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EFFECTIVENESS OF ADDING EXPIRATORY MUSCLE STRENGTHENING EXERCISE IN ELDERLY EXERCISE ON FATIGUE COMPLAINTS OF PRE-FRAIL ELDERLY POPULATION

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ABSTRACT

Background: The aging process induces changes in the anatomical and physiology of multiple organs and body systems, resulting in gradual reduction in cardiovascular and pulmonary functional capacities. This decline subsequently impairs cardiorespiratory fitness, ultimately leading to complaints of fatigue, that can be assessed by a Fatigue Assessment Scale (FAS). Aerobic exercise, such as elderly exercise, enhances cardiorespiratory fitness by promoting increasing blood flow to muscles. Supplementing these activities with expiratory muscle strengthening exercises using a Positive Expiratory Pressure/PEP threshold device help to reinforce the expiratory muscles, which are commonly weakened with aging. **Objective:** To prove the effectiveness of adding expiratory muscle-strengthening exercises to elderly exercise the fatigue complaints of the pre-frail elderly. **Methods:** A randomized controlled trial was used for this research. There were 24 subjects who met the study criteria were randomly divided into an intervention group (n=12) who receive PEP 5 times per week + elderly exercise 3 times per week for 6 weeks, and a control group (n=12) who only had elderly exercise 3 times per week for 6 weeks. Fatigue complaints were measured before and after intervention using the FAS questionnaire. **Results:** There was an increase in FAS scores before and after treatment in both the intervention group ($p<0.001$) and the control group ($p<0.001$). Comparison between groups showed a significant FAS score difference in the intervention group ($p=0.010$). **Conclusion:** The addition of expiratory muscle strengthening exercises to elderly exercise for 6 weeks had a better improvement in fatigue complaints compared to only having elderly exercise.

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INTRODUCTION

According to 2021 data from "Badan Pusat Statistik (BPS)", there are 29.3 million elderly people in Indonesia, equivalent to 10.82 percent of total population. The growing elderly population presents a significant challenge for countries due to the high costs associated with their care. However, this demographic also offers substantial potential if the elderly remain healthy, independent, active, and productive. Managing the increasing number of seniors demands adequate resources, but with proper support, the elderly can contribute economically and socially. [1]

The aging process is a natural and continuous process that leads to a decline in the function of various organs and body systems, resulting in various health problems in the elderly, including frailty.[2, 3]

Frailty is a dynamic process, where an elderly person first experiences a predisposing condition known as pre-frail.[4] The condition of reduced activity is the most commonly encountered component and is related to cardiorespiratory fitness, so early detection by identifying the pre-frail status in elderly individuals can be an opportunity to provide effective management. Interventions involving the provision of multicomponent programs can prevent an elderly

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person from falling from the pre-frail condition into frailty. [3-5]

In the elderly, anatomical and physiological changes occur in the respiratory system, resulting in decreased lung ventilation.[6] This leads to progressive decline in cardiovascular capacity and lung functional capacity, which in turn affects cardiorespiratory fitness and subsequently causes complaints of fatigue.[7, 8] Several common indicators of fatigue include decreased ability and reduced motivation. To measure these indicators, there are several questionnaires specifically designed to assess the fatigue experienced by an individual. Vries, Michelsen, and Van Heck (2003) compared six measurement questionnaires and recommended the Fatigue Assessment Scale (FAS) as the most suitable subjective questionnaire-based tool for measuring fatigue.[9-11]

One effort to slow down the decline in physical fitness is through physical exercise. Elderly exercise refers to planned, structured, and repetitive physical activities designed specifically for individuals in later life (typically aged 60 years and older). Such exercise programs aim to improve or maintain physical fitness components such as aerobic capacity, muscle strength, balance, flexibility, and functional independence, while minimizing age-related physiological decline, preventing chronic diseases, and enhancing overall health and quality of life.[12] In this study, elderly exercise refers to low-impact aerobic exercise. Generally, aerobic exercise improves cardiorespiratory fitness by increasing blood flow to the muscles.[13,14] Expiratory muscle strengthening exercises using Positive Expiratory Pressure (PEP) threshold help strengthen the expiratory muscles. Several previous studies have reported that during the aging process, expiratory muscles are more affected by functional decline compared to inspiratory muscles.[15] Previous studies have also shown that strengthening expiratory muscles has a positive effect on improving cardiorespiratory fitness.[16,17] To the best of the author's knowledge, there has been no research on the effectiveness of adding expiratory muscle strengthening exercises to elderly exercise in reducing fatigue complaints among the pre-frail elderly population in Indonesia, which has motivated the researchers to propose this study design.

METHODS

The research was carried out after obtaining ethical clearance from the Ethics Commission of Dr. Kariadi General Hospital Semarang with number 1476/EC/KEPK-RSDK/2023. This study was a parallel randomized controlled trial. This research was conducted at Wisma Wredha Rindang Asih I and II in April – June 2023. Subjects were then randomly randomized, and divided into two groups, namely the intervention 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 inclusion criteria were 60-75 years old; Pre-frail elderly; MOCA-Ina ≥ 26; can understand commands; can walk without tools; MMT score =5 for four extremities; Geriatric Depression Scale score ≤ 5; cooperative and willing to participate in research by signing informed consent.

The subjects excluded while there were 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). Subjects were dropped out if they were not following an expiratory muscle strengthening exercise and elderly exercise program three times non-consecutively or two times consecutively, did not attend the initial and final evaluation of the study, unable to complete the training sessions 3 times non-consecutively or 2 times consecutively.

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. Intervention 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

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elderly exercise 3 times a week for 6 weeks. Meanwhile, the control group did elderly exercise 3 times a week for 6 weeks.

The study outcome was assessed at the beginning and at the end of the 6-week intervention. Outcome measure was fatigue complaints assessed by Fatigue Assessment Scale (FAS). FAS is a validated fatigue screening tool consisting 10 questions that were contributed to mental and physical fatigue. Questions 1 to 10 were rated by 1-5 scale (1 for never had symptoms and 5 for always had symptoms). Total scores range from 10 to 50, where a score below 22 typically indicates no fatigue, and 22 or higher suggests significant fatigue.[10, 11]

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.

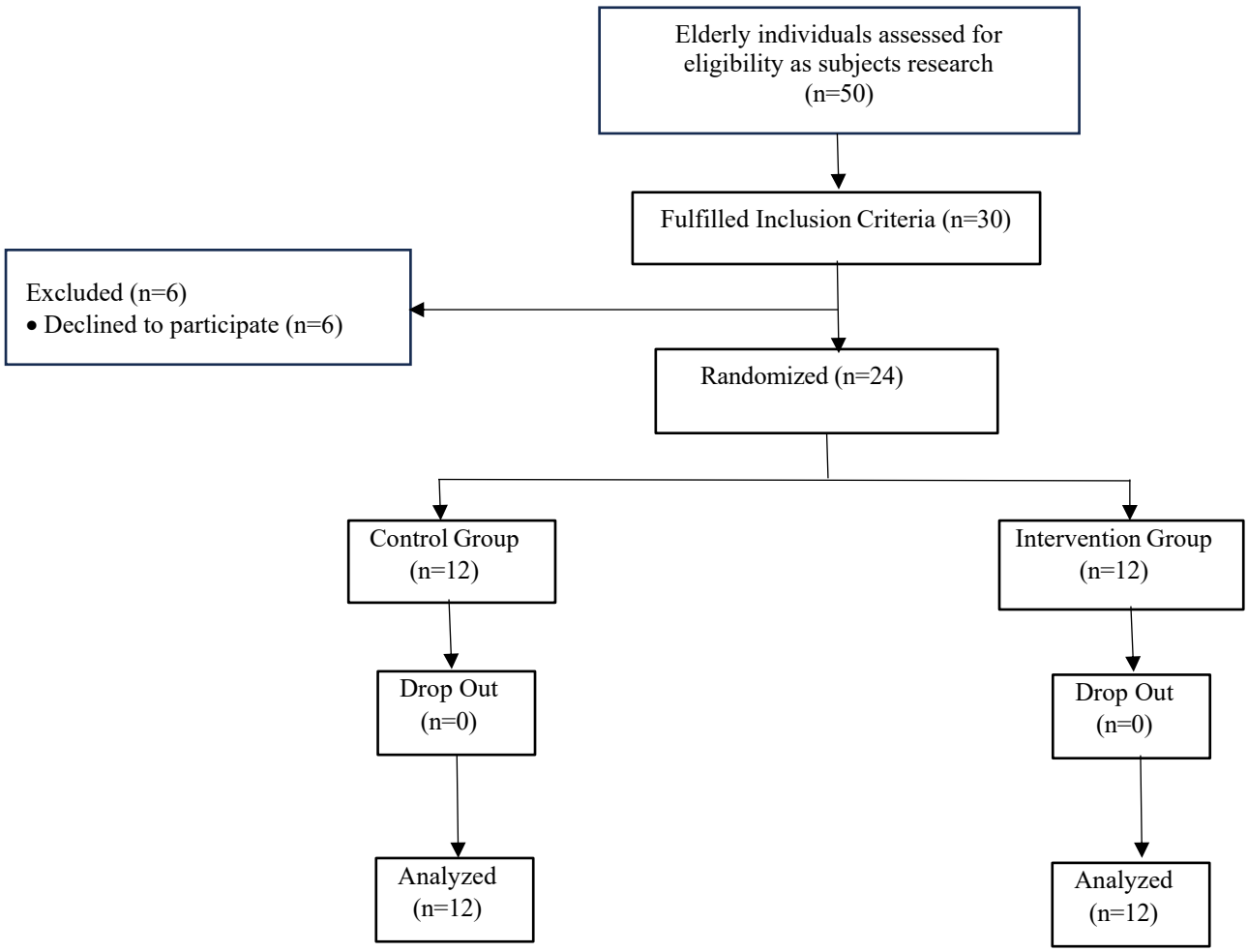


Figure 1. Flow Diagram of the Study

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RESULTS

The study began with informed consent, and initial assessment of fatigue complaints was performed with a FAS questionnaire. The intervention began on April to June 2023.

The participants' characteristics described in Table 1. The two groups did not differ statistically significantly (p value > 0.05). It indicated that both groups' research subjects had similar characteristics. There were also no significant differences at baseline measurement before intervention between them.

The paired difference test within both the intervention and control groups showed significant results (p<0.005) that described in Table 2. In the unpaired difference test, the pre-intervention Fatigue Assessment Scale scores were not significant (p=0.546), whereas the post-intervention Fatigue Assessment Scale scores and the differences in Fatigue Assessment Scale scores were significant (p=0.46).

Table 1. Baseline characteristics

Variable	Groups		*p*
	Intervention	Control	
Age (years)	68,67 ± 6,37	70,33 ± 3,55	0,437
Gender			
Male	6 (42,9%)	8 (57,1%)	0,679
Female	6 (60,0%)	4 (40,0%)	
Body weight (kg)	53,42 ± 10,26	53,75 ± 14,18	0,817
Body height (cm)	154,33 ± 8,13	153,17 ± 9,18	0,745
BMI (kg/m^2)	22,44 ± 4,09	22,64 ± 4,17	0,840
Frailty criteria			
1	6 (50%)	6 (50%)	1,000
2	6 (50%)	6 (50%)	
Physical Activities			
Low	12 (50%)	12 (50%)	–
Normal	0 (0 %)	0 (0 %)	

Table 2. Differences in Fatigue Assessment Scale posttest dan delta score

Fatigue Assessment Scale	Group		*p*
	Intervention	Control	
Pre test	34,58 ± 4,23	35,50 ± 3,03	0,548§
Post test	27,67 ± 4,01	30,58 ± 2,50	0,046§*
p	<0,001¶*	<0,001¶*	
Difference score	-6,92 ± 2,07	-4,92 ± 1,31	0,010§*

* Significantly (p < 0,05); § Independent T test; ¶ Paired T test

DISCUSSION

There were no significantly differences in participants demographic data (Table 1). Participant characteristics were said to be homogeneous based on data of age, gender, BMI, frailty criteria and physical activity. The data normality test for FAS score results was assessed using the Shapiro-Wilk test. The FAS score in the intervention group before and after treatment, as well as the difference in FAS score in the control group were normal (Table 2).

In this study, we found that the baseline FAS scores in both groups did not differ significantly (p = 0.548 > 0.05). This means that the initial fatigue levels of the participants were equivalent before the intervention. After the intervention, the intervention group had a lower FAS score (27.67) compared to the control group (30.58), and the difference was statistically significant (p = 0.046 < 0.05). This means that the intervention reduced fatigue better than the control. Both the intervention and control groups showed a significant reduction in fatigue after the intervention (p < 0.001). This means that any exercise or treatment given was effective in reducing fatigue within each group. The average decrease in the intervention group was -6.92, while in the control group it was -4.92, and the difference between the groups was statistically significant (p = 0.010). This means that the reduction in fatigue in the intervention group was greater than in the control group and was statistically significant (Table 2).

The previous study results showed that the majority of elderly individuals experienced moderate fatigue, with 32 people (55.2%), mild fatigue in 15 people (25.9%), and severe fatigue in 11 people (19%). Most of the total sample reported frequently feeling tired and lacking energy, having low motivation when working or doing activities, and experiencing decreased performance.[18]

The findings of this study indicate that exercise for the elderly enhances cardiorespiratory fitness. Elderly exercise consists of low-impact aerobics

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activities performed at light to moderate intensity in a continuous manner. These exercises involve simple movements that are easy to perform and carry minimal risk of injury. The routine movements are consistent, making the exercise suitable for healthy elderly individuals, pre-frail elderly, frail elderly, elderly with controlled comorbidities such as hypertension and diabetes mellitus, as well as those not experiencing acute illnesses.

Previous study on home-based exercise training including elderly exercise showed improvements in both physical fitness and fatigue levels among elderly subjects, highlighting the practical benefit of structured exercise programs in fatigue management.[19]

Gunda S et al. said that regular elderly exercise has a positive impact on their physical and mental health, supporting the creation of a more active and harmonious life atmosphere.[20] This is consistent with the components of the Fatigue Assessment Scale (FAS) questionnaire, which describes the individual's fatigue status encompassing both physical and mental fatigue.[10, 11] In this study, significant reductions in fatigue were observed in participants who engaged in elderly exercise 3 times a week for 6 weeks within the control group (p < 0.001).

Tsukamoto T et al.'s research said that expiratory muscle training in 4 weeks increased fatigue tolerance of the sternocleidomastoid, rectus abdominis, and internal and external oblique muscles in healthy individuals.[21]

Breathing exercises using Positive Expiratory Pressure (PEP) work by creating resistance during exhalation, which generates pressure in the mouth transmitted to the airways. This pressure strengthens the expiratory muscles, keeps the airways open during exhalation, and prevents premature airway closure, thus shortening the expiration time. As a result, lung volume increases, hyperinflation is reduced, and airway clearance is enhanced.[3, 7, 22]

Shoseyov D et al. suggests that respiratory muscle training programs, potentially involving PEP, should be developed to prevent respiratory complications and muscle fatigue in patients.[23] This study showed a significant reduction in fatigue complaints in the intervention group that performed expiratory muscle strengthening exercises using the PEP Threshold Phillips device, five times per week for six weeks, with three 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 elderly exercise 3 times a week for 6 weeks (p < 0.001).

There is currently no research that specifically examines the combined effect of Positive Expiratory Pressure (PEP) therapy and aerobic exercise on fatigue complaints in pre-frail elderly individuals. However, it is hypothesized that adding PEP therapy to elderly exercise regimens such as elderly exercise may result in greater improvements in fatigue complaints among this population.

This study has several limitations. First, the sample size was relatively small, indicating that the results should be interpreted with caution. Second, this study did not include follow-up assessments after the intervention period, with the outcomes measured only immediately upon completion. Consequently, the durability of the intervention's benefits over the long term remains unknown. Lastly, blinding was not feasible in this study due to the specific intervention method and environment. Consequently, the potential influence of placebo effects and observer bias could not be ruled out.

CONCLUSION

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

ETHICAL APPROVAL

The Research Ethics Committee at the Health and Medical Research Ethics Commission of Dr. Kariadi General Hospital Semarang, Indonesia granted ethical approval with the ethical clearance number 1476/EC/KEPK-RSDK/2023.

CONFLICTS OF INTEREST

The authors declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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AUTHOR CONTRIBUTIONS

The authors confirm contribution to the article areas as follows: Conceptualization, Erna Setiawati, Tanti Ajoe Kesoema, and Erma Nihlatul Mufidah; methodology, Erma Nihlatul Mufidah; software, Erma Nihlatul Mufidah; validation, Erma Nihlatul Mufidah; formal analysis, Erma Nihlatul Mufidah; investigation, Erma Nihlatul Mufidah; resources, Erma Nihlatul Mufidah; data curation, Erma Nihlatul Mufidah; writing original draft preparation, Erma Nihlatul Mufidah writing review and editing, Erma Nihlatul Mufidah; visualization, Erma Nihlatul Mufidah; supervision, Erna Setiawati and Tanti Ajoe Kesoema; project administration, Erma Nihlatul Mufidah; funding acquisition, Erma Nihlatul Mufidah.

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REFERENCES

1. Girsang APL RK, Nugroho SW, Sulistyowati NP, Putrianti R, Wilson H. . Statistik Penduduk Lanjut Usia 2021 Jakarta. In: Statistik BP, editor. Jakarta: Badan Pusat Statistik; 2021.
2. Darmojo RB MH. Teori Proses Menua. In: Martono HH, Pranarka K, editors. Buku Ajar Boedhi-Darmojo Geriatri (Ilmu Kesehatan Usia Lanjut). . 4 ed. Jakarta: Balai Penerbit FKUI; 2009.
3. Hazzard's geriatric medicine and gerontology Jeffrey B Halter Hazzard's geriatric medicine and gerontology et al McGraw-Hill Medical £154.99 1760pp 9780071488723 [Formula: see text]. Nursing older people. 2010;22(6):10.
4. Siti S. Geriatric Medicine, Sarkopenia, Frailty, dan Kualitas Hidup Pasien Usia Lanjut: Tantangan Masa Depan Pendidikan, Penelitian dan Pelayanan Kedokteran di Indonesia. eJournal Kedokteran Indonesia. 2013;1(3).
5. HH. M. Kerapuhan dan Gagal Pulih. In: Martono HH, Pranarka K, editors. Buku Ajar Boedhi-Darmojo Geriatri (Ilmu Kesehatan Usia Lanjut). 4 ed. Jakarta: Balai Penerbit FKUI; 2009.
6. HH. M. Aspek Fisiologik dan Patologik Akibat Proses Menua. In: Martono HH, Pranaka K, editors. Buku Ajar Boedhi-Darmojo Geriatri (Ilmu Kesehatan Usia Lanjut). . Jakarta: Balai Penerbit FKUI; 2009.
7. N. N. Medical Exercise in Rehabilitation.Program Studi Pendidikan Dokter Spesialis -1 Ilmu Kedokteran Fisik dan Rehabilitasi Fakultas Kedokteran Universitas Indonesia. 2018.
8. Kalapatapu RK, Cristian A. Assessment of fatigue in adults with disabilities. Physical medicine and rehabilitation clinics of North America. 2009;20(2):313-24.
9. Michielsen HJ, De Vries J, Van Heck GL. Psychometric qualities of a brief self-rated fatigue measure: The Fatigue Assessment Scale. Journal of psychosomatic research. 2003;54(4):345-52.
10. Rida Zuraida HHC. Pengujian Skala Pengukuran Kelelahan (SPK) Pada Responden Di Indonesia. ComTech Vol 5 No 2 Desember 2014: 1012-1020. 2014;5:1012-20.
11. De Vries J, Michielsen HJ, Van Heck GL. Assessment of fatigue among working people: a comparison of six questionnaires. Occupational and environmental medicine. 2003;60 Suppl 1(Suppl 1):i10-5.
12. Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, Minson CT, Nigg CR, Salem GJ, et al. American College of Sports Medicine position stand. Exercise and physical activity for older adults. Medicine and science in sports and exercise. 2009;41(7):1510-30.
13. Basuni DT PH. Uji Latih Beban pada Rehabilitasi Jantung. 1 ed. Jakarta: PB PERDOSRI; 2016.
14. Riebe D. Exercise Prescription for Healthy Populations with Special Consideration and Enviromental Considerations. ACSM's Guidelines for Exercise Testing and Prescription. 10 ed. Philadelphia2018.

JURNAL KEDOKTERAN DIPONEGORO
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JKD (DMJ), Volume 15, Number 6, November 2026 : 530-536

15. Lee SH, Yim SJ, Kim HC. Aging of the respiratory system. kmj. 2016;31(1):11-8.
16. Maki N, Sakamoto H, Takata Y, Kobayashi N, Kikuchi S, Goto Y, et al. Effect of respiratory rehabilitation for frail older patients with musculoskeletal disorders: a randomized controlled trial. Journal of rehabilitation medicine. 2018;50(10):908-13.
17. Emirza C, Aslan GK, Kilinc AA, Cokugras H. Effect of expiratory muscle training on peak cough flow in children and adolescents with cystic fibrosis: A randomized controlled trial. Pediatric pulmonology. 2021;56(5):939-47.
18. Nasution SAS. Tingkat Fatigue Pada Lansia: Universitas Sumatera Utara; 2023.
19. Luawo HP. Efektivitas Home Based Exercise Training dan Senam Lansia Terhadap Kebugaran dan Kelelahan Pada lansia. Surabaya: Universitas Airlangga; 2020.
20. Sri Gunda Fahriana Fahruddin RNI, Inayah Ageng Izza,Ulfa Diya Atiqa, Isfawati Mahmud. Peningkatan Kesehatan Fisik dan Mental Lansia Melalui Program Senam lansia di Komunitas. APMa Jurnal Pengabdian Masyaraka. 2025;5:85-90.
21. Tsukamoto T, Maruyama H. Effect of expiratory muscle training on respiratory muscle fatigue in healthy adults: a randomized controlled trial. Journal of physical therapy science. 2024;36(7):382-91.
22. Hasan H, Maranatha RA. Perubahan Fungsi Paru pada Usia Tua: [Lung Function Alteration in Geriatric Patients]. Jurnal Respirasi. 2017;3(2):52-7.
23. Shoseyov D, Cohen-Kaufman T, Schwartz I, Portnoy S. Comparison of activity and fatigue of the respiratory muscles and pulmonary characteristics between post-polio patients and controls: A pilot study. PLOS ONE. 2017;12(7):e0182036.