Carrying for free? Testing the human capability of load transport without added costs

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Carrying loads is an essential human behavior [1]. Several researches propose that humans have extremely efficient carrying methods, without incurring any extra locomotion costs, named "Free Ride Hypothesis" [2]. Nonetheless, recent investigations do not agree with this assumption [3].

Due to the relevance of carrying behaviors for human ecology, the aim of this research is to evaluate the "Free Ride" capacity on a sample of 48 adult individuals (21 females and 27 males). The energy expenditure of these volunteers was recorded by Indirect calorimetry at resting (Resting Metabolic Rate -RMR) for 30 minutes, and during locomotion tests without loads and while carrying 5, 10 and 15 kg backpacks. The locomotion trials lasted for 10 minutes, with 5 minutes to rest between them. These experimental tests were carried out at the Bioenergy Laboratory of the National Research Center on Human Evolution (CENIEH, Burgos, Spain), under the project led by Dr. A. Mateos, with the approval of the Hospital Universitario de Burgos Ethical Committee (Ref. CEIC 1480).

The net energy expenditure of locomotion trials was calculated extracting the cost of RMR from the gross cost of the tests, in mililitres of oxygen (mlO2). The absolute loads carried were transformed to Relative Carried Loads (RCL), as a percentage of volunteers' body mass. Then, the percentage of the increment in the net cost (Increment Net Cost (%)) of the load trials over the unloaded one was assessed. T-tests were used to compare gross and net costs of burden locomotion trials with the cost of the unloaded locomotion trial. Finally, a simple correlation was computed with the RCL and the Increment Net Cost to observe the relationship between the percentage of body mass represented by the loads carried and the percentage of the increment in the net cost of the carrying trials. This simple correlation was performed considering alternative models, to test if the relationship between the variables fit better on a nonlinear model.

The results show that, although burden trials present higher values of energy expenditure, only the heaviest loads (10 and 15 kg) increase significantly the energy costs over unloaded locomotion. When the RCL is plotted against the Increment Net Cost (%), the best fit is obtained with a quadratic model, not with a linear model. This indicates that the costs of locomotion do not increase in all the individuals in a direct proportion to the burden carried. Hence, it can be observed that the load carriage costs remain stable for loads representing less than 20% of the volunteer's body mass. So, in general terms, we cannot conclude that the volunteers of our sample have the capacity to transport several loads without added cost to locomotion ("Free Ride"), agreeing with Lloyd et al. (2010) [3]. Thus, our results do not support the existence of a "free ride" in the participants of our sample, but we highlight that the energetic costs of locomotion are only significantly incremented when the heaviest loads are carried.

As it has been proposed elsewhere [4] carrying 5, 10 and 15 kg of food resources, covers in excess the energy expenditure of their transport, at least for 2 hours, over flat terrain at a constant speed of 4 km/h. However, the fact that humans have certain load transport energetic efficiency, makes sense when the burden transported does not represent a direct energetic benefit. Therefore, humans can transport loads at least up to 10 kg without a substantial increment over the cost of unloaded locomotion. This issue is relevant when the burdens are dependent children or raw materials. These are daily life behaviors among current hunter-gatherers [5] and are considered essential to understand human evolution.

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