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REVIEW

The effect of exercise on skeletal muscle fibre type distribution in obesity: From cellular levels to clinical application

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Summary Skeletal muscles play important roles in metabolism, energy expenditure, physical strength, and locomotive activity. Skeletal muscle fibre types in the body are heterogeneous. They can be classified as oxidative types and glycolytic types with oxidative-type are fatigue-resistant and use oxidative metabolism, while fibres with glycolytic-type are fatigue-sensitive and prefer glycolytic metabolism. Several studies demonstrated that an obese condition with abnormal metabolic parameters has been negatively correlated with the distribution of oxidative-type skeletal muscle fibres, but positively associated with that of glycolytic-type muscle fibres. However, some studies demonstrated otherwise. In addition, several studies demonstrated that an exercise training programme caused the redistribution of oxidative-type skeletal muscle fibres in obesity. In contrast, some studies showed inconsistent findings. Therefore, the present review comprehensively summarizes and discusses those consistent and inconsistent findings from

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clinical studies, regarding the association among the distribution of skeletal muscle fibre types, obese condition, and exercise training programmes. Furthermore, the possible underlying mechanisms and clinical application of the alterations in muscle fibre type following obesity are presented and discussed.

Contents

Introduction

Skeletal muscle plays an important role in metabolism, energy expenditure, physical strength, and locomotive activity. Heterogeneity of skeletal muscle fibre types can be characterized by different criteria, including contractile property (e.g. slow- and fast-twitch types), myosin heavy chain (MyHC) structures (e.g. type 1, 2a, and 2x) and dominant metabolism of the fibre (oxidative type and glycolytic type) [1]. To determine skeletal muscle fibre type, the immunohistochemistry (IHC) of MyHC by using monoclonal antibodies specific to each myosin heavy chain has been used as the gold standard method for determining muscle fibre types [1]. Previous studies reported that skeletal muscles of the human consist of type 1, type 2a and type 2x fibres [2]. Although all types of skeletal muscle fibres are found in all skeletal muscles of the human body, the distribution of each type in each muscle is varied [3]. The distribution of skeletal muscle fibre type in each individual is influenced not only by genetics, but also by environmental factors [4]. In addition, the distribution of skeletal muscle fibre types has been shown to be a dynamic process, indicating that one type of fibre can be switched to another type following environmental factors. These factors include aging, hypothyroid stage, hyperthyroidism, hypo-gravitational environment as well as obese condition [5]. For example, the skeletal fibre type 2a can switch to either type 1 or type 2x depending upon the environmental changes [5]. These findings suggest that type 2a fibres have intermediate properties, leading to the phenomenon of hybrid fibres, such as type 1/2a and 2a/2x, found in skeletal muscles and represented in their transitional stage [6].

Each muscle in the body is composed of both types of fibre, but in different percentages [3]. For example, the soleus muscle is composed of nearly 90% of type 1 and type 2a fibres, the gastrocnemius is composed of nearly 50% of type 1 or 2a and 50% of type 2x fibre and the vastus lateralis and rectus femoris are composed of nearly 60% of type 2x fibre [7]. However, it has been shown that the percentage of type 1 fibre in one muscle can be used as a representative of the percentage of type 1 fibre in other muscles in the body since there are significant positive correlations among them, especially in cases with systemic conditions [8]. Therefore, a single site biopsy is frequently used to evaluate the percentage of the interested muscle fibre type and to monitor the tendency of the change of fibre type in whole body level [8].

The prevalence of overweight and obese conditions is dramatically increasing worldwide [9].

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