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P1_3 I Would Walk 500 Miles

P. Relton, S. Davis, A. Ramsden, C. Clark

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

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Abstract

In their 1988 song 'I'm Gonna Be (500 Miles)' [1], The Proclaimers state that they would be willing to walk 500 miles, and then 500 more, in order to be the man that falls down at your door. In this paper we examine the feasibility for a Proclaimer, modelled on the average Scottish male human, to walk such distances without food. It was found that a Proclaimer, would lose 1.3% of its body mass after 500 miles and 2.8% after 500 more.

Introduction

As a human walks its body consumes energy in two ways. The energy required to provide forward motion, and the metabolic energy required to continue the usual body functions. Like most animal life humans acquire this energy from the chemical energy in food, without this input the body will consume energy from its fat reserves. Therefore the distance a human can walk is finite.

Method

Metabolic Energy: Mifflin et al, [2] sets out an equation for the energy, E_m $(kcal)$, required per day, for a human of mass, $M(kg)$, height, $H(cm)$, and age, $A(years)$, to complete the metabolic process:

$$E_m = a_1 M + a_2 H + a_3 A + a_4 \tag{1}$$

where: a_1 is $10\,kcal\,kg^{-1}$, a_2 is $6.25\,kcal\,cm^{-1}$, a_3 is $-5\,kcal\,year^{-1}$, a_4 is $5\,kcal$ for men and $-161\,kcal$ for women [2]. In August of 1988 when 'I'm Gonna Be (500 Miles)' was released [1], The Proclaimers were 26 years old. Taking an age of 26, and the average height of a 26 year old Scottish male, $178.2\,cm$ [3], we found that the metabolic energy for a Proclaimer of varying body mass can be simplified to:

$$E_m = b_1 M + b_2 \tag{2}$$

where: b_1 and b_2 are constants $10\,kcal\,kg^{-1}$ and $988.75\,kcal$ respectively. *Walking Energy:* McArdle et al, [4] states that for a human walking with speed $V = 4km\,hr^{-1}$ $(2.49\,Miles\,hr^{-1})$ the energy, $E_w\,(kcal)$, required per day, is:

$$E_w = c_1 + c_2(M - c_3) \tag{3}$$

where: c_1, c_2 and c_3 are constants $5040\,kcal$, $72\,kcal\,kg^{-1}$ and $68\,kg$ respectively. McArdle defines this equation for the $4km\,hr^{-1}$ walking speed, other values for faster walking were given but are not included in this paper. We note here that any other energy requirements, such as resistance from wind or ground inclination, are ignored for simplicity.

Total Energy: It is assumed that The Proclaimers are so dedicated to their journey that they walk continuously over the full 24 hours of the day. This means that the total energy, E_T

($kcal$), required per day for a Proclaimer of varying mass is:

$$E_T = E_m + E_w = d_1 M + d_2 \tag{4}$$

where: d_1 and d_2 are constants $82\,kcal\,kg^{-1}$ and $1132.75\,kcal$ respectively.

Results

Energy-Mass Relation: The energy required for the walk must come from the reserves of fat within the Proclaimer's body. The average human male is between 22.9% and 30.9% fat [5], therefore the Proclaimer cannot burn a higher percentage of his body mass than 30.9%. Body fat contains $8840\,kcal\,kg^{-1}$ [6]. This means that the rate of change of the loss of body mass, in kilograms per day, can be written as:

$$\frac{dM}{dt} = \frac{E_T}{8840} = AM + B \tag{5}$$

where: A is a dimensionless constant of value 9.28×10^{-3} and B is a constant $0.128\,kg$.

Time-Mass Relation: Solving Eq. 5 using the integrating factor method, applying the condition that at time $t = 0$ the loss of body mass is zero, and then subtracting this from $M_{initial}$ an equation for the Proclaimers body mass at time $t\,(days)$ can be found:

$$M(t) = M_{initial} - \frac{A}{B}\,(e^{Bt} - 1) \tag{6}$$

Rearranging this for time, t, and multiplying by the walking speed V, the relation between distance walked, D, and body mass, M, is:

$$D = \frac{V}{B} Ln[1 - \frac{B(M - M_{initial})}{A}] \tag{7}$$

Discussion

As shown in Eq. 7, there is a logarithmic relation between the distance walked and the mass of the Proclaimer. This means that as a Proclaimer walks their mass decreases. The average mass of a Scottish male, between 26 and 34 years old is $83.9kg$. Assuming this is the initial body mass, it is found that their body mass would be reduced to $82.8kg$ (98.7% of initial mass) when they have walked 500 miles, and $81.6kg$ (97.2% of initial mass) when they walk 500 more.

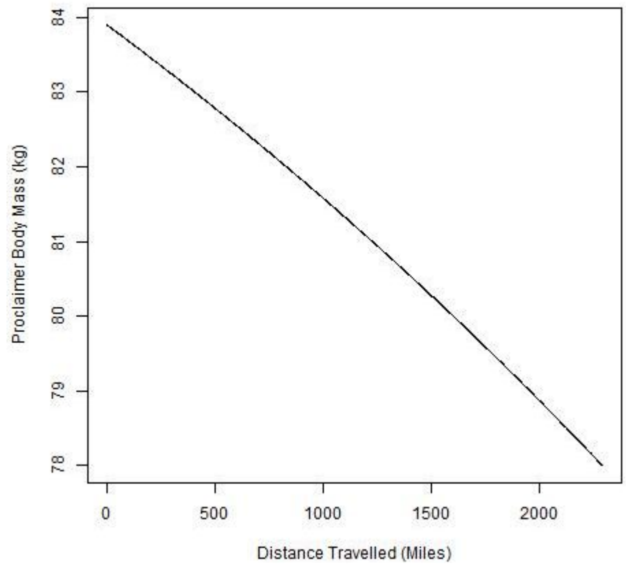

Figure 1: Graph of walking distance to body mass relation. Here set for a Proclaimer of initial mass $83.9kg$

Conclusion

We found a logarithmic relation between body mass and distance walked. From this we found that a Proclaimer walking the full 1000 miles would have reduced their body mass to 97.2% of its initial value, well within the average fat percentage of an adult Proclaimer. Future work could look at the relation for a Proclaimer carrying food.

References

[1] `https://en.wikipedia.org/wiki/The_Proclaimers` [Accessed 30/10/17]

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[6] Audrey et al, 1995. *The concise encyclopedia of foods and nutrition.*