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VARIATIONS OF MECHANICAL ENERGY FATIGUE IN THE RUN

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SUMMARY

The aim of the study was to compare the average values of total, internal and external energy variations and peak value of the total energy in two running situations: with and without fatigue. We assessed 4 subjects, healthy runners, already accustomed to running on treadmills. The running test consisted of a race at a constant rate (equivalent to 10% over the threshold velocity) held until exhaustion of the individual. The 2 cameras (60 Hz) were placed at a distance and height to permit the registration of the individual running on a treadmill with the intention of keeping the hip of the individual at the center of the image. The calculations of all the variables involved in the calculation of mechanical energy were made using a program developed at the Institute of Biomechanics of Cologne. This program is called Energia. To compare the values of the mechanical energy in situations with and without fatigue, we used the paired t test with significance level of 0.05. By comparing the situations with and without fatigue, no significant differences were found between the energies. This can be explained by the fact that the running velocity has been maintained constant, what led to only little changes in the values. It can be concluded that although there were no significant differences in mechanical energy in running with and without fatigue considering the whole body, further studies should be conducted to better understand how the process of energy transfers occurs between the segments when the fatigue occurs.

INTRODUCTION

Running is a physical activity performed for training or health maintenance, being a locomotion way that demands a complex coordination of movements [1]. Therefore, several studies have been conducted to study each variable that influences the running. An example would be the relationship between the physiological and the mechanical factors, by showing that changing the mechanical pattern can be improved about 4% by maximizing the vertical oscillation [2].

However, little is known about the variation of mechanical energy in running, and how the movement's efficiency would result from the division of the physiological by the mechanical parameters. If we determine which mechanical changes are influencing the fatigue, it is possible to develop techniques to improve movement's efficiency and minimize fatigue.

The aim of the study was to compare the average values of total, internal and external energy variations and peak value of the total energy in two running situations: with and without fatigue.

METHODS

We assessed 4 subjects, healthy runners, already accustomed to running on treadmills. A test was performed to determine the cardiopulmonary respiratory compensation point equivalent to the individual lactate threshold, which served to determine the test's speed and heart rate.

The running test consisted of a race at a constant rate (equivalent to 10% over the threshold velocity) held until exhaustion of the individual. The total time to exhaustion was recorded and fatigue parameter was determined by the scale of Borg exertion, and observing the change in the movement pattern.

Two cameras (60 Hz) were placed at a distance and height to allow the record of the individual running on a treadmill with the intention of keeping the hip of the individual at the center of the image. The recorded images were transferred to the computer using the Pinnacle card and the digitizing process was performed using the program Dvideow [3].

The calculations of all the variables involved in the calculation of mechanical energy were made using a program developed at the Institute of Biomechanics of Cologne. This program called "Energia" [4] processed data using primarily as input the anthropometric variables: weight and height, and the reconstructed three-dimensional coordinates of the marks placed at the subjects' joints, which are the output variables of the program "Dvideow."

The program is based in Zatsiorsky et al. (1987) [5] determining the total energy as obtained by the sum of the energy generated by the center of mass of the body with the energy generated by each body part, this formula is a variation of the equation presented by Winter (1979) [6] which divides the total energy in internal and external.

To compare the values of the mechanical energy in situations with and without fatigue, we used the paired t test with significance level of 0.05.

RESULTS AND DISCUSSION

The average values of variations, for total, internal and external energies can be seen in Table 1.

Table 1 - Average values of energy variations in the curves of external and internal energy (J).

	External	Internal
Without Fatigue	129,54 ± 40,69	22,42 ± 6,54
With Fatigue	121,40 ± 46,66	20,27 ± 12,24

By comparing the situations with and without fatigue, no significant differences were found between the energies. This can be explained by the fact that the running velocity has been maintained constant, what led to only little changes in the values

Regarding peak value of total energy, there was also no significant difference between conditions with and without fatigue (Table 2).

Table 2 - Mean values for peak value of total energy (J).

Without Fatigue	With Fatigue
1780,29±231,66	1791,67±234,39

The fact that we have not found significant differences considering the whole body may suggest that changes occur between the segments leading to the need of new tests to verify these possibilities.

CONCLUSIONS

It can be concluded that although there were no significant differences in mechanical energy in running with and without fatigue considering the whole body, further studies should be conducted to better understand how the process of energy transfers occurs between the segments when the fatigue occurs.

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