



ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2021; 7(8): 305-308
www.allresearchjournal.com
Received: 17-06-2021
Accepted: 21-07-2021

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Effect of lower extremity plyometric training on physiological cost index in overweight individuals after 4 weeks: An experimental study

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Abstract

Overweight is to weigh more than a standard weight for one's height and age. Excessive body fat reflects the association of a person's eating habits with his or her energy use and storage. BMI in overweight ranges between 25.0 - 29.9. Overweight are defined as abnormal or excessive fat accumulation that may impair health^[1].

Excess weight may increase the risk for many health problems, including, type 2 diabetes, high blood pressure, heart disease and strokes, certain types of cancer, sleep apnea, osteoarthritis, fatty liver disease, kidney disease, pregnancy problems, such as high blood sugar during pregnancy, high blood pressure, and increased risk for caesarean delivery (C- section). The prevalence of overweight in India is increasing faster than the world average. For instance, the prevalence of overweight increased from 8.4% to 15.5% among women between 1998 and 2015, and the prevalence of obesity increased from 2.2% to 5.1% over the same period. Physiological cost index is the measure of energy cost of walking. It uses heart rate to indicate the energy cost of walking. The measurement relies on the assumption that heart rate is linearly related to oxygen expenditure (vo₂) 3 items: resting heart rate, working heart rate, and walking speed. The PCI is an easy to use valid and reliable measure of energy expenditure and it is recommended as a useful tool for physiotherapist in the assessment and evaluation of functional performance. The relation of BMI and PCI was studied and, the underweight and normal BMI participants have PCI which was lower than the overweight individual. The speed of walking was decreased as BMI increased normal BMI participants have PCI which was lower than the overweight and obese individual. The speed of walking was decreased as BMI increased. Hence, it can be concluded that as BMI increases, the PCI increases which suggested poor economy. The energy expenditure was directly proportional to body weight. Plyometric training (PT) is a very popular form of physical conditioning of healthy individuals. Plyometrics is a training technique used to increase strength and explosiveness.

Conclusion: This study concluded 4 weeks of plyometrics training, decrease in PCI value.

Keywords: eating habits, excessive fat accumulation, high blood pressure, diabetes

Introduction

Overweight Individuals

To be "overweight" is to weigh more than a standard weight for one's height and age. Excessive body fat reflects the association of a person's eating habits with his or her energy use and storage. Overweight develop as energy intake exceeds energy expenditure over time^[1]. Overweight are defined as abnormal or excessive fat accumulation that may impair health^[1]. Excess weight may increase the risk for many health problems, including, type 2 diabetes, high blood pressure, heart disease and strokes, certain types of cancer, sleep apnea, osteoarthritis, fatty liver disease, kidney disease, pregnancy problems, such as high blood sugar during pregnancy, high blood pressure, and increased risk for caesarean delivery (C-section)^[7].

Raised BMI is a major risk factor for noncommunicable diseases such as

- Cardiovascular diseases (mainly heart disease and stroke), which were the leading cause of death in 2012.
- Diabetes.

- Musculoskeletal disorders (especially osteoarthritis – a highly disabling degenerative disease of the joints).
- Some cancers (including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon).

Adequate goal-setting is important in health counselling and treatment for overweight. Being overweight is associated with poorer functional status (e.g., overweight is given as the main reason for functional limitations by 13 per cent of people with such limitations) and with considerable pain, worry, and restricted activity because of this condition (e.g., 88 per cent of people who believe they are overweight worry at least a little about it). Only about 7 per cent of those who perceive they are overweight are under a doctor's care to lose weight. The lay overweight respondents viewed the problem of obesity arising from their personal shortcomings (i.e. motivational and physical), juxtaposed to blame-absolving accounts often involving specific challenges associated with day-to-day living. All respondents presented personal stories of complex battles of short-term weight loss and longer-term weight gain, usually characterised by a sense of failure.

Plyometric Training

Plyometric training (PT) is a very popular form of physical conditioning of healthy individuals.

Plyometrics is a training technique used to increase strength and explosiveness.

Plyometrics consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric or shortening action of the same muscle.

The eccentric pre-stretch phase has also been described as the readiness, pre-loading, pre-setting, preparatory, facilitatory, readiness, potentiation, counter-force, or counter-movement phase. The eccentric pre-stretch phase of a plyometric activity stretches the muscle spindle of the muscle-tendon unit and the non-contractile tissue within the muscle (series elastic components [SEC] and parallel elastic components [PEC]).

The term *amortization* has been developed to describe the time from the cessation of the eccentric pre-stretch to the onset of the concentric muscle action.

This phase is the key to the performance of plyometrics, because the shorter the amortization phase the more effective and powerful is the plyometric movement because the stored energy is used efficiently in the transition.

The concentric phase can also be referred to as the resultant power production performance phase. This phase has also been described as the facilitated or enhancement phase of plyometrics.

The stored elastic energy within the muscle is used to produce more force than can be provided by a concentric action alone. Researchers have shown that plyometric training when used with a periodized strength-training program can contribute to improvements in, leg strength, muscular power, increased joint awareness, and overall proprioception.

An important part of performance-based rehabilitation programs is the development of power often addressed by using plyometric exercises.

Because of this there is an increasing demand to progress performance as quickly as possible. Plyometrics may be incorporated as an integral component of an exercise program that can produce all the aforementioned outcomes.

The physiological cost index (PCI)

It uses heart rate to indicate the energy cost of walking. The measurement relies on the assumption that heart rate is linearly related to oxygen expenditure (vo_2) 3 items: resting heart rate, working heart rate, and walking speed.

The PCI is an easy to use valid and reliable measure of energy expenditure and it is recommended as a useful tool for physiotherapist in the assessment and evaluation of functional performance.

The 6-min walk test (6 MWT) is submaximal test which is an inexpensive, relatively quick, safe, and well-tolerated method of assessing the functional exercise capacity ^[4].

Body mass index

Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2).

The common interpretation is that it represents an index of an individual's fitness. It also is widely used as a risk factor for the development of or the prevalence of several health issues. The BMI has been useful in population-based studies by virtue of its wide acceptance in defining specific categories of body mass as a health issue.

Classification

For adults, WHO defines overweight and obesity as follows: Overweight is a BMI greater than or equal to 25; and obesity is a BMI greater than or equal to 30 ^[5].

Inclusion Criteria

- Overweight individuals. BMI ($\geq 25-30$).
- Adults who will continue throughout the study.
- Both male and female, between the age of 18-25.
- Adults who are willing to participate.

Exclusion Criteria

- Medical conditions (exercise induced asthma, cardio-respi conditions or neuro conditions).
- Medical conditions (exercise induced asthma, cardio-respi conditions or neuro conditions).
- Participants who do not give consent.
- Soft tissues injuries of upper or lower limb since last six months.
- Subjects participating in other activities and subjects who continue gym.
- Reduced calcium deficiency.
- Obese individuals.

Method

- Various participants were visited in and around the city.
- The subjects were selected on the basis of their inclusion and exclusion criteria.
- The subjects were explained about the study before starting the procedure. Consent was taken from the subjects who wish to participate in the study.
- Physiological cost index was taken on the subjects and the data will be recorded.
- The subjects underwent plyometric training, 3 times a week for 4 weeks.
- At the end of 4 weeks the subjects were re assessed using physiological cost index and the data was recorded again.

- Data analysis was done

Conclusion

- This study concludes that 4 weeks of lower extremity plyometric training is effective in improving the PCI values in overweight individuals.

Review of literature

1. Physiological cost index of different body mass index and age of an individual

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The energy expenditure is the amount of energy (or calories) that a person needs to carry out a physical function such as breathing, circulating blood, digesting food, or a physical movement. The method for estimating the energy cost using measurement of heart rate (HR) is the physiological cost index (PCI). Aims and Objective: The aim of this study is to measure and correlate the relationship of energy expenditure of a normal healthy individual with different body mass index (BMI) and age. Materials and Methods: A total of 115 participants (59 males and 56 females) were included in this study. Written consent form was obtained. Before exercise testing, each participant's was measured that BMI was the standard formula (kg/m^2). Each participant was given rest for 5 min and recorded resting HR. Participants were asked to walk on 30 m straight floor track for 6- min walk test (6 MWT) at the normal speed. Pre-and post-walked vitals were taken, and PCI was calculated by formula. Results: There is highly statistically significant relation with age and PCI ($P < 0.05$) as age (40.86 ± 15.56) increases, PCI (0.26 ± 0.11) value was increases. BMI (25.39 ± 4.56) increases, PCI value was increase and not much difference with BMI and distance covered by normal individual in 6 MWT, but adult age group was covered more distance than the older age group. Conclusion: The present study concluded that as the age and BMI increases the PCI increases, suggestive of more energy expenditure.

2. Management of overweight and obesity in adults

Behavioral Intervention for Long-Term Weight Loss and Maintenance Navigation. European Journal of Cardiovascular Nursing, Volume 5, Issue 2, 1 June 2006, Pages 102-114, <https://doi.org/10.1016/j.ejcnurse.2005.11.002>. Published: 01 June 2006 Article history Abstract. Background: The World Health Organization has identified obesity as a global epidemic. While weight loss is a considerable challenge, long-term maintenance of weight loss is an even greater problem. Aims: This review of the assessment and management of overweight and obesity in adults covers factors contributing to overweight and obesity, components of weight-loss management, and interventions and effects of behavioral treatment for long-term weight loss and maintenance. Methods: A thorough search of the medical and nursing literature recorded in the MEDLINE database from 1995 to 2003 was conducted by using the keywords "overweight", "obesity", and "behavioral therapy". Results: Obesity is a complex, multifaceted condition in which excessive body fat places a person at risk of multiple health problems. Excessive body fat results from energy intake that exceeds energy expenditure.

Conclusions: Increasing evidence suggests that obesity is not simply a problem of will power or self-control but a complex disorder involving appetite regulation and energy metabolism that is associated with a variety of comorbid conditions. Effective strategies of weight loss require management strategies in a combined approach of dietary therapy and physical activity by using behavioral interventions

3. Short-term high intensity plyometric training program improves strength, power and agility in male soccer players

Márk Váczi 1, József Tollár 2, Balázs Meszler 1, 2, Ivett Juhász 1, 2, and István Karsai

The aim of the present study was to investigate the effects of a short-term in-season plyometric training program on power, agility and knee extensor strength. Male soccer players from a third league team were assigned into an experimental and a control group. The experimental group, beside its regular soccer training sessions, performed a periodized plyometric training program for six weeks. The program included two training sessions per week, and maximal intensity unilateral and bilateral plyometric exercises (total of 40 – 100 foot contacts/session) were executed. controls participated only in the same soccer training routine, and did not perform plyometrics. Depth vertical jump height, agility (Illinois Agility Test, T Agility Test) and maximal voluntary isometric torque in knee extensors using Multicont II dynamometer were evaluated before and after the experiment. In the experimental group small but significant improvements were found in both agility tests, while depth jump height and isometric torque increments were greater. The control group did not improve in any of the measures. Results of the study indicate that plyometric training consisting of high impact unilateral and bilateral exercises induced remarkable improvements in lower extremity power and maximal knee extensor strength, and smaller improvements in soccer-specific agility. Therefore, it is concluded that short-term plyometric training should be incorporated in the in-season preparation of lower level players to improve specific performance in soccer.

4. Current concepts of plyometric exercise

George davies, pt, dpt, scs, atc, med, cscs, fapta, 1 bryan l. Riemann, phd, atc, fnata,1 and robert manske, pt, dpt, scs, atc, med, cscs ^[2,3].

As knowledge regarding rehabilitation science continues to increase, exercise programs following musculoskeletal athletic injury continue to evolve. Rehabilitation programs have drastically changed, especially in the terminal phases of rehabilitation, which include performance enhancement, development of power, and a safe return to activity. Plyometric exercise has become an integral component of late phase rehabilitation as the patient nears return to activity. Among the numerous types of available exercises, plyometrics assist in the development of power, a foundation from which the athlete can refine the skills of their sport. Therefore, the purpose of this clinical commentary is to provide an overview of plyometrics including: definition, phases, the physiological, mechanical and neurophysiological basis of plyometrics, and to describe clinical guidelines and contraindications for implementing plyometric programs.

5. More of the same? Conflicting perspectives of obesity causation and intervention amongst overweight people, health professionals and policy makers JoeGreenera FloraDouglasb Edwinvan Teijlingenbc

This paper presents the findings of a qualitative study conducted in the United Kingdom of the perceptions of overweight individuals, as well as health professionals and policy makers working in the area of obesity prevention and weight management. In 2006–2007, we conducted interviews with 34 men and women (18–50 years old) who self-identified as being overweight; 20 health professionals; and 9 policy makers. We explored their understandings of the causes of obesity/overweight; beliefs about factors that enabled or inhibited weight loss/gain; and opinions regarding effective obesity/overweight interventions. We found a range of views, which corresponded with biomedical and socio-ecological perspectives of health and disease.

The lay overweight respondents viewed the problem of obesity arising from their personal shortcomings (i.e. motivational and physical), juxtaposed to blame-absolving accounts often involving specific challenges associated with day-to-day living. All respondents presented personal stories of complex battles of short-term weight loss and longer-term weight gain, usually characterised by a sense of failure. All expressed a strong sense of personal responsibility to overcome their weight problems, and looked to another not-yet-tried, technocratic weight loss programme to address the problem, despite all reporting past failures.

Health professionals and policy makers on the other hand viewed obesity as a socio-ecologically determined problem, detailing social and environmental explanations. Health professionals were more inclined towards individual-orientated weight management interventions as effective responses. Policy makers considered environmental and social policy changes as most likely to make a substantial difference to current obesity trends, but considered it unlikely that such policies would be implemented without the political will and popular support. Our data highlight dissonance between policy maker, health professional and public obesity perceptions and points to a challenge for those who believe that wholesale systemic change is required if obesity trends are to be reduced or halted.

6. Effects of being overweight

A L Stewart, and R H Brook Published Online: October 07, 2011

Based on cross sectional data from a general population of 5,817 people aged 14 to 61, objective overweight is compared with perceived overweight, and information is provided on morbidity due to being overweight, and on what people are doing to try to lose weight. We found that 10 percent of this population are moderately overweight and 12 per cent are severely overweight (although 41 per cent perceive they are overweight). Being overweight is associated with poorer functional status (e.g., overweight is given as the main reason for functional limitations by 13 per cent of people with such limitations) and with considerable pain, worry, and restricted activity because of this condition (e.g., 88 per cent of people who believe they are overweight worry at least a little about it). Only about 7 per cent of those who perceive they are overweight are under a doctor's care to lose weight. If physicians wish to assume a larger

role in caring for overweight people, the nature of their role must be carefully evaluated.

7. Body mass index, obesity, BMI, and health: A critical review

The body mass index (BMI) is the metric currently in use for defining anthropometric height/weight characteristics in adults and for classifying (categorizing) them into groups. The common interpretation is that it represents an index of an individual's fatness. It also is widely used as a risk factor for the development of or the prevalence of several health issues. In addition, it is widely used in determining public health policies. The BMI has been useful in population-based studies by virtue of its wide acceptance in defining specific categories of body mass as a health issue. However, it is increasingly clear that BMI is a rather poor indicator of percent of body fat. Importantly, the BMI also does not capture information on the mass of fat in different body sites. The latter is related not only to untoward health issues but to social issues as well. Lastly, current evidence indicates there is a wide range of BMIs over which mortality risk is modest, and this is age related. All of these issues are discussed in this brief review.

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