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by Ni Nengah Ariati

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The Ergonomic Elderly Gym Improving Physical Fitness and Increasing The Bone Mass of The Elderly

N.N. Ariati*, N. Adiputra, K. Tirtayasa, I.P.G Adiatmika, A. Pangkahila, I.D.P. Sutjana, I.M. Bakta, I.B.P. Manuaba, I.M. Sutajaya

ABSTRACT

The public is increasingly aware of the importance of exercise for the elderly because exercise is an option to reduce complaints due to setbacks and improve the health of the elderly. In fact, the implementation in the field is often wrong as in *Banjar Benaya* which implements routine exercises only once a week with a duration less than 30 minutes, does not pay attention to nutritional needs, does not use sports clothing, and displays that are not clear. The measurement of elderly physical fitness is still relatively low. Based on these problems, improvements were made to the application of ergonomic elderly gymnastics due to improve the elderly's physical fitness and increase the bone mass. This study used treatment by subject design conducted in April 2017 – August 2018. The target population was all elderly in Denpasar and the affordable population was determined by multistage random sampling then selected *Banjaya Benaya* Peguyangan Village with a sample of 20 people who met the inclusion criteria. The data collections were physical fitness and bone mass. The difference in treatment effects was analyzed using a Paired Sample t-Test with $\alpha = 0.05$ for data with normal distribution and Wilcoxon test, $\alpha = 0.05$ for data with the abnormal distribution. Data showed that there were differences in physical fitness improvement in Period I and Period II after 8 weeks of gymnastics at 43.43% with very bad categories being bad, the difference in the increase in whole-body bone mass was 16.76% and leg bone mass 68.67%. Analysis of Paired Sample-t-Test physical fitness data and Wilcoxon test for bone mass data in Period I and Period II after gymnastics for 8 weeks, found that there was a significant difference ($p < 0.05$). It can be concluded that ergonomic elderly gym can significantly improve physical fitness and increase the bone mass of the elderly. It is recommended that the elderly continue to exercise with a duration of 30 – 45 minutes, the frequency of three times a week to maintain the elderly's physical fitness.

Keywords: Ergonomic Elderly Gymnastics, Physical Fitness, Bone Mass.

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1. INTRODUCTION

Aging is a natural process and a challenge that must be encountered as it is interpreted to be deteriorating work performance and decreasing physical capacity. Physical changes often result in psychological disorders for the elderly, pessimistic feelings, the emergence of feelings of insecurity and anxiety, mental disorder, feeling threatened by an illness, fear of being abandoned because they feel useless, less capable and tend to be introverted. Dealing with old age to be healthy and prosperous, this situation needs to be managed properly.

The elderly population in Indonesia is among the top five in the world, and according to the 2010 population census, the number of elderly in Indonesia is 18.1 million (7.6% of the total population), while the elderly population of Denpasar City is higher than the national percentage 9.8% (Sunaryo et al., 2016). The population of the elderly is expected to continue to

N. Ariati* is with the Department Polytechnic of Health, Bali (email: ariatinengah@ymail.com).
N. Adiputra, K. Tirtayasa, I.P.G. Adiatmika, A. Pangkahila, I.D.P. Sutjana, I.M. Bakta, and I.B.P. Manuaba are with Faculty of Medicine, Universitas Udayana, Bali.
I.M. Sutajaya is with Ganesha Education, Universitas Singaraja, Bali.
* Corresponding author

increase, and in 2030 it is estimated that it will reach 36 million (Ministry of Health Republic of Indonesia, 2013). The estimated average life expectancy of the Indonesian population has increased, namely in 2005 reaching 67.8 years, increasing to 70 years in 2005 – 2010. While the life expectancy of Denpasar City is higher than the national figure which has reached 72.1 years (Sunaryo et al., 2016).

Economically the annual budget for the health care of the elderly is quite high. This cost will increase if life expectancy increases. The elderly are often associated with age that is already unproductive and even assumed to be a burden on productive age due to setbacks experienced by the elderly (Kurnianto, 2015). Elderly people in Indonesia, their lives are borne by productive age, then the dependence rate is still high because Indonesians generally live in the type of extended family.

Dealing with old age to be healthy and prosperous needs to be managed properly. Exercise is a cheaper option than treatment to reduce complaints due to setbacks and improve the health of the elderly. A sport that is suitable for the elderly is a type of aerobic exercise such as gymnastics, walking, and swimming (Suhartarsih, 2006).

Elderly gymnastics is a light exercise and easy to do and it does not burden the elderly. Gymnastics used to do by the elderly in Banjar Benaya lasts less than 30 minutes, namely 16 minutes 95 seconds, there are movements that should not be done by the elderly, gymnastics frequency once a week, music and gymnastic movements seen through a 14 inch TV so that gymnastic images and music are less clear to the backside, and does not have a gymnastics instructor. Elderly use casual clothes without shoes, do not carry supplies of drinking water and after analysis of nutritional intake is still below the need. Exercise pulses measurement has resulted in nearly 90% of the elderly not reaching the training zone so that the training objectives will not be achieved. These data showed that the condition of the elderly gymnastics in *Banjar Benaya* still does not meet the ergonomic conditions in terms of eight aspects of ergonomics, namely in terms of nutrition, muscle power utilization, posture, time, environment, social, human-machine information, and interaction.

Measurement of physical fitness for twenty elderly people in *Banjar Benaya* was measured through muscle strength tests using the sit to stand method to get 85% of the elderly including the score category below 50% and only 15% who achieved scores above 50%. Measurement with a balance test found that 60% of the elderly had a balance deficit and only 10% of the balance was classified as safe. Assessment with a 6-minute road test gets all elderly (100%) in the category of 5% fitness level. Flexibility test with sit-and-reach method obtained 30% of elderly can reach toe ((+) value) and 70% of elderly cannot reach ((-) value).

Research on sports in the elderly, especially elderly gymnastics has been carried out like Tera Indonesia gymnastics can improve pulmonary heart fitness by 0.87 ml/ kg/minute in elderly at *Wana Seraya* Nursing Home Denpasar (Parwati et al., 2013). Other research on sports in the elderly has a relationship between osteoporosis exercise and the incidence of osteoporosis in Surabaya Islamic Hospital and this study concludes osteoporosis exercise can slow the decline in bone mass due to age (Umamah and Faisal, 2016). Studies of elderly gymnastics affecting blood pressure, asthma, diabetes, and others have been widely revealed, but no one has revealed and resolved the problem completely with a total ergonomics approach.

Improvement with a total ergonomics approach using the SHIP approach (Systemic, Holistic, Interdisciplinary and Participatory). The SHIP approach improvements are made systemically, work holistically, utilizing various disciplines and experiences in an interdisciplinary and prioritizing the participation of all parties. This improvement is utilizing Appropriate Technology by attention to technical, economic, ergonomic, socio-cultural aspects, energy-saving, and without damaging the environment. The elderly exercise uses simple movements so that it is easily followed and implemented by the elderly, so that is more efficient technically. Economically, it increases productiveness and does not require expensive costs because the process of making gymnastics only uses music. Ergonomically, it does not cause any danger because the exercise movements adjusted to the physical abilities of the elderly with the rhythm of the music that can be followed by the elderly, and there is no forced movement that endangers the limbs. Socio-cultural can be justified, using sports clothing from cotton which is easy to absorb sweat, pants are not tight so it does not interfere with motion and politely in accordance with local socio-cultural norms. Energy-saving because gymnastics elderly only use television aids and speakers that are easy to get at affordable prices. Since it only needs simple technology, it does not have an impact on the environment itself.

The total ergonomic approach within this improvement has the advantage of attention in all aspects that affect the physical fitness and bone mass of the elderly. Hence it is still trying to find alternative improvements with the concept of appropriate technology. Corrections to problems are carried out systemically using a participatory approach. Involving the elderly and cadres in the determination of music and the preparation of the gymnastic movement can prevent individual arrogance, then all have the same commitment. All participant commitments in implementing improvements are the main strength of the total ergonomics approach so that the improvements made can be applied on an ongoing basis.

Elderly gymnastics training with a total ergonomics approach can create an ENASE state (effective, comfortable, safe, healthy, and efficient) so that the elderly become productive, the quality of life increases and can interact socially well. Effective: because the exercises are simple so it is easy to follow, comfortable:

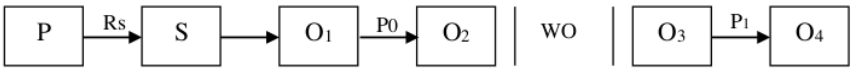

Figure 1. Study design

because the movements are easy to do, so the elderly are comfortable during the movements, safe: because all movements are in accordance with physiological methods, no forced movements, healthy: exercise frequency three times a week with a duration of 30 minutes according to physiological methods to achieve physical fitness, and efficient: do not require expensive costs in doing this exercise. Improvements in the field of sports with a total ergonomics approach have been carried out with improvements to the types of training for maximum and efficient utilization of muscle power, providing nutrition in the form of sweet tea, regulating environmental conditions and comfortable student clothes, regulating social conditions to maintain in interaction, regulating information conditions, and managing a convenience human-machine interactions. The results obtained an increase in physical fitness after being given ergonomically oriented physical training (Adhi, 2013).

Based on those problems, improvements were made in the form of ergonomic elderly gymnastics using a total ergonomics approach with the SHIP approach and the application of appropriate technology. SHIP approach as it is expected on the improvements made can be applied and take place continuously.

2. MATERIAL AND METHOD

This study used treatment by subject design (Nasir, 2003) as illustrated in Figure 1.

Note:

- P : Population.
- S : Sample.
- R_s : Random sampling.
- P_0 : Period I, conventional elderly gymnastic.
- P_1 : Period II, improvement by ergonomic elderly gymnastics.
- O_1 : Early data collection in physical fitness and bone mass in group P_0.
- O_2 : Final data collection in physical fitness and bone mass in group P_0.
- O_3 : Early data collection in physical fitness and bone mass in group P_1.
- O_4 : Final data collection in physical fitness and bone mass in group P_1.
- WO : A period when the sensitivity decreasing after 7 days practicing elderly standard gymnastic. Washing out is a process similar to Period I and Period II, the elderly do the daily routine.

Adaptation in the gymnastic movement was applied after 7 days washing out with the frequency of exercise 3 times a week (Sunday, Tuesday, and Thursday).

The study was conducted in *Banjar Benaya*, Peguyangan Village, from April to August 2018 with the target population were all the elderly in Denpasar, while the affordable population was determined by multistage random sampling then the selected 28 people *Banjar Benaya* as representative of Peguyangan Village. Based on the calculation of the number of samples obtained the number of samples as many as 19,18 rounded up to 20 people and the sample size in this study was 20 elderly people (Colton, 1974).

An operational definition of variable:

a. Gymnastics repairs in the form of elderly ergonomic gymnastics are repaired exercises carried out with the SHIP approach applying appropriate technology in the form of 1) nutrition in the form of 200 ml milk snacks and 80 gr Ambon bananas consumed two hours before exercise (3:00 p.m.) and drinking 220 ml water which is taken just before exercise and after cooling; 2) gymnastic movements that are simple and easy for the elderly to follow; 3) gymnastic movements with physiological posture; 4) comfortable environmental conditions by holding gymnastics in the previous place at the same time namely Pk. 5:00 p.m.; 5) the duration of gymnastics is 34 minutes 32 seconds, with the frequency of exercise three times a week (Sunday, Tuesday, Thursday) (setting days can adjust); 6) gymnastic clothing in the form of a shirt that easily absorbs sweat, rather loose training pants, and sports shoes according to the size of the elderly anthropometry; 7) use speakers and gymnastics instructors (taken from cadres); 8) TV and speakers are permanently mounted on the wall to make it easier for cadres and elderly people to play gymnastics.
b. Conventional gymnastics are: 1) Physical Fitness for the Elderly issued in 1999 with a duration of 16 minutes 95 seconds repeated twice so that the duration becomes 33 minutes 90 seconds takes place every day (Sunday, Tuesday and Thursday); 2) nutrition in the form of ambon banana 80 g snack and 200 ml milk consumed two hours before exercise (at 3:00 p.m.) and drink 220 ml of drinking water just before exercise and after cooling; 3) clothing in the form of a shirt that easily absorbs sweat, rather loose training pants, and sports shoes for gymnastics; 4) comfortable environmental conditions by continuing to hold gymnastics in the previous place at the same time namely Pk. 5:00 p.m.; 5) using speakers and gymnastics instructors (taken from cadres); 6) TV and speakers are permanently mounted on the wall to make it easier for cadres and elderly people to play gymnastics.
c. Physical fitness is a state of health of the elderly by measuring 6 components of physical fitness, namely: grip strength, sit-ups, flexibility, balance, walking 10 meters with obstacles, and walking 6 minutes. Measurement results were analyzed using

Table 1. Reference value of *Battery Test* on elderly's physical fitness

Reference value	Grip strength (x_1)(kg)	Sit-ups (x_2) (times)	Fleksibility (x_3)(cm)	Balance (x_4) (sec)	Walk 10 meters with obstacles (x_5) (sec)	Walk 6 minutes (x_6) (m)
10	62	33	61	120	3,0	1043
9	58	30	56	102	3,5	973
8	54	27	51	64	3,9	903
7	50	24	47	43	4,4	833
6	47	21	43	29	4,8	770
5	44	18	38	21	5,5	714
4	41	15	33	14	6,1	658
3	37	12	27	10	6,6	602
2	32	9	21	7	7,3	546
1	31	8	20	4	8,4	510

Table 2. Descriptive analysis on subject condition

Num	Subject condition		Mean±SD	
			Period I	Period II
1.	Age (years)		65±5,49	65±5,49
2.	Height (cm)		153,9±4,23	153,9±4,23
3.	Weight (kg)	Before	57,4±8,42	57,3±8,33
		After	57,2±8,28	56,3±7,90
4.	Body mass index (BMI) (kg/m^2)	Before	24,2±3,07	24,1±3,02
		After	24,1±3,00	23,7±2,85

composite indexes such as Table 1. Physical fitness measurement results were included/ grouped according to the reference values in Table 1, then each reference value of the physical fitness item is added up.

d. Bone mass is bone density obtained by measuring the bone of the calcaneus/ heel using the OsteoSys bone mass meter Sanos 3000 brand made in Korea. The heel of the subject to be measured is cleaned first, then put into the OsteoSys tool, after a few seconds, the tool will show the results of the T-Score describing the entire body's bone mass, the Z-Score describes the foot bone mass. The value of T-Score and Z-Score are categorized as normal if the value is> -1, osteopenia if -1 s.d. -2.5, and osteoporosis if the value is <-2.5.

The difference test between groups before and after treatment is done to determine the difference in mean and level of significance. The type of test used is according to the normality of the data, namely: a) Data is normally distributed to environmental conditions (wet temperature, dry temperature, and air humidity) and physical fitness, then a different test is conducted Paired Samples t-Test at significance level $\alpha = 0.05$; b) the data are abnormally distributed in bone mass data then a Wilcoxon different test is carried out at a significance level of $\alpha = 0.05$.

3. RESULTS

3.1. Subject Condition

The research subjects were the elderly who were active in the elderly posyandu activities in *Benaya Banjar*, Peguyangan Village, with 20 people. All healthy-bodied samples were based on a physical examination by a doctor. Descriptive analysis of subject conditions as in Table 2.

The mean age of the subject was 65.45 ± 5.49 years and the mean height of the subject got 153.97 ± 4.23 cm. Data collection on the subject's body weight was carried out four times, namely before and after gymnastics for 8 weeks in Period I, and before and after gymnastics for 8 weeks in Period II, so that they gained four times the average weight. The mean weight and BMI of subjects in Period II before and after gymnastics for 8 weeks decreased more than in Period I. The difference in weight loss between Period I and Period II after exercise for 8 weeks was 1.63% and the difference in the decrease in BMI was 1.62%.

3.2. Environmental Condition

The results of the study obtained mean wet temperatures in Period I were 27.25 ± 0.50˚C and in Period II 25.67 ± 0.29˚C. The comparability test results found that the wet temperatures in Period I and Period II were comparable ($p \geq 0.05$). This shows the wet temperature has the same conditions in Period I and Period II.

The average dry temperature in Period I was 28.33 ± 0.58˚C and 27.17 ± 0.29˚C, while in Period II was

Table 3. Physical Fitness Data Difference Test Results in Period I and Period II Before and After 8 Weeks Gymnastics

Num	Physical fitness	Period I	Period II	t	p
1.	Before	9,75±2,34	9,85±2,06	-0,623	0,541
2.	After	9,90±2,19	14,20±3,11	-10,987	0,001

Tabel 4. Bone Mass Data Difference Test Results in Period I and Period II Before and After Gymnastics for 8 Weeks

Num	Bone Mass		Period I	Period II	Z	p
1.	Feet bone mass	Before	-1,59±1,36	-1,66±1,33	-0,674	0,500
		After	-1,66±1,41	-0,52±1,69	-3,774	0,001
2.	Whole body bone mass	Before	-1,86±0,97	-1,85±0,97	-1,000	0,317
		After	-1,85±0,96	-1,54±0,97	-3,852	0,001

29.25˚C and 28.25˚C. The comparability test results found that the dry temperatures in Period I and Period II were comparable ($p \geq 0.05$), meaning dry temperature factors had the same conditions in Period I and Period II.

The mean air humidity in Period I was 86.67 ± 2.89% and in Period II was 85.00 ± 0.00%. The comparability test results found that relative humidity in Period I and Period II was comparable ($p \geq 0.05$). This mean that relative humidity has the same conditions in Period I and Period II.

3.3. Physical Fitness

Physical fitness was assessed by composite index by assessing six parameters to get values of each < 20% in Period I before and after gymnastics for 8 weeks, and in Period II before gymnastics so that it was included in the category very bad. In Period II after gymnastics for 8 weeks got a value of > 20% so that it was included in the bad category. The increase in average physical fitness in Period I was 1.54%, while the increase in Period II was 44.16%. The difference in improvement in physical fitness in Period I and Period II after 8 weeks was 43.43%. Analysis of the different physical fitness tests is presented in Table 3.

Table 3 shows the analysis of different tests of Paired Sample-t-Test in Period I and Period II before gymnastics, getting no significant differences ($p > 0.05$), indicating that the initial conditions in Period I and Period II were the same. Analysis in Period I and Period II after gymnastics for 8 weeks found a significant difference ($p < 0.05$).

3.4. Bone Mass

The results analyzed are the T-Score values that describe the body's overall bone mass, a Z-Score that describes the body's bone mass in a measured place in this case at the foot. The analysis of the bone mass difference test is presented in Table 4.

Analysis of Wilcoxon difference in bone (foot and whole-body) mass data in Period I and Period II before gymnastics found no significant differences ($p > 0.05$), indicating that the initial conditions in Period I and Period II were the same. Analysis in Period I and Period II after gymnastics for 8 weeks found a significant difference ($p < 0.05$).

4. DISCUSSION

4.1. Subject Condition

The mean age of subjects in this study was 65.45 ± 5.49 years which showed subjects in old age. According to Law Number 13 of 1998, it is stated that the elderly are people who are 60 years old and above (BPKP, 1998). The aging process is often interpreted as a process of decline, decreased physical capacity, and decreased physiological function (Ministry of Health Republic of Indonesia, 2016).

Data collection on height gained a mean body height of 153.97 ± 4.23 cm. The size of elderly men and women will experience shrinkage of approximately 5% (Tarwaka et.al., 2004). Anatomically there are physical changes, namely changes in bone shape such as hunchback in the spine, especially in women (Kroemer, 2003).

There was a decrease in body weight and a greater BMI in Period II compared to Period I, this is caused by doing regular exercise that can burn calories in the body so that the fat stored in the body will decrease (Daley, 2015). Decreasing fat in the body will cause weight loss and body mass index. This is in line with research that provides health education and training for elderly people in Nagano Japan reporting significant differences in subject weight in the group given training and health education compared to the control group (Nakade et.al., 2017).

4.2. Environmental Condition

The mean wet temperature, dry temperature and air humidity in Period I and Period II are comparable ($p \geq 0.05$), meaning that the temperature factor has the same conditions and has the same effect in Period I and Period II. Air temperature in one room should be between 20-24°C in winter and between 23-26°C in summer to provide a comfortable atmosphere in the room13. Indonesians in the tropics are acclimatized or feel comfortable with dry temperatures between 26-28°C (Helander, 1995).

The average relative humidity in Period I was 86.67 ± 2.89% and in Period II was 85.00 ± 0.00%. The relative humidity percentage is in a convenient category, namely for comfort, the relative humidity of the air must not be below 30% (Manuaba, 1998).

4.3. Physical Fitness

Measurement of overall physical fitness with composite indexes found a significant difference ($p < 0.05$) of 43.43% in Period I and Period II after doing ergonomic elderly gymnastics for 8 weeks with very bad categories being bad. This shows that total ergonomics research carried out comprehensively can improve physical fitness. Ergonomic elderly gymnastics carried out according to the module can improve the physical fitness of the elderly because the modules have been regulated with improved gymnastics with a total ergonomics approach using the SHIP Approach and utilizing Appropriate Technology.

Exercise frequency and the duration under physiological conditions, ergonomic gymnastic movements (simple, easy to follow, harmless / does not cause injury), resulting in maximum utilization of muscle energy, meeting nutritional needs, regulating environmental conditions and comfortable old clothes, regulating the condition of human-machine information and interactions to be comfortable, and regulating social interactions between the elderly, can significantly improve physical fitness. Similar improvements were made to students who took football extracurricular activities at Amlapura 2 High School with ergonomics-based physical training to get an increase in students' physical fitness[4]. Other studies with improvements by total ergonomics approach have been carried out which have resulted in an increase in work productivity as in the metal painting industry (Adiatmika, 2007), and in the steaming bread-making industry (Dinata, 2018).

Exercise is pivotal to avoid changes in the elderly due to the aging process. The aging process can be slowed by regulating patterns of life and physical activity (Pangkahila, 2013). The type of exercise the elderly can do is elderly gymnastics. Elderly gymnastic activities will help the body to stay fit and fresh because training bones remain strong, so that muscle strength, muscle endurance, flexibility, and balance can be trained (Sumintarsih, 2006).

4.4. Bone Mass

Data showed a significant increase bone mass ($p < 0.05$) after gymnastics for 8 weeks between Period I and Period II at 68.67% in the legs and 16.76% in the whole body. This finds out that elderly ergonomic gymnastics with a total ergonomics approach which is carried out comprehensively can strengthen the bone mass of the elderly.

Bone changes will always occur in the body's skeleton, then new and strong bones will replace brittle old bones. The aging process will accelerate the loss of bone mass, faster than bone formation. This causes the body to lose 1% of bone every year after 30 years of age (Hui, et.al., 1999). Under certain conditions such as loss of estrogen due to menopause or overactive thyroid gland resulting in decomposition of bone will be faster than its formation and bone loss happened (Riggs, 2002). Exercise regularly will make bone formation run faster and the body will get additional bone (Winters, 2013). The results of research on exercise for osteoporosis which is carried out regularly can slow the decline in bone mass thereby reducing the risk of osteoporosis at the Surabaya Islamic Hospital[3]. Another study in the elderly in Kenagarian Api-Api, Bayang District, Pesisir Selatan Regency, found that there was a relationship between physical activity (exercise) and the risk of osteoporosis, the lower the physical activity, the greater the risk of osteoporosis (Minropa, 2013).

5. CONCLUSIONS

Based on the results and discussion, it can be concluded as follows:

1. Ergonomic elderly gymnastics is proven to be able to significantly improve elderly physical fitness ($p < 0.05$). The difference in increasing physical fitness of the elderly in Period I and Period II after exercise for 8 weeks was 43.43%.
2. Ergonomic elderly exercise has been shown to significantly increase elderly bone mass ($p < 0.05$). The difference in the increase in bone mass in Period I and Period II after exercise for 8 weeks was 8.67% in leg bone mass and 16.67% in bone mass throughout the body.

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CONFLICT OF INTEREST

The author has no conflict of interest regarding to all elements in this study.

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