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P1_5 I Would Walk 500 More

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Abstract

In the paper 'P1_3 I Would Walk 500 Miles' [1] the reduction in body mass of the average Scottish male, or 'Proclaimer', was considered as a relation to distance walked. It was further proposed that a model could be formed in which the Proclaimers' energy is drawn from some carried mass of food, rather than its own body fat. In this paper we consider the relation between body mass and the necessary carried mass of food for a Proclaimer to walk, with negligible mass reduction, over fixed distances. It was found that the mass a Proclaimer must carry is directly proportional to the Proclaimers' body mass. It was also found that the initial carried mass increases exponentially over journey length. It is therefore not feasible for the Proclaimer to carry its own food over the full 1000 miles.

Introduction

In the paper 'P1_3 I Would Walk 500 Miles' [1] it was found that a Proclaimer, walking at a speed of $4\,km\,hr^{-1}$ ($59.7\,miles\,day^{-1}$), would suffer a loss in body mass logarithmically related to the distance walked. By drawing this energy from a carried mass of food, not the Proclaimers' body fat, a more realistic picture can be drawn of how the journey would affect a Proclaimers' body.

Theory and Method

As shown in [1], the total energy consumed by the Proclaimer depends on the metabolic energy of the Proclaimer and the energy the Proclaimer uses to walk. The metabolic energy depends solely on the Proclaimers' body mass, however the walking energy will be affected by the mass of carried food. The equation for walking energy in [1] must be adapted to replace the body mass, M, with the sum of the Proclaimers' body mass, M_P, and the carried mass, M_C. Therefore the equation for the total energy required per day ([1], equation 4) becomes:

$$E_T = E_m + E_w = A + B\,M_P + C\,M_C \quad (1)$$

where: A, B and C are constants $1130\,kcal$, $82\,kcal\,kg^{-1}$ and $72\,kcal\,kg^{-1}$ respectively [1]. This energy is taken from the mass of food being carried by the Proclaimer. As the Proclaimers are Scottish it is assumed that the only food they eat is haggis. Haggis has an energy density of $2850\,kcal\,kg^{-1}$ [2], by dividing the total daily energy consumption by this value, the rate of change of carried mass can be found:

$$\frac{dM_C}{dt} = \frac{E_T}{2850} = D + EM_P + FM_C \quad (2)$$

where: D, E and F are constants $0.398\,kg\,days^{-1}$, $0.0288\,days^{-1}$ and $0.0253\,days^{-1}$ respectively.

Using the boundary conditions $\Delta M_C = 0$ at $t = 0$, equation 2 can be solved to find the

change in carried mass as a function of time. Subtracting this from the initial carried mass M_C, the total carried mass at time t can be found:

$$M_C(t) = M_{C_i} + \frac{D + EM_P}{F}(1 - e^{Ft}) \quad (3)$$

where: M_{C_i} is the initial carried mass in kilograms. Equation 3 clearly shows that as time increases the carried mass decreases. Equation 3 can be adapted for a relation between the initial carried mass and body mass for journeys of fixed distances. By replacing the time, t, with distance, d, over velocity, v, and applying the condition that $M_C(\frac{d}{v}) = 0$, this relation can be found:

$$M_{C_i} = \frac{D + EM_P}{F}(e^{\frac{Fd}{v}} - 1) \quad (4)$$

Results and Discussion

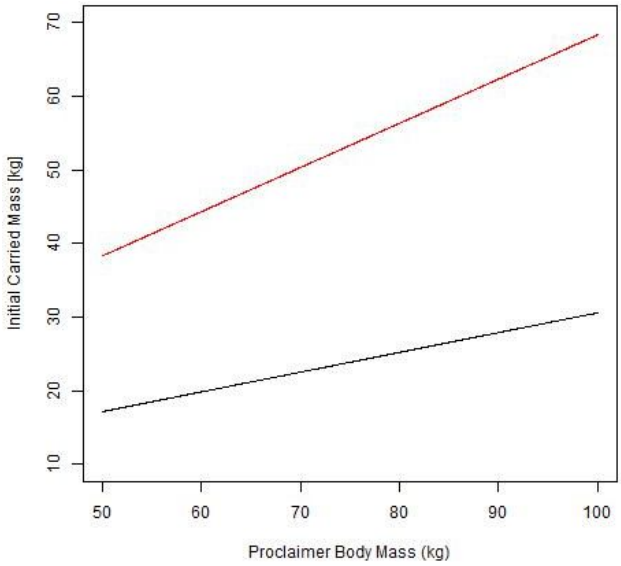

Figure 1: A graph showing the relation between Proclaimer body mass and initial carried mass. The black line is for a journey of 500 miles, the red line is for 1000 miles.

Figure 1 clearly shows that there is a linear relation between the Proclaimers' body mass and the mass it must initially carry. However, as seen in figure 2, there is an exponential relation between the initial carried mass and the distance walked. A Proclaimer of average Scottish male

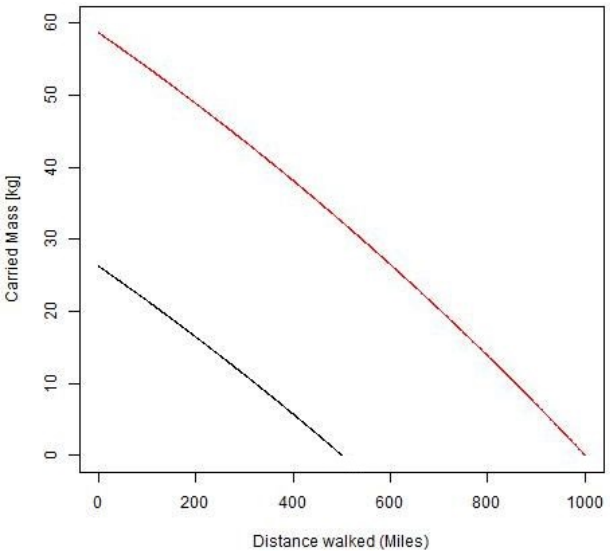

Figure 2: A graph showing the relation between the carried mass and the distance walked. Here set for an $83.9kg$ Proclaimer carrying haggis. The black line is for a journey of 500 miles, the red line is for 1000 miles.

weight, $83.9kg$ [3], would require $26.2kg$ of haggis to walk 500 miles, and $58.7kg$ to walk 500 more. This paper, ignores any resistance forces such as wind and other energy uses such as cooling due to atmospheric temperature. Incorporating these energy uses would increase the requires mass of haggis for the Proclaimer.

Conclusion

We found that the mass of carried haggis will exponentially increase for a longer journey. A Proclaimer that wishes to walk 500 miles must carry $26.2kg$ of haggis, while a more committed Proclaimer, willing to walk the full 1000 miles, must initially carry $58.7kg$ of haggis. It is very unlikely that a Proclaimer could carry this weight for such a long period without other energy requirements on the body of the Proclaimer.

References

[1] Relton et al., 2017. P1_3 I Would Walk 500 Miles. Physics Special Topics.

[2] `http://www.macsween.co.uk/products/delicious-every-day-haggis/`

[3] Corbett et al., 2009. The Scottish health survey 2008. The Scottish Government, Edinburgh.