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Effect of Exercises on Energy Expenditure after Lower Limb Amputation - An Evidence Based Study

Krupa Prabhakar[1], Dr. Anjali Bhise[2]

[1]Ph.D. Scholar, Gujarat University, Tutor/Physiotherapist, Civil Hospital, Asarwa, Ahmedabad, India

[2]Ph.D. Guide, Gujarat University, Principal Chief Physiotherapist, U. N. Mehta institute of cardiology and research centre, Ahmedabad, India

Abstract: ***Introduction: Amputation is the surgical removal of an external part of the body, most often a limb or part of it, as a form of treatment with aim to save the patient's life and/or reduce debility. Oxygen consumption (VO_2max) and Physiological cost index (PCI) are measures for energy expenditure. Compared to normal ambulation, the energy costs for amputees are much higher. Cardio respiratory endurance of amputees was clearly lower than that of able-bodied individuals. Methods: Published articles from 2005 to 2020 were identified using electronic database in PEDro, PubMed, Cochoran library and ScienceDirect and selected according to the inclusion and exclusion criteria. Procedure: Articles showing effect of prosthetic changes on energy expenditure were excluded. The study design, participant information, description of interventions and outcome measures were extracted. Result: Evidences were systematically reviewed and analyzed. 4 out of 5 studies confirmed that effect of exercises were statistically significant in improving energy expenditure. 1 out of 5 studies showed that effect of exercises for changing biomechanics of walking was not statistically significant in improving energy expenditure instead increases cost of walking. Conclusion: Based on evidences exercises are effective in reducing energy expenditure of amputees if biomechanics of walking is not changed.***

Keywords: energy expenditure, lower limb amputation, exercises.

1. Introduction

Amputation is the surgical removal of a part of the body as a form of treatment, most often a limb or part of it[1] with the aim to save the patient's life and/or reduce debility. There are various condition in which amputation is required like, when a limb is severely crushed, dead due to impaired blood circulation(vascular diseases), infection (gangrene), burns, frostbite and to prevent the growth of bone cancer[1]. Amputation requires not only rehabilitation, but also prosthetic creation, management and maintenance[2].

The energy costs for amputees are much higher than normal individuals. The energy required for ambulation in lower extremity amputees are as follows: unilateral trans-tibial amputation 40–60%, unilateral trans-femoral amputation 90 to 120%, bilateral trans-tibial amputation 60–100% and bilateral trans-femoral amputation >200% above the normal and this energy demand becomes even higher if additional significant co morbidities exist[3]. Energy expenditure can be measured by different measures like: oxygen consumption (VO_2max), Physiological cost index (PCI) and metabolic cost. Compared to normal ambulation, the energy costs for amputees are much higher.

Cardio respiratory endurance of amputees was clearly lower than that of able-bodied individuals. Evidence supports the inverse relationship between exercises and cardiovascular disease and its risk factors[4]. Along with it exercises lowers incidence rate of stroke, type 2 diabetes mellitus, osteoporotic fractures, anxiety and depression[4]. So this study is done to evaluate the effect of exercises even after long duration of amputation on energy expenditure.

2. Methodology

Published articles from 2005 to 2021 were identified using electronic database PEDro, PubMed, Cochoran library and Science Direct.

Articles were selected according to the following criterias

Inclusion criteria

- Energy expenditure as one of the outcome measure
- Published during 2005 to 2021
- Any exercise as an intervention

Exclusion criteria

- Articles published in other than English language
- Full article not available

3. Procedure

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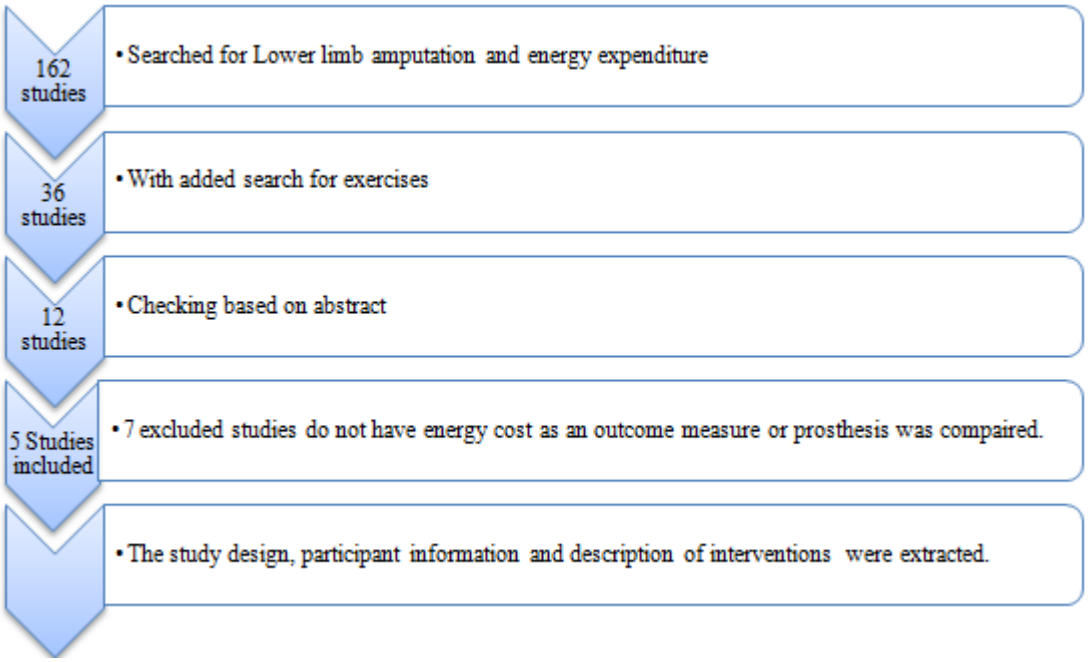

Chart 1: Search Strategy

Selected articles were evaluated according to checklist for statistical review of general paper.[5]

Table 1: Data from the Studies

Title	N	Score	Study Design	Intervention	Duration	Conclusion
Gait training using the Honda Walking Assist Device for individuals with transfemoral Amputation[6]	2	7/ 11	Case Study	Gait training using Honda walking assistive device	1 week For 20 minutes	In both patients, walking speed, step length, and cadence increased after the intevention.
The Effect of Body Weight Support on Energy Expenditure in an Individual With High-Level Lower Extremity Amputation[7]	1	8/ 11	Case study	Treadmill walking with incremental speed at every 3 min interval starting from 0.5 mph up to 2.0 mph	-	Oxygen uptake efficiency improved under BWS condition.
Behavior-change intervention targeting physical function, walking, and disability after dysvascular amputation [8]	19 in each group	10/ 11	A randomized controlled trial (pilot study)	home exercise, walking activity, and disease self-management		Physical function shows improvement after the intervention (p=.001)
Home-Based Treadmill Training to Improve Gait Performance in Persons With a Chronic Transfemoral Amputation [9]	8 in each group	10/ 11	Experimental study	Home-based treadmill walking	30 min for 3 days/ week for 8 weeks	Effective method to improve gait performance in persons with TFA (EE p<.01)
Can real-time visual feedback during gait retraining reduce metabolic demand for individuals with transtibial amputation? [10]	8	9/ 11	Experimental study	real-time visual feedback were provided during gait retraining to reduce center of mass sway and thigh muscle activation magnitudes and duration		Attempts to modify gait to decrease metabolic demand may actually adversely increase the physiological effort of walking in individuals with lower extremity amputation

4. Results

- 4 out of 5 studies confirmed that effect of exercises were statistically significant in improving energy expenditure.
- 1 out of 5 studies showed that exercises which causes changes in biomechanics of the gait increases energy expenditure instead of reducing it.

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5. Conclusion

- These articles conclude that patients are having difficulty in ADL even after completion of rehabilitation protocol.
- Based on evidences, exercises are effective in reducing energy expenditure of amputees if biomechanics of walking is not changed.

6. Clinical Implication

- Training programs for lower limb amputees only cover walking training with prosthesis and ambulatory aids, maximal aerobic capacity does not improve to the level. Therefore, prosthetic and ambulatory aid training should accompany some kind of endurance exercise training with the aim of improving fitness of amputees.
- As fewer evidences are available, more studies can be done to see the effect of different exercises on energy expenditure and thus can be incorporated in the rehabilitation protocol.

7. Limitations

As only 5 studies were found during 2005 to 2021 period.

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