Electronic Supplementary Materials

For Manuscript:

Dietary Macronutrient Content, Age-Specific Mortality and Lifespan

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# Text S1: Calculation of Life Tables

We calculated *px* (probability of surviving to age *x*+1, at age *x*) and *qx* (probability of dying prior to age *x*+1, at age *x*) via equation S1:

$p\_{x}= \frac{l\_{x+1}}{l\_{x}}=(1- q\_{x})$ eq. S1,

where *lx* is the proportion of a cohort surviving to age *x* calculated from predicted values of *α β* as described in the methods of the main text.

From values of *px* we calculated life expectancy at age 3 (the age at which animals entered the study; *e*3) and the standard deviation in age at death (*s*) using the same method as van Raalte and Caswell [1]. For our purposes we assessed *k* age classes corresponding to values of *p*3 through *p*163-1. The mean time spent in age class *x*, conditional on starting age *j*, is given by entry (*x*, *j*) of matrix **N*,*** which was found by equation S2:

$N=(I-U)^{-1}$ eq. S2,

where **I** is an (*k* × *k*) identity matrix and **U** is a(*k* × *k*) matrix containing *p*3 through *p*163-1 in the diagonal elements and 0’s in the off diagonal elements. A vector of the life-expectancies at each of the *k* age classes considered (**η**) is then given by equation S3:

$η=(e^{T}N)^{T}-0.5e$ eq. S3,

where **e** is a vector of 1’s, T denotes the transpose of a vector and **N** is as above. The life-expectancy at the beginning of the study (*e*3) is given in the first entry of this vector. A corresponding vector of standard deviations in age at death (**s**) for individuals at each age class is found as:

$s=\sqrt{(e^{T}N\left(2N-I\right)-η^{T}∘η^{T})^{T}}$ eq. S4,

where ° is the Hadamard product and all other notation is as above. We are primarily interested in the standard deviation in age at death for all animals at the beginning of the study, *s*, which is the first element of **s**.

For the LTRE analysis contributions (**c**) of changes to age specific mortality rates as a function of a changing macronutrient ratio (*m*) to concomitant changes in indices of interest were calculated via equation S5:

$c\left(m\right)= \left(\frac{dy}{dθ^{Τ}}\right)^{Τ}∘\left(\frac{dθ}{dm}\right)$ eq. S5,

where **c** is a vector of contributions, *m* is a macronutrient ratio, **θ** is a vector of predicted mortality rates (*q*3 through *q*163) for *m*, *y* is an index of interest (*e*3 or *s*), $\frac{dy}{dθ^{Τ}}$ is a vector giving the sensitivity of *y* to **θ** (found following [1]) and $\frac{dθ}{dm}$ gives the rate of change in **θ** over *m*. $\frac{dθ}{dm}$ was calculated using the ‘gradient’ function in the package *pracma* [2]. By integrating **c** over a series of *k* values of *m* for which life tables have been predicted we get the contributions to the change in *y* from changes in *qx* from *m*1 to *mk* via equation S6:

$y\left(m\_{k}\right)≈y\left(m\_{1}\right)+\sum\_{i=m\_{1}}^{m\_{k}}c(i)$ eq. S6.

# References

1. van Raalte A.A., Caswell H. 2013 Perturbation analysis of indices of lifespan variability. *Demography* **50**(5), 1615-1640. (doi:10.1007/s13524-013-0223-3).

2. Borchers H.W. 2018 pracma: Practical Numerical Math Functions. *R* package version 2.2.2.

# Table S1

Parameters for model life tables for each diet. Parameters were estimated by linear regression (equation 1, main text), and standard errors (SE) associated with estimation are given. Also shown is the content of protein (P), carbohydrate (C) and Fat in each diet.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Diet ID | *α* | *β* | SE *α* | SE *β* | P kJ/g | C kJ/g | F kJ/g |
| SF09-043 | -2.61 | 1.91 | 0.32 | 0.18 | 4.8 | 1.6 | 1.6 |
| SF09-044 | -0.19 | 1.12 | 0.13 | 0.10 | 7.8 | 2.6 | 2.6 |
| SF09-045 | -0.68 | 0.80 | 0.15 | 0.07 | 10.2 | 3.4 | 3.4 |
| SF09-047 | 0.73 | 0.79 | 0.07 | 0.03 | 0.65 | 9.75 | 2.6 |
| SF09-048 | 0.38 | 0.74 | 0.11 | 0.06 | 0.85 | 12.75 | 3.4 |
| SF09-051 | -0.46 | 0.57 | 0.07 | 0.02 | 0.85 | 3.4 | 12.75 |
| SF09-052 | 0.47 | 0.95 | 0.15 | 0.10 | 2.64 | 3.84 | 1.6 |
| SF09-053 | 0.82 | 1.04 | 0.08 | 0.05 | 4.29 | 6.24 | 2.6 |
| SF09-054 | -0.16 | 1.14 | 0.10 | 0.08 | 5.61 | 8.16 | 3.4 |
| SF09-055 | -3.41 | 2.06 | 0.18 | 0.10 | 2.64 | 1.6 | 3.84 |
| SF09-056 | 0.01 | 1.47 | 0.08 | 0.07 | 4.29 | 2.6 | 6.24 |
| SF09-057 | -0.14 | 1.64 | 0.11 | 0.10 | 5.61 | 3.4 | 8.16 |
| SF09-060 | 0.56 | 0.70 | 0.14 | 0.06 | 0.85 | 8.16 | 8.16 |
| SF09-061 | -1.18 | 1.02 | 0.24 | 0.13 | 1.12 | 2.32 | 4.56 |
| SF09-062 | -0.06 | 0.95 | 0.09 | 0.06 | 1.82 | 3.77 | 7.41 |
| SF09-063 | -0.15 | 1.27 | 0.18 | 0.16 | 2.38 | 4.93 | 9.69 |
| SF09-064 | -1.21 | 1.31 | 0.16 | 0.11 | 1.12 | 4.56 | 2.32 |
| SF09-065 | 0.87 | 0.97 | 0.10 | 0.06 | 1.82 | 7.41 | 3.77 |
| SF09-066 | 0.98 | 1.55 | 0.08 | 0.07 | 2.38 | 9.69 | 4.93 |
| SF09-067 | -2.55 | 1.97 | 0.12 | 0.08 | 3.36 | 2.32 | 2.32 |
| SF09-068 | 1.49 | 1.26 | 0.11 | 0.08 | 5.46 | 3.77 | 3.77 |
| SF09-069 | 0.51 | 0.64 | 0.07 | 0.03 | 7.14 | 4.93 | 4.93 |
| SF09-070 | -2.15 | 1.82 | 0.18 | 0.12 | 1.84 | 3.04 | 3.04 |
| SF09-071 | 1.42 | 1.51 | 0.11 | 0.09 | 2.99 | 4.94 | 4.94 |
| SF09-072 | -0.85 | 1.32 | 0.06 | 0.05 | 3.91 | 6.46 | 6.46 |