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ORIGINAL ARTICLE

Modeling the influence of body mass on resistance exercise performance of non-athletes

Modélisation de l'influence de la masse corporelle sur les performances au cours d'exercices contre résistance de sujets non athlètes

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KEYWORDS
Muscle strength;
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Gender;
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Summary
Aim. — The purpose of this study was to verify the appropriateness of allometry to provide a size-independent index of resistance exercise performance of non-athletes and to compare men and women from absolute and allometric perspectives.
Materials and methods. — Twenty-five healthy individuals participated in the study: 11 men (22 ± 3 years; 69.91 ± 8.14 kg; 1.75 ± 0.09 m) and 14 women (22 ± 3 years; 55.92 ± 5.94 kg; 1.65 ± 0.09 m). They were evaluated using Bench Press and Leg Press 45° exercises. Log-linear regressions were established from natural logarithms of the values of body mass and muscle strength (weight lifted in kilograms), and regression diagnostics were performed to evaluate the suitability of the allometric model ($y = ax^b$).

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Results. — The results indicate that men were stronger in all exercises, even after scaling, but when the body mass effect was partitioned out allometrically, the difference of muscle strength between genders was reduced by 5% for superior limbs and 12% for inferior limbs. The problems associated with the residuals distribution observed in previous studies involving weightlifting athletes were not observed in this study, which indicates that allometry may be used with non-athletes. Thus, allometric modeling should be considered an adequate scaling method to compare the resistance exercise performance of groups when the specific training program's efficacy or different sports are taken into account.

MOTS CLÉS
Force musculaire ;
Exercice ;
Genre ;
Étude comparative

Résumé
Objectifs. — L'objectif de cette étude a été de vérifier l'adéquation de l'allométrie afin de fournir un indicateur de performance de l'exercice contre résistance indépendant de la masse corporelle de la personne chez les non athlètes et de comparer les valeurs absolues et relatives entre homme et femme.
Matériels et méthodes. — Vingt-cinq personnes saines ont participé à cette étude, 11 hommes (moyenne ± écart-type : 22 ± 3 années ; 69,91 ± 8,14 kg ; 1,75 ± 0,09 m) et 14 femmes (22 ± 3 années ; 55,92 ± 5,94 kg ; 1,65 ± 0,09 m). Elles ont été évaluées au cours de deux types d'exercices : le *Bench Press* et le *Leg Press* 45°. Les régressions log-linéaires ont été établies à partir des logarithmes naturels de la masse corporelle et de la force musculaire (poids soulevé en kilogramme). Les calculs de régressions ont été effectués pour évaluer la pertinence du modèle allométrique ($y = ax^b$).
Résultats. — Les résultats ont indiqué que les hommes étaient plus forts dans les deux conditions d'exercices, même après la mise à l'échelle. Cependant, en supprimant l'effet masse corporelle du modèle allométrique la différence de force musculaire de l'homme par rapport la femme a été réduite à 5 % pour les membres supérieurs et 12 % pour les membres inférieurs. Les problèmes liés à la distribution des résidus observés dans les études précédentes impliquant des athlètes d'haltérophilie n'ont pas été observés dans cette étude, ce qui suggère que l'allométrie peut être utilisée chez les non-sportifs. Ainsi, la modélisation allométrique peut être considérée comme une méthode de mise à l'échelle adéquate pour comparer les performances entre différents groupes selon le type d'entraînement ou de modalité sportive.

1. Introduction

Muscle strength (MS) is one of the most important variables affecting a person's life, manifesting in essential activities such as the act of rising from a chair and physical activities of leisure or sports. Therefore, the increase and maintenance of MS level is closely related to the promotion of good health and physical fitness, and its evaluation may be useful for the intervention of professionals of the health and human movement sciences.

In sports, injury prevention or rehabilitation, the performance on physical tests that involve MS is directly affected by the body dimensions. In absolute values, heavier and taller individuals are usually stronger than lighter and shorter ones, which may lead to erroneous conclusions when comparisons are made between individuals or groups. This in turn can affect the analysis of efficacy of different types of training or rehabilitation programs or of the fitness improvement in different sports, particularly when the main goal of the interventions is the gain in MS or power output [1,2].

One example of this can be seen in gender differences. Perhaps due to the fact that men usually have more muscle mass (MM) and more absolute MS [3], it is common to believe that women are weaker than men. This belief is sustained despite the MS per unit cross-sectional area of the muscle being similar between different individuals [4], with small or inexistent differences between genders [5,6]. In fact, in execution of motor tasks or tests that require significant MS production, female performance seems to be different than male performance, but this may be more strongly related to quantitative (total volume of MM) more than qualitative (contractile proprieties of the fibers) aspects [7,8]. Considering that accurate measurement of the cross-sectional area of the muscles is often expensive, usually being performed in research using computed tomography [5] or ultrasonic methods [6], scaling approaches with easier measurement variables have been utilized to adequately compare the MS of different individuals.

Even though other variables are also biologically correlated to MS [4—6,9], the influence of body mass (BM) has attracted the interest of researchers and professionals, mainly in the area of sports [2,10—20]. When the effect of BM or another variable correlated to MS is partitioned out through the use of adequate scaling, the MS values become relative and the difference between heavier and lighter people may be reduced or even disappear [2,19,20].