Strength training versus chest physical therapy on pulmonary functions in children with Down syndrome

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Abstract  Background: Children with Down syndrome clinically show a diminished activity limit at all ages due to muscle weakness and respiratory problems.

Purpose: To compare the effect of strength exercises to lower limb muscles and effect of chest physical therapy treatment program on pulmonary functions in Down syndrome children.

Methods: Thirty Down syndrome children of both sexes (24 boys and 6 girls) were selected from outpatient clinic of the National Research Center for motor disabilities in children at Cairo, Egypt. Children were selected to be ranged in age from 10 to 14 years and to be free from any innate heart deformities. They were randomly divided into two groups of equal numbers (group A and group B). Group (A) received chest physiotherapy, and group (B) received strength training program for hip, knee and ankle muscles by utilizing universal exercise unit 3 times/week for 12 weeks. Ergospirometry system was utilized to evaluate the pulmonary functions (forced vital capacity, forced expiratory volume in 1 s, maximum voluntary ventilation, and peak expiratory flow) that were measured before and after the proposed treatment period.

Results: Post treatment results of FVC and PEFR showed a statistically significant difference in each group while no significant difference was recorded between both groups. Post treatment results of FEV1 and MVV showed significant distinction between both groups in favor to group (A).

Conclusion: Strength exercises to lower limb muscles are not effective as chest physical therapy on improving pulmonary functions in children with Down syndrome.

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1. Introduction

Down syndrome (DS) is trisomy of chromosome 21 which is the most common trisomy among live births. DS is caused by the presence of an additional chromosome 21 in all cells of the body [1]. Overall growth of children with Down syndrome is relatively slow when they are compared to their peers,
as those children are floppy and poorly coordinated because of diminished muscle tone during childbirth (i.e., hypotonic) however it improves with age [2].

Down syndrome includes a combination of birth defects, mental retardation, characteristic facial features, heart imperfections, expanded infection, pulmonary problems, in addition to visual and auditory problems. Thus the severity of these problems varies greatly among those children [3]. Children with DS are at the risk of restrictive pulmonary disease with weak cough, concomitantly to a decrease in lung volume because of generalized trunk and extremity weakness [4]. Respiratory problems are a primary cause of morbidity and/or hospital admission particularly in young children with DS. There is an increased prevalence of sleep-related upper airway obstruction and lower airway disease [5]. A deficiency of the pulmonary system to oxygenate the mixed venous blood or remove the carbon dioxide from this blood may contribute to a high incidence of respiratory infections, reduced effectiveness of cough and diminished lung volume (i.e., vital capacity and total lung capacity) [4].

Pulmonary efficiency has been measured to be useful in assessing the presence and severity of both heart and lung diseases [6]. Spirometer is utilized to set up a baseline of lung functions, evaluate dyspnea, detect pulmonary disease, monitor the effects of therapies used to treat respiratory disease, evaluate respiratory impairment, evaluate operative risk, and perform surveillance for occupational related lung disease. It measures the mechanical function of the lung, chest wall, and respiratory muscles by surveying the aggregate volume of air exhaled from a full lung (total lung capacity) to an empty lung (residual volume) [7].

Children with DS usually suffer from overall muscle weakness, slow postural reactions, and response time, in addition to hyper flexible joints [8]. Adolescents with DS do not demonstrate the physiological increase in muscle strength as that typically occurs at 14 years of age [9], thus the preservation of muscle strength in DS child at a satisfactory level is necessary for the activities of daily life. The presence of hypotonicity, joint laxity, and decreased muscle strength will cause excessive wear and tear on the joints over time. Adults with DS develop early musculoskeletal changes, including patello-femoral instability, genu valgus, pes planus, and hip instability [10].

Children with DS are commonly more sedentary and less physically active, they are at increased danger of secondary health conditions, including type II diabetes, cardiovascular disease, and osteoporosis [11]. So strength especially to lower-extremity muscles in children with DS and individuals with mental retardation, has a central significance to their general health and daily activity performance ability [12]. Cardiovascular exercise programs and community programs to keep children physically active have been shown to improve peak oxygen consumption and maximum workload [13]. Intervention to improve strength and coordination and to decrease wear and tear on the weight-bearing joint structures should be implemented as preventive practice. Training includes endurance training which involves large group of muscles working at moderate intensity for a more extended period, and strength training which involves small group of muscles working for short period with three sets for eight repetitions. Strength training was shown to be equally as effective as endurance training on exercise capacity and health quality [14]. This study had been conducted to compare between the strength training to lower limb muscles and chest physical therapy on pulmonary functions in children with Down syndrome.

2. Subjects

A group of 30 children with Down syndrome from both sexes (24 boys and 6 girls) with a mean age 12.80 ± 1.32 years selected from National Institute for Research of Motor disability in children, Cairo University hospitals, participated in the current study. They were selected by taking after consideration criteria: they could walk independently, no history of congenital cardiopulmonary defects. The IQs level was more than 70 to be able to understand and follow instructions. The IQ level was determined by a psychologist on the Stanford-Binet Intelligence Scale [13]. That study had been carried out at Matariya teaching hospital after parents or care givers of each child signed a consent form that was approved by the Ethical Research Committee of the Faculty of Physical Therapy, Cairo University, Egypt. Selected children were randomly divided by sealed envelopes into group A and group B. Group A received chest physical therapy program. Group B received strength training to lower limb muscles (hips, knees, and ankles) using universal exercise unit.

3. Instruments and procedures

3.1. Zan-680 “Ergospirometry system”

Ergospirometry system was used to detect the pulmonary functions including forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1), maximum voluntary ventilation (MVV), and peak expiratory flow (PEF) [15]. Ergospirometry system was calibrated before operating procedure. Data including the child’s name, sex, age (year), height (cm) and weight (kg) were entered into the unit. The child was instructed to put the mouth piece of spirometry in his/her mouth, and breathe normally and inhale fully then exhale slowly as much as possible for vital capacity, inhale slowly and fully and exhale fully as much force as possible blasting out the air in the lungs for PEFR and FEV1 maneuver, inhale slowly and fully and exhale fully as much force fully as possible for 15 s for MVV. After each maneuver, the child was allowed to relax for five minutes.

3.2. Universal exercise unit (UEU)

It was utilized to increase muscle strength, by expanding dynamic and inactive scope of movement [16]. Before the strength training session, all children were requested to perform 10 min of low intensity aerobic exercise and stretching of hip, knee and ankle joint muscles.

The muscles of lower limbs that were fortified, included (1) hip flexors, extensors, abductors, and adductors, (2) knee flexors and extensors, and (3) ankle dorsi and planter flexors. The strength training exercise was done following the program of UEU illustrated in Table 1. Weight was increased by 0.5 kg once the child successfully completed 3 sets of 30 repetitions of isolated movement, with a 30-s rest between each exercise.
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