The efficacy of specific patterns of movements and brain exercises on the cognitive performance of healthy senior citizen in Jakarta

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Abstrak

Tujuan penelitian ini adalah untuk melihat manfaat dari gerak dan latih otak pada warga senior sehat. Gerak dan Latih Otak (GLO) terdiri dari peregangan otot, latihan pernafasan dan gerakan menyilang garis tengah tubuh dari mata, kepala dan ekstrimitas, yang dilakukan dua kali seminggu selama dua bulan. Pada 70 warga senior dilakukan 5 tes performa kognitif sebelum dan setelah selesai program latihan tersebut yang terdiri dari visual scanning and tracking (VST), delayed recall (DR), verbal fluency (VF), digits backward (DB), dan trail making test-B (TMT-B). Rentang usia subjek 48 hingga 70 tahun dan lama pendidikan 6 hingga lebih dari 18 tahun. Hasil analisis statistik menunjukkan bahwa semua subjek mengalami kenaikan sangat bermakna dalam kelima tes kognitif. Wanita menunjukkan kenaikan bermakna pada kelima tes kognitif, sedang pada laki-laki kenaikan bermakna hanya didapatkan pada tes VST, DR dan TMT-B. Tidak didapatkan perbedaan bermakna pada kedua kelompok umur (di bawah 60 tahun dan 60 tahun atau lebih), dan jenjang pendidikan kecuali pada kelompok pendidikan tinggi. Disarankan penelitian lebih lanjut dengan sampel yang lebih besar dan metodologi yang sama di berbagai kota di Indonesia. ***(Med J Indones 2003; 12: 155-61)***

Abstract

The objective of this study was to determine the efficacy of brain movement and exercise in healthy senior subjects. Brain movement and exercise or Gerak dan Latih Otak (GLO) which comprised of muscles stretching, breathing exercise, and crossing the body's midline of the eyes, head and extremities were performed two times weekly for two months by 70 normal healthy senior subjects. A pre- and posttest on 5 cognitive performance, consisted of visual scanning and tracking (VST), delayed recall (DR), verbal fluency (VF), digits backward (DB), and trail making test-B (TMT-B). The age range of the subjects was 48 to 70 years and duration of education ranged from 6 to 18 years or more. The results of the statistical analyses showed that all the subjects showed high significant increase performance on the five cognitive domains. Women performed significantly in all the tests, while in men the significant increase was on VST, DR, and TMT-B. No different significant increase cognitive performance could be obtained between the two age groups (below 60 years and 60 years upward) and level of education, except for the high education group. It is suggested that further studies with larger scale subjects and same methodology should be performed in several places in Indonesia. ***(Med J Indones 2003; 12: 155-61)***

Keywords*: brain movement and exercise, cognitive performance tests, age, gender, education*

The aging of older population, which is characteristic of most of the world's countries, including Indonesia, is growing fast. Many senior citizen complain most often of forgetfulness (age-associated memory impairment / AAMI), which might be due to a general slowing in information processing and attention deficits with increasing age, this might be a distressing factor for them. Several therapeutic approaches have been done through several strategies such as taking neurotrophic drugs or doing memory training programs or both, to maintain or delay the progress of their cognitive functioning besides maintaining health status.[1]

Caper reported some studies by neuroscientists on brain research in rats which has produced evidence that stimulating the brain intellectually and physically can caused measurable changes in its structures (increase number of neurons and branching dendrites). She also reported the results of new findings in older people by researchers that through aerobic exercises (a brisk of one-hour walk) or yoga-type stretching could increase their cognitive functions on cognitive tests of executive control and

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memory.[2] Studies on comprehensive cognitive performance in the middle-age and elderly people with combination of specific patterns of movements and brain exercises has not been reported. So our team performed a study on specific patterns of movements and brain exercises, which comprises of stretching, breathing exercise, brain movement and exercises, named *Gerak dan Latih Otak (GLO).*

Stretching is needed by older persons to prevent joint and muscles stiffness. Although the brain weight is only 2 percent of the body weight, it requires 20% of the body's total intake of oxygen. In elderly people due to vasoconstriction of the blood vessels, oxygen flow to the brain reduces, which causes slowing in information processing and attention deficits. Breathing exercise increases oxygen flow to the brain, which in turn influence the cognitive functions.[3]

Series of specific patterns of movements and brain exercises are based on the basic mechanism that underlie the attention, memorization process, and recall strategies, i.e.:

1) Brain-body connection could enhance breathing, flexibility, balance, sensory perception, and emotional stability.[4,5]
2) Dual task by motor learning or motor skills. Performing each movements needs attention and concentration.[6]
3) Sensory integration. Stimulating more than one senses together (auditory, visual, touch, kinesthetic) could increase the brain potential.[7,8]
4) Movements crossing the body's midline (eyes, head, extremities) would encourage both brain to work together → whole-brain thinking.[8, 9,10,11,12] These movements also stimulate the midbrain (the ancient brain), which is the center for arousal and attention.[12,13, 14]

The main purpose of this study is to determine the efficacy of specific patterns of movements and brain exercises on the cognitive performance of senior citizens.

METHODS

This study was conducted in September – November 2002. The subjects were healthy senior citizens in Jakarta, residing at five places i.e. Cibubur, Kayu Putih, Mangga Besar, Kelapa Gading, and Senayan. Most of them regularly doing physical exercises. The age range was limited from 48 to 70 years. The minimal education level was finishing elementary school. Before intervention with movements and brain exercises program, medical history, and medical check-up were performed to exclude subjects with severe visual or hearing loss, physical handicapped or suspected to suffer from diseases affecting cognitive functioning. To exclude individuals with possible early dementia, all subjects with MMSE score (Mini Mental State Examination) below 24 were omitted.

All the subjects were told on the purpose and methods of the study; signed written informed consent was obtained from each subject before inclusion. Brain movement and exercise or *Gerak dan Latih Otak / GLO* is series of movements and brain exercises consisted of stretching, breathing exercises, alternating movements of the extremities and crossing movements of the head, eyes, and extremities.The subjects were told that this patterns of exercises is not an aerobic one, so it should be done slowly, gently and with maximum awareness, so that the brain receive precise sensory feedback from the exercises.[12-16] This exercise program was accompanied by music. The number of flute sounds and different color flags were used by the instructor to change the patterns of movements. In this aspect the subjects have to pay attention to memories which patterns of movements should be done according to the flute sound or color of flag. The time required to complete these exercises is around 30 minutes.

To evaluate the benefit of this exercise program, a pre- and post-test of cognitive performance were assessed to the subjects, which were done by well-trained doctors and nurses. The five cognitive performance tests administered individually were: Visual Scanning and Tracking, Delayed Recall, Verbal Fluency, Digits Backward, and Trail Making Test-B. Visual Scanning and Tracking (VST) is a concentration endurance test, to assess sustained attention and visual scanning ability. The subject has to cross out from left to right in a row and count all the tail-letters (g,j,p,q,y). Time for administration is 2 minutes. The total raw score refers to the number of tail-letters the subject has considered regardless of errors. Delayed Recall (DR) is a memory test. The subject has to learn 10 object items mentioned by the tester, repeated three times, and after interference for 15 minutes, the subject has to recall the learned object

items. The scoring is the number of items recalled by the subject. One item scores 1 point. Verbal Fluency (VF) is to assess the ability to name animals as quickly as possible. The time allocation is one minute. And one correct response score 1 point. The total naming score is summing the number of correct responses. Digits Backward (DB) is to evaluate attention and short memory span. The subject has to repeat backward the numbers mentioned by the tester. Start with two digits series. Each digit scores 1 point. The scoring is the maximum digits number the subject could repeat backward.

Trail Making Test-B (TMT-B) is to evaluate the speed for visual search, attention, short term memory capacity, executive function, and motor function. Circles were numbered 1 to 13, and letters A to L. Subjects were instructed to connect the consecutively order numbered and alphabetically lettered circles, by alternating between the two sequences (i.e. 1-A-2-B…); start with circle number 1 until reaching the circle number 13 marked END.

The subject were told not to lift the pencil from the paper and to connect the circles as fast as they could. Performance time was recording the time in seconds from start to complete the test correctly. The subjects had to follow the exercise programs 2 times weekly, half an hour exercise session for two months (16 times). After completing the program, a post-test on the 5 cognitive domain were obtained.

RESULTS

The number of subjects after screening for healthy status, not demented, had followed the exercise program, and completed the pre- and post-test was 70, consisted of 82 females (88,6%) and 8 males (11,4%). The age range was 48 to 70 years, with a mean age of 58,9 $\pm$ 6,03. The education level ranged from 6 to $\geq$ 18 years of schooling. The number of subjects finishing elementary school was 5 (7,1%), junior high school 8 (11,4%), senior high school 32 (42,7%), academy or university 25 (35,7%). Most of the subjects finished senior high school, followed by academy or university. The MMSE scores ranged was 24 to 30 with a mean score of 28,67 $\pm$ 1,41 For statistical analysis the education of the subjects were divided into three groups: low education with duration of education 6-9 years, intermediate 10-12 years, and high 13 or more years (Table 1).

Table 1. Characteristic of subjects by age, education, MMSE scores

Classification	n	%	Mean	SD
No. of subjects		70		
Gender: Female (F)	62	88,6		
Male (M)	8	11,4		
Age (years) range 48-70			58,9	6,03
F			58,2	5,74
M			64,8	5,15
Age group: < 60 years	38	54,3	F / M: n = 37 : 1	
> 60 years	32	45,7	F / M: n = 25 : 7	
Education:				
Low (6-9 yrs)	13	18,6		
Intermediate (10-12 yrs)	32	42,7		
High ($\geq$ 13 yrs)	25	35,7		
MMSE scores range 24 -30			28,67	1,41

Table 2 shows that all the subjects showed high significant increase performance in all the five cognitive domains after performing specific patterns of movements and brain exercises for 16 times half an hour exercise sessions (p=0.000).

Table 3 shows women performed better significantly on all the 5 cognitive tests (p=0.000). Further analyses revealed no significant increase cognitive performance in men, except for VST, DR, and TMT-B (respectively p=0,000, p=0,012, p=0,036).

No different significant increase cognitive performance could be obtained between the age group below 60 years and the age group of 60 years and older (Table 4).

Table 5 show no different significant increase cognitive performance for the low, intermediate, and high educated groups, except for digits backward in the high educated group (p=0,085). The data of the present study in general show a significant increase cognitive performance for age, education, except for gender. Women performed better than men.

Table 2. Distribution of pre- and post-test scores of 70 subjects

Tests	Pre-test		Post-test		
	Range	Mean ± SD	Range	Mean ± SD	p-value
VST	13 - 173	95,74 ± 31,46	63 - 229	131,20 ± 35,49	0,000**
DR	4,0 - 10,0	7,57 ± 1,56	8,0 - 10,0	9,87 ± 0,41	0,000*
VF	10 - 35	16,44 ± 3,27	14 - 30	20,13 ± 3,81	0,000*
DB	2,0 - 6,0	3,99 ± 1,07	3,0 - 6,0	4,80 ± 0,99	0,000**
TMT	53,0 - 300,0	113,66 ± 45,99	25,0 - 198,0	72,57 ± 36,32	0,000**

Abbreviation: VST = Visual Scanning & Tracking, DR = Delayed Recall, VF = Verbal Fluency, DB = Digits Backward, TMT = Trail Making Test-B.
p-value: * = t-test, ** = Wilcoxon Matched-pairs Signed-ranks Test.

Table 3. Distribution of pre- and post-test by gender

n	F: 62 (88,6%)			M: 8 (11,4%)		
Tests	Pre-test Mean (SD)	Post-test Mean (SD)	p	Pre-test Mean (SD)	Post-test Mean (SD)	p
VST	98,85 (31,95)	134,77 (35,84)	0,000**	72,75 (10,74)	103,50 (15,31)	0.000*
DR	7,89 (1,52)	9,85 (0,44)	0,000*	6,75 (1,91)	10,0 (0,00)	0,012**
VF	16,42 (3,23)	20,24 (3,83)	0,000*	16,75 (3,81)	19,25 (3,85)	0,094**
DB	3,94 (1,07)	4,81 (0,97)	0,000**	4,38 (l,06)	4,75 (1,12)	0,419**
TMT	11261 (44,29)	78,74 (28,18)	0,000**	121,75 (60,62)	86,00 (0,97)	0,036**

Table 4. Distribution of pre-test and post-test by age

Age n Tests	< 60 years 38 (54,3%) Pre-test Mean (SD)	Post-test Mean (SD)	p	≥ 60 years 32 (45,7%) Pre-test Mean (SD)	Post-test Mean (SD)	p
VST	102,53 (31,43)	138,08 (37,63)	0,000**	87,72 (30,01)	123,03 (31,41)	0,000**
DR	7,87 (1,34)	9,87 (0,41)	0,000*	7,63 (1,86)	9,88 (0,42)	0,000**
VF	16,79 (3,44)	20,53 (3,82)	0,000*	16,06 (3,09)	19,66 (3,82)	0,000*
DB	4,00 (1,12)	4,87 (0,96)	0,0002**	3,97 (1,03)	4,84 (91,37)	0,002**
TMT-B	108,13 (37,01)	75,39 (27,28)	0,000**	120,22 (54,69)	84,53 (35,34)	0,000**

Table 5. Distribution of pre- and post-test by education

Education	Low n = 13			Intermediate n = 32			High n = 25		
Tests	Pre-test Mean (SD)	Post-test Mean (SD)	p	Pre-test Mean (SD)	Post-test Mean (SD)	p	Pre-test Mean (SD)	Post-test Mean (SD)	p
VST	80,46 (37,97)	114,54 (26,37)	0,002**	98,75 (30,58)	134,41 (37.22)	0,000**	99,88 (27,57)	135,76 (36,04)	0,000**
DR	7,85 (1,73)	9,92 (0,28)	0,001*	7,72 (1,80)	9,88 (0,42)	0,000**	7,76 (1,27)	9,84 (0,47)	0,000*
VF	14,46 (2,16)	19,47 (2,40)	0,000*	16,16 (3,61)	20,47 (4,15)	0,000*	7,88 (2,68)	24,4 (3,99)	0,001*
DB	3,85 (1,46)	4,62 (1,12)	0,012**	3,81 (0,97)	4,86 (0,75)	0,000*	4,28 (0,94)	4,80 (1,19)	0,085*
TMT	142,00 (46,84)	108,59 (31,49)	0,002**	117,63 (52,15)	76,00 (32,80)	0,000**	93,84 (24,63)	69,08 (18,69)	0,000**

DISCUSSION

Many senior citizen complain of memory deficits, due to the reduced function of the right brain, which in part affects the arousal and attention.[17,18] Several studies reported the effectiveness of specific patterns of movements and brain exercises on learning in children and students,[12,14] but research involving senior citizen and elderly had not been found.

The results of the present study shows a comprehensive overview of cognitive changes following specific patterns of movements and brain exercises. The cognitive domains changes were for the sustained attention (VST, DB, and TMT-B), visual scanning ability (VST, TMT-B), memory (DR, DB), language ability (VF), mental ability (TMT-B).

The result of VST after intervention showed highly significant increase (p=0,000) in sustained attention, visual search ability, and memory which was not related to gender, and increasing age. In relation to duration of schooling, subjects in the low educated group (n=13) showed slight lower increase cognitive functions (0,002) compared with the two higher educated groups (p=0.000).

Subjects could memorized better after intervention. No age-related and educational differences were observed (p=0,000), although men showed lower performance in delayed recall than women (p=0,012), which might be due to the small number of male subjects and the mean age of men (64,8 years) was higher than female subjects (58,3 years).

No age related and education level were found on VF post-test. Both showed highly significant increase (p=0,000). In contrast male subjects showed no significant increase (p=0,094).

On the DB test, no significant increase was observed in male subjects (p=0,429) and in the high education group (p=0,085). In the present study increasing age did not influence on the DB test, both showed significant increase ($p \leq 0{,}002$). TMT-B performance showed highly significant increase in relation to age, and duration of education (p=0.000). In male subjects the significant performance increase was lower (p=0,036) than in female subjects (p=0,000).

The significant increase of the cognitive performance could be explained as follows: Stretching relax muscles which improves control of movements, attention, and concentration. Vigorous breathing exercises increase blood flow to the brain which improves blood and oxygen circulation, releases endorphine in the brain and helps to relax; all of which are important for the brain power. Certain patterns of movements that emphasized both sides of the body and both eyes through cross lateral movements would encourage both brain hemispheres to work together. Alfred Tomatis reported his study that listening to music could activate the brain, release endomorphine which increase attention, concentration, memory, motivation for social interaction, and reduce stress.[20]

Although most of the subjects are doing physical exercises regularly, having the above results, we could interpret that in senior citizen summing up the combination of exercises through brain movement and exercise / *GLO* could better enhanced the attention, memory, motor skills and executive functions. This support the 7 fundamental Leviton's concept of "use your brain" to increase the brain power.[3] This in turn could maximize the quality of later life.[19]

CONCLUSION

The results of the statistic analyses showed that:

- In general the subjects showed increase cognitive performance after brain movement and exercise (*GLO*).
- Women showed higher cognitive performance on all the five cognitive tests than men.
- No different significant increase cognitive performance was found between the two age groups.
- In relation to education level the significant increase of the cognitive performance was found for the three education level, except for the DB test in the high education groups.

Suggestion: further studies should be done with the same methodology on larger scale subjects in several places in Indonesia.

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