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ORIGINAL ARTICLE

# Physiological response during running in athletes with similar body mass but different body composition

## *Réponses physiologiques en course à pied chez des athlètes de même masse corporelle mais de composition corporelle différente*

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**KEYWORDS**
Oxygen uptake;
Body fat;
Lean body mass;
Running performance;
Ventilatory threshold;
Allometric scaling

**Summary**
*Objective*. — The aim of the paper was to evaluate the physiological response during running in athletes with similar body mass but different body composition.
*Material and methods*. — Thirty-three recreational athletes composed three study groups: control, increased body fat (HBF) and increased lean body mass (HLBM). The HBF and HLBM groups were similar in total body mass and the pattern of mass distribution within the body, but differed significantly in body composition. Maximal oxygen uptake and second ventilatory threshold were determined in an incremental test. Physiological response and running economy were evaluated during submaximal runs performed at four different speeds.
*Results*. — Absolute oxygen consumption during the run was similar in the HBF and HLBM groups, and at the same time, significantly greater than in the control group. Comparison of the groups showed similar running economy expressed as oxygen uptake relative to body mass, and as the

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amount of oxygen needed for running 1 km. Only the relativization of oxygen uptake to lean body mass showed significant intergroup differences. Work intensity during running was significantly larger in the HBF than in the control group. In the HLBM group, the physiological response during runs at lower speeds was similar to the control group. With an increase of running speed, running economy in the HLBM group became more similar to the running economy of the HBF group.
*Conclusions*. — Increased body mass resulting from high body fat adversely affects the running economy. In runs that exceed the second ventilatory threshold, physiological response is similar in participants with increased body mass, regardless of their body composition.


**MOTS CLÉS**
Consommation d'oxygène ;
Graisse corporelle ;
Masse maigre ;
Performance en cours d'exécution ;
Seuil ventilatoire ;
Échelle allométrique

**Résumé**
*Objectif*. — Le but de l'étude était d'évaluer la réponse physiologique pendant la course chez des athlètes avec la même masse corporelle, mais une composition corporelle différente.
*Matériels et méthodes*. — Trente-trois athlètes moyennement entraînés ont constitué trois groupes expérimentaux : un groupe témoins, un groupe avec pourcentage important de masse grasse (HBF) et un groupe avec un pourcentage important de masse maigre (HLBM). Les groupes de HBF et HLBM avaient des masses corporelles similaires, mais des distributions de masse grasse et maigre différentes. La consommation maximale d'oxygène et le deuxième seuil ventilatoire ont été déterminés dans un test incrémenté. La réponse physiologique et l'économie de course ont été évaluées au cours de courses submaximales effectuées à quatre vitesses différentes.
*Résultats*. — Les valeurs de consommation d'oxygène en valeur absolue étaient similaires dans les groupes HBF et HLBM, mais significativement plus élevées que dans le groupe de témoins. La comparaison des groupes a montré une économie de course similaire lorsqu'elle était exprimée par rapport à la masse corporelle. En revanche, l'expression de la consommation d'oxygène relativement à la masse maigre a révélé des différences significatives entre les groupes. Pour des vitesses faibles, la réponse physiologique du groupe HLBM était similaire à celle du groupe témoin, alors qu'avec l'augmentation de la vitesse elle se rapprochait de celle du groupe HBF. Au-delà du second seuil ventilatoire, la réponse physiologique est similaire chez les participants quelle que soit la composition corporelle.


## 1. Introduction

Running performance depends on maximal oxygen uptake ($VO_2$max), the ability to sustain a high percentage of $VO_2$max for an extended period of time without accumulating lactic acid, lactate threshold and running economy (RE) [1—3]. Running economy is defined as the energy demand for a given submaximal running speed, which is determined by measuring steady-state oxygen uptake and respiratory exchange ratios [3]. The decisive factor determining success in sports for two competitors with similar $VO_2$max levels may be running economy. More economical runners use less oxygen than less economical runners at the same steady-state speed or intensity [4]. Running economy is related to body dimensions [2], and the pattern of mass distribution in the body [3]. Previous studies were more focused on the influence of absolute body mass on running economy, describing studied participants as ''smaller subjects'' or ''larger or heavier individuals'' and indicate better economy for competitors with smaller body size and slim legs [2,5,6]. Aerobic demand is increased by 1% for every extra kilogram carried in the trunk [7].

The present study focuses not only on the influence of absolute body mass on RE but also the influence of body composition. Our assumption is that two subjects with similar body mass may significantly differ in body fat (%F) and lean body mass (LBM). A gain in body mass (BM) due to increased %F or LBM may affect running economy in different ways. In distance runners, excess body fat requires greater muscular effort to accelerate the legs and energy expenditure at the same running velocity is higher [8]. Our hypothesis is that apart from absolute body mass, body composition also impacts running economy. Therefore, physiological response during running in athletes with similar absolute body mass but different body composition may be different. Thus, we evaluated both the effects of increased %F and LBM on running economy. The aim of the study was to evaluate the physiological response to running at different speeds in subjects with similar BM but with significantly different body composition. Moreover, in this study, we also evaluated the effect of increased body mass (due to increased body fat or lean body mass) on the physiological response to running. Bergh et al. [9] indicated that oxygen consumption during running does not increase proportionally to body mass. To minimize the confounding effect of body mass in the comparison of individuals with different masses, allometric scaling was applied in this study. Applying the allometric scale allows physiological variables of a specific group to be analyzed while taking their characteristics into consideration [10]. These findings may be useful for coaches and runners in order to maximize running performance: the resultant data provides information which