Original Article

# Effectiveness of Adding Expiratory Muscle Strengthening Exercise to "Senam Lansia" on Cardiorespiratory Fitness of Pre-Frail Elderly

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***Abstract***

***Introduction:*** *The aging process will cause anatomical and physiological changes in various organs and the body systems, including changes in the cardiovascular, respiratory, and musculoskeletal systems which then progressively reduce cardiovascular and pulmonary functional capacity, ultimately affecting cardiorespiratory fitness, which can be assessed by a 6-minute walk test/6MWT. Aerobic exercise, including senam lansia, will affect cardiorespiratory fitness by increasing muscles blood flow. Adding expiratory muscle strengthening exercises with a Positive Expiratory Pressure/PEP threshold will strengthen expiratory muscles, the most common muscles affected in aging. This study aims to prove the effectiveness of adding expiratory muscle-strengthening exercises to senam lansia on the cardiorespiratory fitness of the pre-frail elderly.*
***Method:*** *24 subjects who met the study criteria were randomly divided into an intervention group (n=12) who receive PEP 5 times per week + senam lansia 3 times per week for 6 weeks, and a control group (n=12) who only had senam lansia 3 times per week for 6 weeks. Cardiorespiratory fitness was measured before and after intervention using the 6MWT.*
***Result:*** *There was an increase in 6MWT scores before and after treatment in both the intervention group ($p=0.002$) and the control group ($p<0.001$). Comparison between groups showed a significant 6MWT score difference in the intervention group ($p<0.001$).*
***Conclusion:*** *The addition of expiratory muscle strengthening exercises to senam lansia for 6 weeks had a better improvement in cardiorespiratory fitness compared to only having senam lansia.*

***Keyword:*** *Pre-frail, Senam lansia, Positive Expiratory Pressure (PEP), Cardiorespiratory fitness*

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# *Efektivitas Penambahan Latihan Penguatan Otot Ekspirasi pada Senam Lansia terhadap Kebugaran Kardiorespirasi Lansia Pre-Frail*

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***Abstrak***

***Pendahuluan:*** *Proses penuaan akan menyebabkan perubahan anatomi dan fisiologis pada berbagai organ dan sistem tubuh, termasuk perubahan pada sistem kardiovaskular, pernapasan, dan muskuloskeletal yang kemudian secara progresif mengurangi kapasitas fungsional kardiovaskular dan paru, yang akhirnya memengaruhi kebugaran kardiorespirasi, yang dapat dinilai dengan tes jalan 6 menit/6MWT. Latihan aerobik, termasuk senam lansia, akan memengaruhi kebugaran kardiorespirasi dengan meningkatkan aliran darah otot. Menambahkan latihan penguatan otot ekspirasi dengan ambang Positive Expiratory Pressure/PEP akan memperkuat otot ekspirasi, otot yang paling umum terpengaruh pada penuaan. Penelitian ini bertujuan untuk membuktikan efektivitas penambahan latihan penguatan otot ekspirasi pada senam lansia terhadap kebugaran kardiorespirasi lansia pre-frail.*
***Metode:*** *24 subjek yang memenuhi kriteria penelitian dibagi secara acak menjadi kelompok intervensi (n=12) yang menerima PEP 5 kali per minggu + senam lansia 3 kali per minggu selama 6 minggu, dan kelompok kontrol (n=12) yang hanya melakukan senam lansia 3 kali per minggu selama 6 minggu. Kebugaran kardiorespirasi diukur sebelum dan sesudah intervensi menggunakan 6MWT.*
***Hasil:*** *Terdapat peningkatan skor 6MWT sebelum dan sesudah perlakuan pada kelompok intervensi (p=0,002) dan kelompok kontrol (p<0,001). Perbandingan antar kelompok menunjukkan perbedaan skor 6MWT yang signifikan pada kelompok intervensi (p<0,001).*
***Kesimpulan:*** *Penambahan latihan penguatan otot ekspirasi pada senam lansia selama 6 minggu memberikan peningkatan kebugaran kardiorespirasi yang lebih baik dibandingkan dengan hanya melakukan senam lansia.*

***Kata Kunci:*** *Pre-frail, Senam lansia, Positive Expiratory Pressure (PEP), Cardiorespiratory fitness.*

## Introduction

According to data from "Badan Pusat Statistik" (BPS) in 2021, there are 29.3 million elderly people in Indonesia or it is equivalent with 10.82 percent of the total population.[1] The increase in the number of elderly people is a challenge for the country due to its demand for adequate costs. On the other hand, the elderly have many potentials if they are healthy, independent, active and productive.The aging process is a natural process that runs continuously, and has an impact on decreasing the function of various organs and body systems thus various health problems arise in the elderly, including frailty.[2,3] Frailty is a dynamic process, where previously the elderly will experience predisposing conditions, namely pre-frail. Early detection by finding pre-frail status in the elderly can be an opportunity to provide effective management. Intervention by providing a multi-component programs will be able to prevent an elderly person from falling from a pre-frail condition to frailty.[3,4]

The aging process results in a decrease in cardiovascular and lung functional capacity which can affect cardiorespiratory fitness.[1,2] One indicator of cardiorespiratory fitness is the results of the 6 minutes walk test, a test

that can be used to estimate cardiorespiratory fitness. [5,6]

Physical exercise is an effort to slow down the declining process of physical fitness. One of the exercises for the elderly is low impact aerobic exercise. In general, aerobic exercise will have an effect on cardiorespiratory fitness by increasing blood flow to the muscles.[2,6,7] Several previous studies stated that in the aging process, expiratory muscles are more affected than inspiratory muscles. Previous studies also showed the effect of strengthening expiratory muscles on cardiorespiratory fitness.[8,9] Knowing that there is no research which can explain the effectiveness of adding expiratory muscle strengthening exercises to senam lansia on the cardiorespiratory fitness of pre-frail elderly in Indonesia, the researchers were interested in carrying out a design research on the effectiveness of adding expiratory muscle strengthening exercises to senam lansia on the cardiorespiratory fitness of the prefrail elderly population.

## Method

The research was carried out after obtaining ethical clearance from the Ethics Commission of Dr. Kariadi General Hospital Semarang with number 1366/EC/KEPK-RS-DK/2022.This study was a parallel randomized controlled trial. This research was conducted at Wisma Wredha Rindang Asih I and II in February – March 2023. Subjects were then randomly randomized, and divided into two groups, namely the treatment group and the control group, where the number of subjects in the control group was 12 people and in the treatment group there were 12 people. The samples were then selected based on inclusion and exclusion criteria, the inclusion criteria were; age ≥ 60 years; Pre-frail elderly; MOCA-Ina ≥ 26; Can understand commands; Can walk without tools; Geriatric Depression Scale score ≤ 5; Cooperative and willing to participate in research by signing informed consent. Meanwhile, the exclusion criteria are; Having concomitant diseases (angina pectoris, myocardial infarction, uncontrolled diabetes mellitus, pulmonary disease, stroke, parkinsonism, osteoarthritis of the knee or hip grade III-IV); Having a history of malignant hypertension (blood pressure ≥ 180/120 mmHg); Having acute sinusitis or epistaxis, disease of the tympanic membrane or inner ear structures; Having a leg length difference of > 2 inches; Fear of falling (fall efficacy scale > 70). The sampling method was carried out using the consecutive sampling method. Every elderly person who met the research criteria was included in the next study. Based on sample size calculations. The minimum number of research subjects in one group is 10 people; To anticipate the possibility of dropping out, 2 research subjects were added, so that the total number of research subjects was 12 people for each group. Treatment group participants performed expiratory muscle strengthening exercises with PEP Threshold Phillips, 5 times per week for 6 weeks, 3 sets of 10 repetitions, with an initial intensity of 60% MEP (30 RM), and the intensity would be increased if participants felt comfortable for 2 weeks and do senam lansia 3 times a week for 6 weeks. Meanwhile, the control group did senam lansia 3 times a week for 6 weeks.

All data is processed with the help of a computer using SPSS® software. Significance in this study is obtained if a p value <0.05 is obtained with a 95% confidence interval.

## Result

The study began with informed consent, and initial assessment of cardiorespiratory fitness was performed with a 6-minutes walk test. The intervention began on February 13, 2023 and ended on March 25, 2023. Characteristics data showed that research subjects had positive frailty phenotype components for physical activity (100%), hand grip strength (91.6%), and walking speed (8.3 %). All re-

**Table 1. Comparison of the Control and Treatment Groups Seen from the Results of the 6 Minute Walk Test**

| 6-minute walk test | Group | | p |
|---|---|---|---|
| | Treatment | Control | |
| Pre-intervention | 230,25 ± 76,25 | 192,25 ± 72,18 | 0,223§ |
| Post - intervention | 288,13 ± 78,95 | 206,63 ± 71,97 | 0,015§* |
| p | 0,002†* | <0,001¶* | |
| Difference | 57,88 ± 21,78 | 14,38 ± 2,18 | <0,001‡* |

*Notes: * Significant (p < 0.05); § Independent t; ‡ Mann Whitney; ¶ Paired t; †Wilcoxon*

search subjects had low scores on the physical activity scale, caused by a lack of moderate and heavy intensity physical activity in nursing homes. Data that influence cardiorespiratory fitness, such as age, gender, temperature and body composition, are homogeneous.

The normality test assessed using the Shapiro-Wilk test showed normal data for the results of the 6-minutes walk test in both groups and the difference in the values of the control group, while the difference values in the treatment group were not normal.

**Table 2. Comparison of Control and Treatment Groups Seen from the V02Max Results**

| VO2max | Group | | p |
|---|---|---|---|
| | Treatment | Control | |
| Pre-intervention | 7,11 ± 4,74 | 5,20 ± 3,66 | 0,453‡ |
| Post - intervention | 10,17 ± 4,88 | 5,97 ± 3,63 | 0,023‡* |
| p | 0,002†* | <0,001¶* | |
| Difference | 3,07 ± 1,15 | 0,76 ± 0,12 | <0,001‡* |

*Notes: * Significant (p < 0.05); ‡ Mann Whitney; ¶ Paired t; †Wilcoxon*

The data normality test for VO2max results was assessed using the Shapiro-Wilk test. The VO2max values in the treatment group before and after treatment, as well as the difference in METS values in the control group were normal. The VO2max values in the control group before and after treatment, as well as the difference in VO2max values in the treatment group were not normal.

**Table 3. Comparison of Control and Treatment Groups Seen from METS Results**

| METS | Group | | p |
|---|---|---|---|
| | Treatment | Control | |
| Pre-intervention | 2,03 ± 1,35 | 1,49 ± 1,05 | 0,453‡ |
| Post-intervention | 2,91 ± 1,39 | 1,70 ± 1,04 | 0,023‡* |
| p | 0,002†* | <0,001¶* | |
| Difference | 0,88 ± 0,33 | 0,22 ± 0,03 | <0,001‡* |

*Notes: * Significant (p < 0.05); ‡ Mann Whitney; ¶ Paired t; †Wilcoxon*

The data normality test for METS results was assessed using the Shapiro-Wilk test. METS values in the treatment group before and after treatment, as well as the difference, are normal. METS values in the control group before and after treatment also the difference were not normal.

## Discussion

In this study, we found that both senam lansia 3 times a week for 6 weeks and senam lansia followed by expiratory muscle strengthening exercises 5 times a week for 6 weeks, 3 sets x 10 repetitions significantly improved cardiorespiratory fitness in pre-frail elderly ($p=0.002$ in the treatment group and $p<0.001$ in the control group). However, the change in the average value of cardiorespiratory fitness as assessed by the 6- minutes walk test in the treatment group at the end of the study (288.13 ± 78.95) was greater than the average value of the 6-minutes walk test in the control group at the end of the study (206, 63 ± 71.97), with the mean difference between the two groups found to be significant ($p<0.001$).

The results of the subject's VO2 max and METS were also found to be significant, there was an increase in METS values after treatment (2.91 ± 1.39) greater than the control group (1.70 ± 1.04) with a significant difference in METS values = $p < 0.001$. These results indicate that the addition of expiratory muscle strengthening exercises can further improve the cardiorespiratory fitness of pre-frail elderly people. At the end of this study, it was found that 70% of participants experienced an increase in the intensity of expiratory

muscle strengthening exercises by 1-2 cm Hg. Previous studies have shown that in elderly populations in Asia, a change of 17.8 meters in testing is considered as minimal clinically significant change. A systematic review stated that the minimum clinically significant change in the adult population with pathological conditions is 14 – 35 meters. Based on this research, the average increase in the 6-minutes walking test score has reached the minimum clinically significant value.[10,11]

The results of this study show that elderly exercise improves cardiorespiratory fitness. Elderly exercise is low impact aerobic exercise, with light to moderate intensity continuously, the movements are easy to do, the movements will not cause injury, the movements themselves rarely change so they can be done by healthy elderly, pre-frail elderly, frail elderly, elderly with comorbidities. such as controlled hypertension and diabetes mellitus as well as elderly people who do not experience acute disease conditions. Putra D, et al.'s research stated there is a significant effect of giving seniors exercise for a total of 20 minutes, 3 times a week for 4 weeks on increasing cardiorespiratory fitness.[2,12]

The basic of breathing exercises using PEP is to apply pressure due to resistance during expiration, resulting in pressure in the mouth which is transmitted to the airway which will strengthen the expiratory muscles, hold the airway open during expiration and prevent premature closure of the airway so that the expiration time will be shorter. This results in increased lung volume, reducing hyperinflation and increasing airway clearance.[3,13,14]

There are several studies which prove that giving PEP can improve patients cardiorespiratory fitness, including research conducted by Su et al.[15] who gave PEP with an expiratory pressure of 10-20 cmH2O 2 times a day for 1 month as home therapy to 16 elderly COPD patients showed an increase in functional capacity as measured using the 6-minutes walk test.[15] Naoki et al.[8] conducted a study on 63 elderly patients with musculoskeletal diseases where after 6 weeks there were significant changes in the distance traveled in the 6-minutes walk test, respiratory function, swallowing ability and quality of life in the treatment group who received conventional rehabilitation plus training using PEP. In the study conducted by Mauren et al.[16] conducted on patients undergoing CABG surgery, the results of the 6-minutes exercise test 1 week before surgery and 1 month after surgery increased significantly in the treatment group given exercise with PEP.[16]

There has been no research that discusses the effect of PEP and aerobic exercise on the cardiorespiratory fitness of pre-frail elderly people. The addition of PEP to elderly exercise is predicted to further improve the respiratory function of pre-frail elderly. Increasing ventilation and oxygenation by administering PEP increases lung volume, increasing the diffusion process, thereby opening the airway for better breathing.[14,17]

This research has several limitations. First, blinding could not be performed in this study because of the intervention technique and environment. Second, this study did not objectively measure the lung and heart function of the research subjects. This study also did not objectively assess blood hemoglobin levels, which can predict a decrease in VO2 Max.

## Conclusion

There was a significant difference in cardiorespiratory fitness improvement of pre-frail elderly who received additional expiratory muscle strengthening exercises by doing elderly exercise.

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