Original Article

Effect of Structured Cardio-Respiratory Fitness Protocol on Physical Function and Performance in Geriatric Patients: A Quasi Experimental Study

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Abstract

Background: Exercise interventions have emerged as a promising avenue for mitigating age-related declines, particularly in the context of physiological changes such as sarcopenia and muscle strength loss. A recent study utilizing the International Classification of Functioning, Disability, and Health (ICF) framework underscored declines in physical functioning among older adults. Geriatric individuals commonly undergo cardio-respiratory changes and experience a decrease in physical fitness. This study seeks to compare the effects of a structured cardio-respiratory fitness protocol with a conventional exercise program on physical function and performance in geriatric patients, with a specific focus on the impact of cardio-respiratory fitness on overall physical function.

Methods: Employing a quasi-experimental pre-test post-test design spanning six months, two groups of participants aged 50 to 70, encompassing both genders and with a BMI between 20 and 30, was included. The experimental group adhered to the structured cardio-respiratory fitness protocol, while the control group received conventional physiotherapy. Measured parameters included heart rate (HR), respiratory rate (RR), peak expiratory flow rate (PEFR), and Borg scale ratings. Pre and post-treatment data underwent statistical analysis.

Results: Both groups demonstrated improvements in HR, RR, PEFR, and Borg scale ratings post-intervention. Notably, the experimental group exhibited significantly greater improvements in these parameters compared to the control group ($p < 0.05$).

Conclusion: The structured cardio-respiratory fitness protocol yielded a significant enhancement in physical function and performance among geriatric patients. Recommendations for future research involve incorporating larger sample sizes, extended intervention durations, and personalized approaches to maximize effectiveness. This study contributes valuable insights into the potential benefits of structured cardio-respiratory fitness interventions for augmenting geriatric physical function and overall quality of life.

Keywords: Structured Cardiorespiratory Fitness Protocol, Physical Function, Geriatric Patients

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Introduction

The ageing population is a growing global concern; with an increasing number of individuals facing age-related declines in physical function and performance.[1] Maintaining or improving physical function is crucial for enhancing the quality of life and independence among geriatric patients. Exercise interventions have been widely recognized as a promising approach to mitigate age-related declines and improve overall health outcomes in this population.[2]A consequence of aging is degeneration in many physiological variables, with the most import being sarcopenia and subsequent loss of muscle strength. [2]

A recent study examining one-year changes in the physical functioning of older adults using the International classification of functioning, Disability and Health (ICF) framework suggested a significant decreased in muscle strength (both hip abductors & knee extensor) walking capacity, speed, mobility, sit-to-stand performance, upper extremity function and balance performance at the end of one year. Although there were no significant changes in the level of participation in activities of daily living.[3]

Aging is associated with decrease lung function and respiratory muscle strength during at a rate of 8% to 15% per decade of life after 50 years of age.[4,5] The deficit in respiratory muscle strength affects physical performance leading to diminish in exercise tolerance, deterioration of gait, and decrease of quality of life with advancing age.[6] The reduction of respiratory muscle function in the elderly thus makes this population vulnerable to disease and disability.[7]This reduction associated with aging occur after 50 years of age and can interfere with coughing efficiency.[8]

Geriatric population shows various cardio-respiratory changes like Degeneration of heart muscle, Decreased heart rate, Decreased myocardial contractility, Increased cardiac output during maximum exercise for cardiac system whereas Decreased total lung capacity & Increased residual volume, Decreased Forced Expiratory Volume. [FEV1], Decreased ciliary action to clear secretion, Decreased strength of respiratory muscle, Chest wall becomes rigid results in increased work of breathing for the respiratory system.[9] Cardio respiratory fitness[11], Physical fitness[12]and physiological components are considered to be more affected in geriatric patients.[10] Skilled components include agility, balance, co-ordination, speed, power and reaction time. Health components include cardio-respiratory endurance, muscular endurance, muscular strength, body composition & flexibility are the other factors that also affect this population.[11,12]

The conventional exercise program, which is commonly used in clinical setting, involves a more generalized approach to physical fitness training.[13]this program typically includes a combination of aerobic exercises, resistance training, and flexibility exercises without a specific focus on cardio-respiratory firness.[14] Previous researchers have stated that exercise can also help to reduce risk of many non-communicable diseases. Exercise has been shown to reduce the risk of coronary heart disease, stroke, certain types of cancers and diabetes, prevent post-menopausal osteoporosis and therefore reduce the risk of osteoporotic fractures, reduce the complications of immobility, reduce the risk of falls, improve mental/cognitive function, reduces stress/ anxiety and improve self- confidence.[15] An aerobic capacity is declined with combined effect of lowered maximum target heart rate, reduced myocardial contraction and consequently stroke volume, in addition to reduce maximum oxygen consumption.[16] An average respiratory rate for geriatric population is 12-28 breath/min.[17]

The optimal exercise protocols for maximizing physical function and performance in geriatric patients are still being explored.[18] Traditional exercise programs typically focus on general fitness training without specific attention to cardio-respiratory fitness, which plays a crucial role in overall physical function. In contrast, structured cardio-respiratory fitness protocols emphasize the development of cardiovascular strength specific to geriatric patient's need. To address this gap, the present study aims to find out the effect of a structured cardio-respiratory fitness protocol by comparing it with a conventional exercise program on physical function and performance in geriatric patients. After investigating the outcomes of these exercise interventions, this study aims to provide evidence-

based recommendations to enhance the effectiveness of exercise programs for this population.

Methodology

The study design employed in this research is a quasi experimental study, specifically a pre-test post-test design with two groups. The study was conducted at Santosh college of physiotherapy in the outpatient department. Duration of the study was 6 months and a convenient sampling was used to select participants consisted of individuals residing in and around the Madurai district. A total of 60 based on G power test for sample size calculations, participants were selected in the study based on the inclusion criteria of age group 50 to 70 years both male and female with the BMI between 20 to 30, also those who have not undergone any cardiac surgery and who can walk at least with the stick. Whereas the patients with severe musculoskeletal, neurological, cardiovascular, psychological as well as who have received physiotherapy treatment in the last 6 months for improving lung function and those who were not willing to participate were excluded.

Later the nature of the study and interventions were explained to the subjects, and a written consent was obtained from those willing to participate. Pre-treatment outcome measures of physical function and performance, including variables such as respiratory rate, heart rate, systolic blood pressure, Borg scale and PEFR were recorded. The participants were allocated in two groups, Group A and Group B. Group A received the baseline treatment (conventional physiotherapy), while Group B received the structured cardio-respiratory fitness protocol. After 6 weeks, post-treatment assessments for physical function and performances were conducted using assessment tools, including respiratory and heart rate, systolic blood pressure, PEFR and Borg scale. Further both the pre and post treatment scores were used for statistical analysis.

Data Analysis:

For the analysis SPSS version 23.0 was used. Analysis was done by descriptive statistics. The Shapiro Wilk test was used for checking normality distribution of data. The data were normally distributed; demographic information was expressed in terms of mean ± standard deviation. Students paired sample t test was used for within group analysis for pre and post interventions in respective control and experimental groups, whereas independent t-test was used for compare the 2 groups. $P<0.05$ with 95% confidence interval was considered as significant.

Results

Table 1: Comparison of pre and post values of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), and Rate of Perceived Exertion in Borg Scale in Control Group subjects.

No of Subjects	Values	HR		RR		PEFR		RPE in Borg Scale	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
30	Mean	76.4	82.3	9.9	12.2	339.1	426.7	6.1	3.6
	SD	7.16	1.34	2.32	1.51	802.32	2108.46	0.77	0.27
	T value	-6.4		3.71		-5.13		7.78	
	P value	0.00001		0.000793		0.000035		0.00001	

$P<0.05^{s***}$

This table shows that the mean, standard deviation, t value and p value of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale in Control Group after the intervention of conventional physiotherapy guided by physiotherapists. There is statistically significant increase in Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale after intervention of conventional physiotherapy in control group $p<0.05$***.

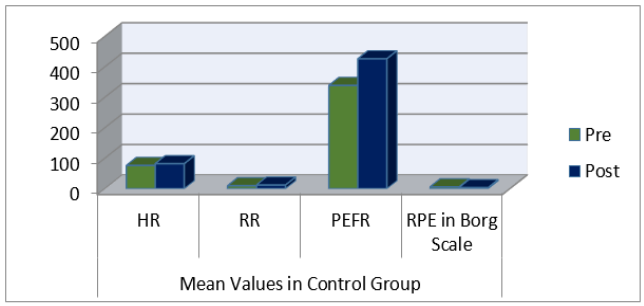

Fig 1: Pre and Post Mean Values of Parameters in Control Group

Table 2: Comparison of pre and post values of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), and Rate of Perceived Exertion in Borg Scale in Experimental Group subjects.

No of Subjects	Values	HR		RR		PEFR		RPE in Borg Scale	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
30	Mean	74.8	85.5	10.4	16.3	379.9	480.3	6.5	2.5
	SD	8.18	3.39	0.93	0.9	2555.21	1214.46	0.28	0.28
	T value	-9.95		-13.78		-5.17		16.97	
	P value	0.00001		0.00001		0.000032		0.00001	

$P<0.05^{s***}$

This table shows that the mean, standard deviation, t value and p value of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale in Experimental Group after the intervention of Structure Cardio Respiratory Fitness Protocol guided by physiotherapists. There is statistically significant increase in Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale after intervention of Structure Cardio Respiratory Fitness Protocol guided by physiotherapists in Experimental Group with p<0.05***.

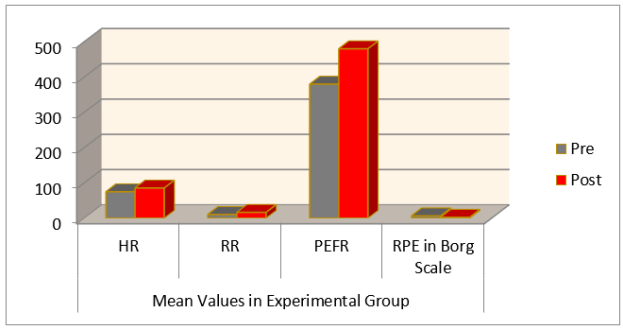

Fig 2: Pre and Post Mean Values of Parameters in Control Group

Table 3: Comparison of pre values of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), and Rate of Perceived Exertion in Borg Scale between Control and Experimental Group to check homogeneity among groups.

No of Subjects	Values	HR		RR		PEFR		RPE in Borg Scale	
60	Group	Con	Exp	Con	Exp	Con	Exp	Con	Exp
	Pre Mean	76.4	74.8	9.9	10.4	339.1	379.9	6.1	6.5
	SD	7.16	8.18	2.32	0.93	802.32	2555.21	0.77	0.28
	T value	1.292		0.8763		-2.2269		-1.23771	
	P Value	0.10633		0.1962		0.019		0.115864	

$P>0.05^{Ns}$

This table shows that the pre mean, standard deviation, t value and p value of Heart Rate (HR), Respiratory Rate (RR), Systolic Blood Pressure (SBP), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale between Control and Experimental Group before intervention. There is no statistically significant difference Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR)*** (Homogeneity is not maintained), Rate of Perceived exertion in Borg scale before intervention of conventional physiotherapy in control group $p>0.05^{NS}$. Thus homogeneity of values maintained between groups which is important prerequisite for experimental study.

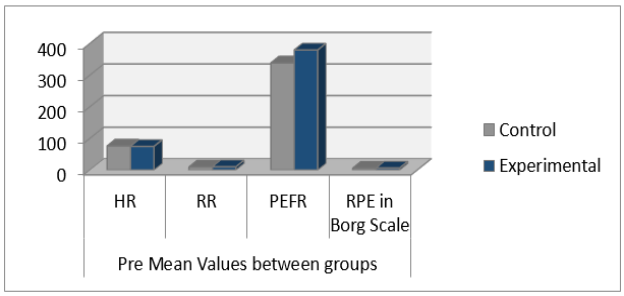

Fig 3: Pre-Mean Values of Parameters between Control and Experimental Group

Table 4: Comparison of post values of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), and Rate of Perceived Exertion in Borg Scale between Control and Experimental Group to check significance between groups.

No of Subjects	Values	HR		RR		PEFR		RPE in Borg Scale	
60	Group	Con	Exp	Con	Exp	Con	Exp	Con	Exp
	Post Mean	82.3	85.5	12.2	16.3	426.7	480.3	3.6	2.5
	SD	1.34	3.39	1.51	0.9	2108.46	1214.6	0.27	0.28
	T value	-4.65122		-8.34978		-2.94039		4.71429	
	P Value	0.000099		0.00001		0.004373		0.000086	

$P<0.05^{***}$

This table shows that the post values of mean, standard deviation, t value and p value of Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale in Experimental Group after the intervention of Structure Cardio Respiratory Fitness Protocol guided by physiotherapists. There is statistically significant increase in Heart Rate (HR), Respiratory Rate (RR), Peak Expiratory Flow Rate (PEFR), Rate of Perceived exertion in Borg scale after intervention of Structure Cardio Respiratory Fitness Protocol guided by physiotherapists in Experimental Group when compared to control group post values with $p<0.05^{***}$.

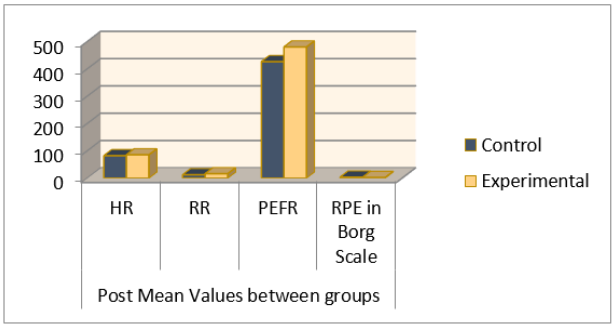

Fig 4: Post Mean Values of Parameters between Control and Experimental Group

Discussion

The findings of this study demonstrate a significant improvement in various variables before and after the intervention in both the control and experimental groups (refer to Table 1 and Table 2). The pre-intervention values of heart rate (HR), respiratory rate (RR), peak expiratory flow rate, and rate of Perceived exertion in Borg's scale were similar between the control and experimental groups, indicating homogeneity (refer to Table 3). However, the post-intervention Mean values of HR, RR, peak expiratory flow rate, and Borg scale in the experimental group showed statistically significant improvement compared to the control group, with p-values less than 0.05 (refer to Table 4). Therefore, the null hypothesis has been rejected, and the alternative hypothesis has been accepted in this study. These improvements in the variables suggest that the structured cardiorespiratory fitness protocol training provided to the geriatric subjects during the study intervention period contributed o enhanced physical function and performance.

In the geriatric population, cardiorespiratory changes such as decreased lung function, lung capacity, and strength of respiratory muscles can adversely affect normal physical function. However, when cardiorespiratory fitness improves, it directly enhances physical function among geriatric patients. This study aligns with the research work conducted by Sarawut J. et al., which highlights the effects of pursed-lip breathing exercise using a windmill on lung function and respiratory muscle strength in the elderly. Ageing leads to a decline in lung function and a reduction in respiratory muscle strength.[19]

Another study by Jin-Seop Kim et al. investigated the impact of balloon blowing exercise on lung function in young adult smokers. The study aimed to determine the lung capacity improvements when using a balloon blowing exercise to enhance patients' ling function. Same concept was used in the current study which showed the balloon blowing exercise was found to improve physical functions in geriatric patients. Recent study reinforces the notion that the geriatric population experiences reduced physical function and performance due to the aging process. However, administering a structured cardiorespiratory fitness protocol can significantly improve these factors among geriatric individuals.[20]

This study had several limitations that need to be considered. Firstly, the sample size was less. Additionally, the study suffered from limited supervision, potentially affecting the quality and effectiveness of the treatment. Another constrain was the smaller number of sessions. Finally, the program focuses exclusively on geriatric patients, which excludes other age groups who may also benefit from the treatment. These limitations highlight the need for further considerations and potential modifications to enhance he inclusivity and effectiveness of the program.

Conclusion

It is concluded that the structured cardio-respiratory fitness protocol training has a statistically significant improvement on physical function and performance in the geriatric population, and the structured cardio-respiratory fitness protocol has a statistically significant improvement in heart rate (HR), respiratory rate (RR), peak expiratory flow rate (PEFR), and the Borg-RPE scale, which reflect physical function and performance in geriatric patients.

Several recommendations and suggestions can be considered such as increasing the sample size, extending the intervention sessions, applying treatment with greater precision and tailored approaches can enhance its effectiveness and address individual needs more effectively. Follow up can be implemented in order to enhance the inclusivity, effectiveness, and long-term outcomes of the treatment program.

CrediT AUTHORSHIP CONTRIBUTION STATEMENT:

Author a: Conceptualization, Formal Analysis, Methodology, Writing – Original Draft, Project Administration.

Author b: Conceptualization, Investigation, Writing – Original Draft, Writing – Review and Editing, Investigation, Project Supervision.

Author c: Formal Analysis, Data Collection, Methodology, Investigation.

Author d: Formal Analysis, Data Collection, Methodology, Investigation.

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