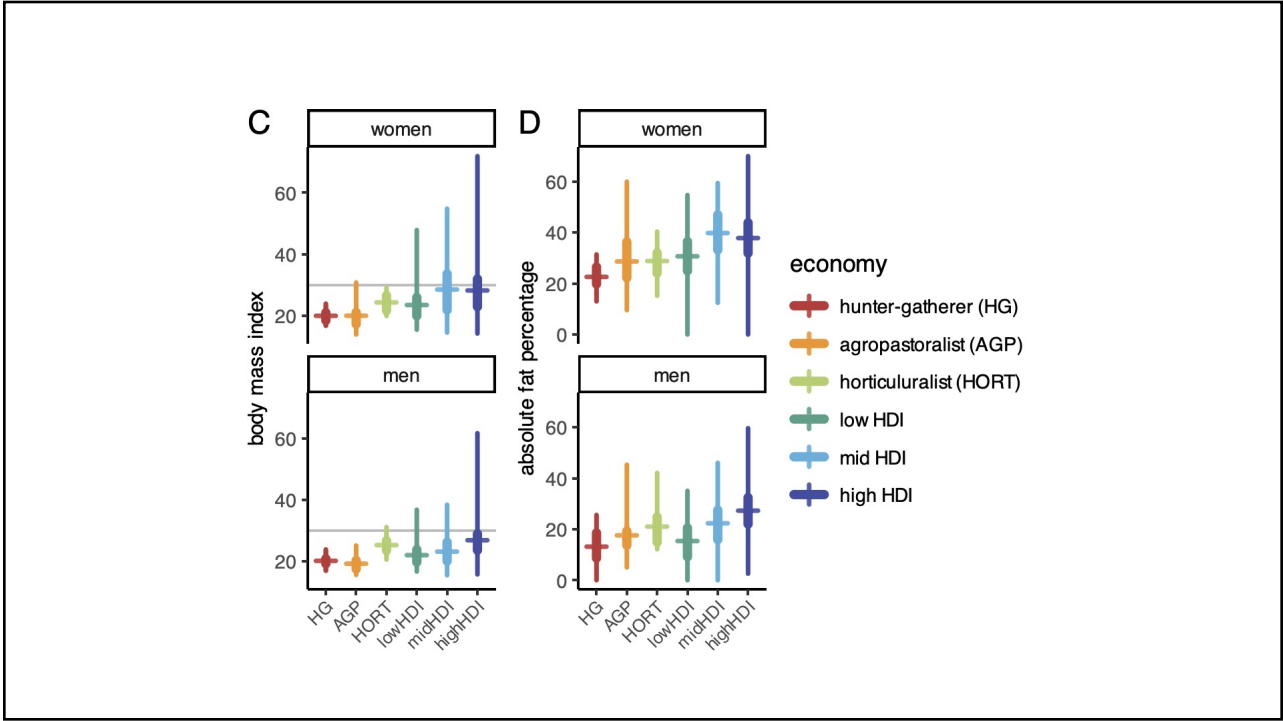
Energy expenditure and obesity across the economic spectrum

- Examine energy expenditure and two measures of obesity (body fat percentage and body mass index, BMI) for 4,213 adults from 34 populations across six continents and a wide range of lifestyles and economies, including hunter-gatherer, pastoralist, farming, and industrialized populations.
- Economic development was positively associated with greater body mass, BMI, and body fat, but also with greater total, basal, and activity energy expenditure.
- Body size–adjusted total and basal energy expenditures both decreased approximately 6 to 11% with increasing economic development but were highly variable among populations and did not correspond closely with lifestyle.
- Body size–adjusted total energy expenditure was negatively, but weakly, associated with measures of obesity, accounting for roughly one-tenth of the elevated body fat percentage and BMI associated with economic development.
- In contrast, estimated energy intake was greater in economically developed populations, and in populations with available data (n = 25), the percentage of ultraprocessed food in the diet was associated with body fat percentage, suggesting that dietary intake plays a far greater role than reduced energy expenditure in obesity related to economic development.

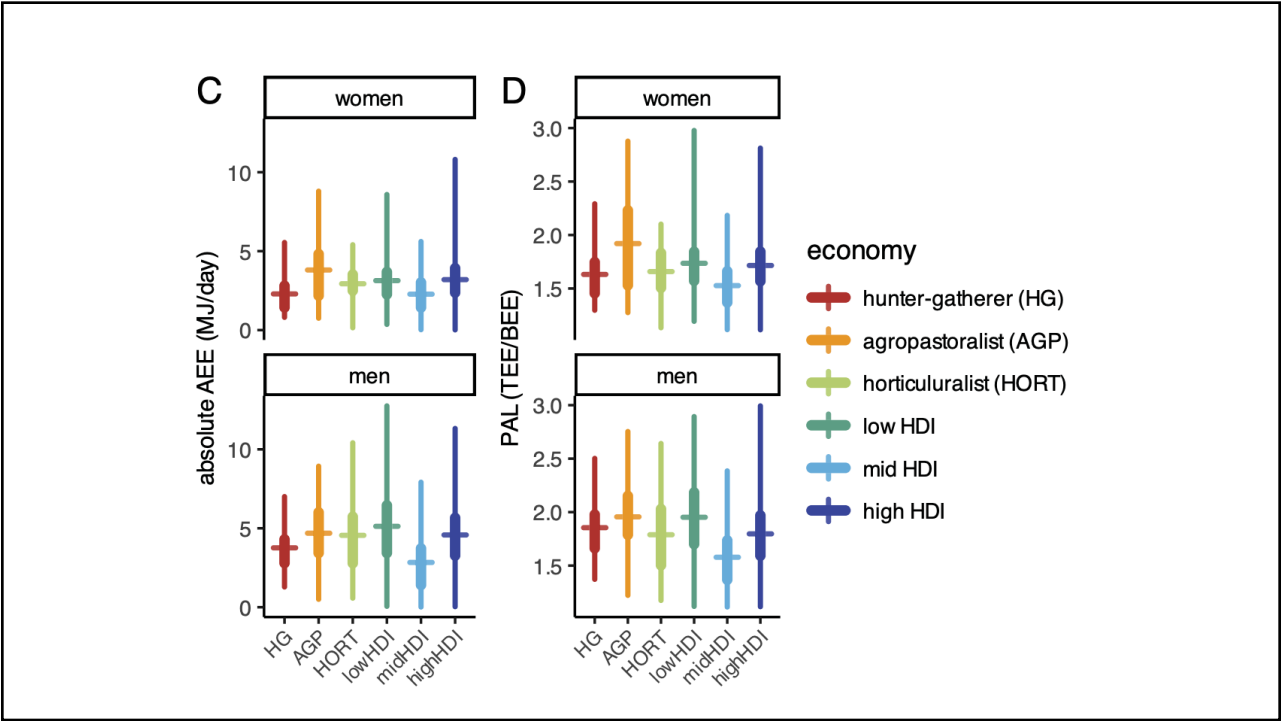
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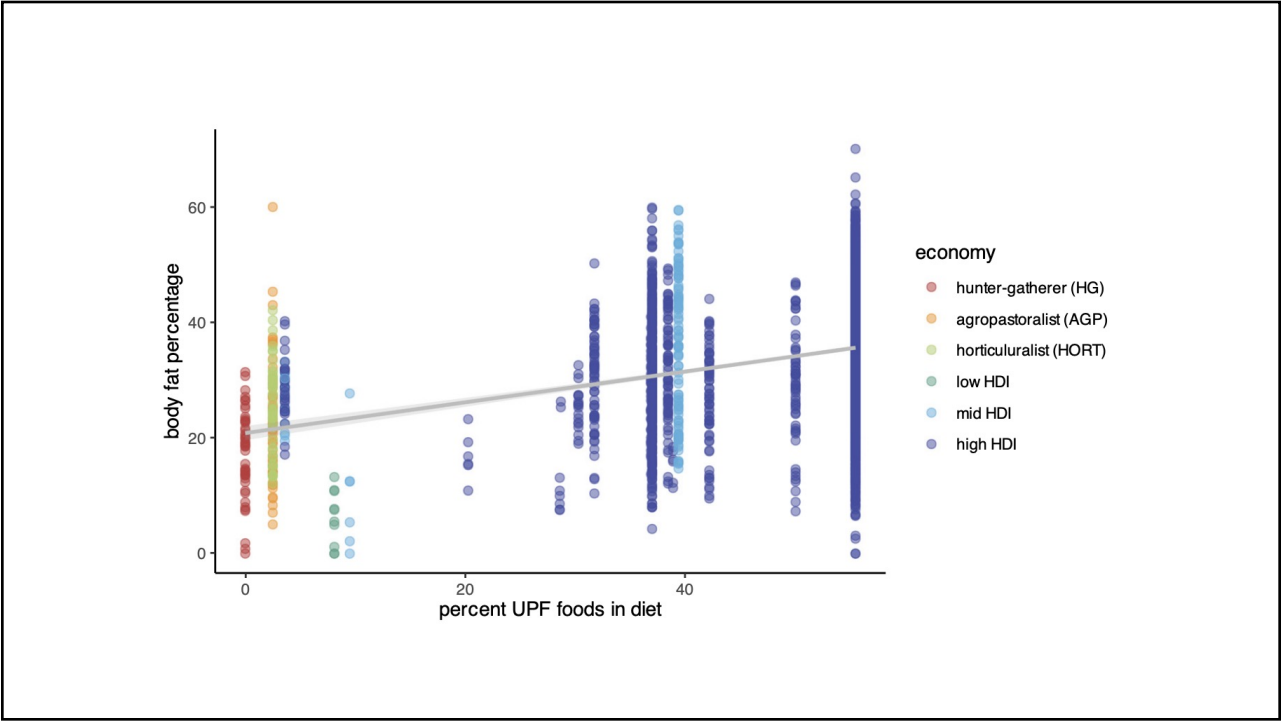
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Western lifestyles differ markedly from those of our hunter-gatherer ancestors, and these differences in diet and activity level are often implicated in the global obesity pandemic. However, few physiological data for hunter-gatherer populations are available to test these models of obesity. In this study, we used the doubly-labeled water method to measure total daily energy expenditure (kCal/day) in Hadza hunter-gatherers to test whether foragers expend more energy each day than their Western counterparts.

As expected, physical activity level, PAL, was greater among Hadza foragers than among Westerners. Nonetheless, average daily energy expenditure of traditional Hadza foragers was no different than that of Westerners after controlling for body size. The similarity in metabolic rates across a broad range of cultures challenges current models of obesity suggesting that Western lifestyles lead to decreased energy expenditure.

We hypothesize that human daily energy expenditure may be an evolved physiological trait largely independent of cultural differences.

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The Four NOVA Groups

- **Group 1:** Unprocessed or minimally processed foods (fresh fruits, vegetables, eggs, milk).
- **Group 2:** Processed culinary ingredients (salt, vegetable oils, butter, sugar).
- **Group 3:** Processed foods (canned vegetables, cheese, freshly baked bread).
- **Group 4 (Ultra-Processed Foods):** Industrial formulations made mostly or entirely from substances extracted from foods, additives, and synthetic ingredients.  National Institutes of H... +4

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How Ultra-Processed Foods Are Identified

- **Ingredient Lists:** Researchers and consumers check labels for non-culinary substances. Examples include high-fructose corn syrup, hydrogenated oils, protein isolates, and cosmetic additives like artificial colors, flavors, and emulsifiers.  National Institutes of Heal...
- **Product Types:** Items typically include mass-packaged snacks, soft drinks, instant noodles, reconstituted meat products (nuggets), and pre-prepared frozen meals.  American Journal of Publi...

How Intake Is Measured in Studies

- **Dietary Energy (%):** Population studies (like NHANES) measure ultra-processed food intake by calculating the percentage of total daily calories (energy) derived from Group 4 items.
- **Weight or Frequency:** Some studies measure intake by total weight consumed or through food frequency questionnaires.  American Society for N... +2

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