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ORIGINAL ARTICLE

The Effect of Strength Training on Quality of Sleep and Psychomotor Performance in Elderly Males

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ABSTRACT

Study Objective: physical weakness in elderly is a key factor that affects the psychomotor performance such as speed processing and selective attention in elderly persons and they tend to experience difficulty sleeping compared to younger adults. Therefore, the aim of this study was to investigate the Effect of Strength Training on quality of sleep and Psychomotor performance in elderly males with sleep disorders

Methods: A quasi experimental with pre and posttest design were conducted in this research by which 36 elderly males were recruited from Preventive healthcare Center and randomly divided into two groups either strength training (3 sessions a week for 12 wk.), or a control group. The participants were asked to fill the Pittsburgh Sleep Quality Index (PSQI) at the beginning and end of the study to identify sleep problems. Body composition measures [Waist Hip Ratio (WHR), and Percent Body Fat (PBF)] which are supposed to have effect on psychomotor performance and sleep quality were controlled using body composition analyzer. Cognitrone test (COG) in Vienna system was used to measure speed processing and selective attention as psychometric performance.

Results: The results suggested that quality of sleep and psychomotor performance including speed processing and selective attention were significantly improved in experimental group ($p \leq 0.05$).

Conclusions: As a result, strength training in the elderly is of utmost importance in improving quality of sleep and psychomotor characteristics improvement.

Keywords: Elderly, strength training, attention, concentration

INTRODUCTION

Based on the scientific evidences, aging process results in neurodegenerative processes with substantial loss of sensory, auditory, and vision which can affect the quality of sleep and psychomotor performance (Terpening et al., 2015). Problems with sleep tend to increase with aging. Research indicates that nearly 67% of the elderly people have at least one sleep-related complaint (Foley, Ancoli-Israel, Britz, & Walsh, 2004). According to the previous studies, those older people with regular strength training have more success in doing their daily lives, including personal works and independency (Arnold & Bautmans, 2014). In a study, Kirk-Sanchez and Mc Gough (2014) reported that regular physical activity in aged people, not only affects the physiological/metabolic pathways positively, but also lead to neuroprotective advantageous, and cognitive improvement (Kirk-Sanchez & McGough, 2014). Babaei (2013), Gorelick et al (2011) suggested that that strength exercises improve the cognitive capacities in older people (Babaei, Azali Alamdari, Soltani Tehrani, & Damirchi, 2013; Gorelick et al., 2011). Studies have shown that exercise, under certain conditions, may have

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beneficial effects upon sleep. Regarding to this issue, Baron et al didn't support the interrelationship between exercises and sleep quality (Baron, Reid, & Zee, 2013). One possible reason could be related to their insomnia before testing. However, the use of exercise as a treatment method in sleep disorders and also its major influence (poor psychomotor performance), is rare in clinical research. To the best of our knowledge, few studies have been investigated the effect of resistance training on psychomotor performance and sleep quality in older participants who are not suffering from any special clinical problems. In one side, Strength training are very suitable for elderly persons but the benefits that go beyond strength gain are poorly described. On the other side, little research has been conducted regarding the mechanisms required in strength training that can affect sleep process and psychomotor performance. Therefore, the aim of this study was to study the effect of strength training on quality of sleep and psychomotor performance in elderly males. It was hypothesized that resistance training in aged males would result in significant improvements in psychomotor performance and sleep quality.

METHOD

Participants and Procedure

36 elderly males with sleep disorder aged between 55 and 65 years were recruited for this study voluntarily. Elderly subjects were removed from the study if they had unstable cardiopulmonary conditions, uncontrolled hypertension, diabetes mellitus; severe renal or hepatic diseases, progressive neurological disease, chronic disabling arthritis, significant dementia, anemia and any medical problems that interfered with the psychomotor performance such as depression. The approval of this study was obtained from the Imam Khomeini International University. All subjects were informed about the procedure and they signed an informed consent form prior to their participation in the study. A total of 28 participants completed all phases of the study. They were randomly allocated to two groups. One group went on strength training, while the other group only had no training intervention. The participants were asked to fill the Pittsburgh Sleep Quality Index (PSQI) at the beginning and end of the study. Body composition measures [Waist Hip Ratio (WHR), and Percent Body Fat (PBF)] which are supposed to have effect on physical pains, psychomotor performance and sleep quality were controlled using body composition analyzer.

Psychomotor Test

The study used the Vienna Test System which was a computerized psychological assessment tool (Schuhfried GmbH, Austria). Cognitrone test (COG) in Vienna system was used to measure attention and concentration as psychometric performance. The Cognitrone is based on the theoretical model of Reulecke (1991), which sees concentration as a state that can in principle be described by Energy, Function and precision of task performance. Many studies emphasized reliability and different aspects of validity (content validity, convergent and discriminant validity, construct validity, criterion validity) have been carried out; all these studies indicate that the test is valid (Ong, 2015). Respondents compare a geometric figure with other geometric figures. They then state whether the comparison figure is identical to one of the other four geometric figures. In the test, respondents press different keys to indicate whether the figure is identical with another one or not. The following main variables are scored:

Mean time correct response or correct rejection: Measure of selective attention.

Number of reactions (correct and incorrect): Measure of processing speed.

Exercise Intervention

The training group was trained for 50 min/session, three sessions a week for 2 months. The exercise protocol had a three phases including warming up lasting for 10 minutes (routine of a brisk walk and gentle stretch of arms, knee flexors, calf muscles, lower back muscles); main program included bench press and double leg press, quarter squats up to right angle knee flexion, wide stance mini-squat, quadruped position and step-up exercises, wall slides with upper limb, and standing on one limb with arm support for 30 minutes; and cooling down for 10 minutes; and finishing with cooling down in the form of a brisk walk for 10 min (Shanb & Youssef, 2014).

Pittsburgh Sleep Quality Index (PSQI)

A 19-item self-report questionnaire designed to assess sleep quality (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI yields a score ranging between 0 and 21. The participants filled out the PSQI at the beginning and end of the study to identify sleep problems total score was calculated as a sleep quality scale for each subject.

Statistical Analysis

Data was analyzed using paired t-test and independent t-test. Significance was reported at $p < 0.05$, and all values were reported as means ± standard deviation (SD).

RESULTS

As shown in Table 1, dependent t-test suggested that WHR, PBF of exercise group was significantly improved ($p<0.05$).

As seen in table 2, all indexes relating to sleep were significantly improved in exercise group ($p<0.05$). The results suggested that there was a significant difference in experimental group at posttest stage of sleep quality (p=0.001) sleep latency (p=0.001), sleep duration (p=0.001), sleep efficiency (p=0.001), sleep disturbance (p=0.001), sleep medications (p=0.001), daytime dysfunction (p=0.001) and finale general quality of sleep (p=0.001).

Based on paired t-test in Fig 1, total PSQI score of Strength training group was significantly improved in posttest compared to pretest (p=0.001), while no

Table 1. The General characteristics of subjects

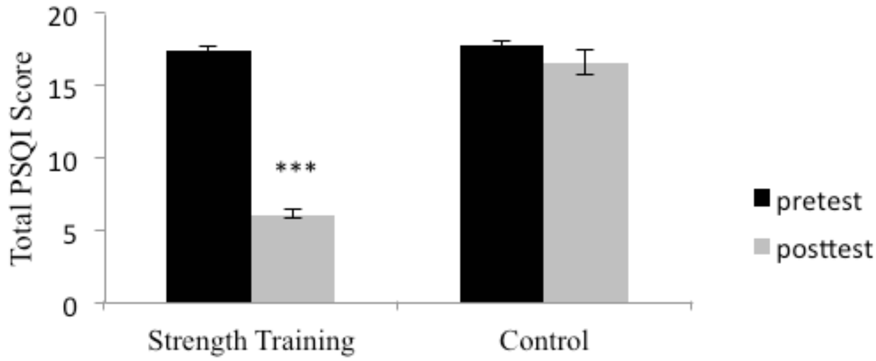
	SG		Control	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**
Age (yr)	59.40±4.67		64.8±.5.8	
Height (cm)	180.2 ± 3.3		179.9±3.8	
Weight (kg)	82.2±3.7	79.1±3.8**	82.8±5.1	83.2±4.9
WHR (cm)	0.91±04	0.88±0.02***	0.91±0.03	0.90±0.04
PBF (%)	0.34±0.03	0.31±0.02***	33.3±1.4	33.1±0.3

**. P<0.01
**. P<0.001
SG, Strength Group; PBF, Percent Body Fat; WHR, Waist/Hip Ratio

Table 2. Sleep indexes of subjects before and after intervention

	Groups	Pre-test	Post-test	t (df)	p	d
Sleep quality	Strength training	2.80±0.56	0.66 ±0.48	12.91(14)	0.001**	3.20
	Control	3.01±.0.53	2.80±0.56	1.38 (14)	.189	0.55
Sleep latency	Strength training	2.06±.96	0.93±0.25	4.14(14)	0.001**	1.61
	Control	2.86±0.63	2.53±0.51	1.32(14)	0.11	0.57
Sleep duration	Strength training	2.80±.41	0.93±0.70	14.00(14)	0.001**	3.25
	Control	2.53±.63	2.26±0.70	1.46(14)	0.16	0.40
Sleep Efficiency	Strength training	2.53±.74	0.80±0.77	8.40(14)	0.001**	2.36
	Control	2 .13±.51	2 .33±0.72	-1.14(14)	0.27	0.32
Sleep disturbance	Strength training	2.26±.45	.99±0.02	10.71(14)	0.001**	3.6
	Control	2.40±.50	2.35±0.48	0.56(14)	0.58	0.10
Sleep medications	Strength training	2.45±.51	0.86±0.50	9.79(14)	0.001**	3.10
	Control	2.13±.74	2.10±0.51	0.001(14)	0.99	0.04
Daytime dysfunction	Strength training	2.53±.51	0.93±0.51	9.76(14)	0.001**	3.11
	Control	2.73±.49	2.46±0.51	3.83(14)	0. 04*	0.53

Data are expressed as mean±SD. *p≤0.05; **p≤0.01



***. p≤0.001

Figure 1. Comparison of Total PSQI Score in strength training and control groups

Table 3. Psychomotor indexes of subjects before and after intervention

		Groups	Pre-test	Post-test	t (df)	p	d
Processing Speed	Number of correct responses	Strength training	22.06±1.60	24.22±1.35	-4.44 (14)	0.001***	1.45.
		Control	22.18±1.63	21.83±1.18	1.23 (14)	0.23	0.24
	Number of correct rejection	Strength training	31.67±1.01	33.49±0.69	-6.68 (14)	0.001***	2.09
		Control	31.48±1.32	31.10±0.77	1.70(14)	0.11	0.35
Selective attention	Mean time for correct responses	Strength training	1.87±0.05	1.61±0.03	20.11(14)	0.001***	5.4
		Control	1.86±0.04	1.87±0.05	-1.30(14)	0.21	0.18
	Mean time for correct rejections	Strength training	1.93±0.11	1.69±0.05	16.31(14)	0.001***	3.1
		Control	1.91±0.02	1.93±0.12	-1.65(14)	0.12	0.26

significant difference was found in control group (p=0.43).

In speed processing index, the number of correct responses and number of correct rejection were significantly improved after exercise intervention (p<0.05) while no significant change was occurred in control group. In selective attention, the mean time for correct responses in training group was significantly improved in both subscales of selective attention (respectively mean time for correct responses and rejections).

DISCUSSION

In this research, the effect of strength training on quality of sleep and psychomotor performance in elderly males was examined. The results suggested that quality of sleep components (quality of sleep, sleep latency, sleep duration, sleep efficiency, sleep disturbance, sleep medications, daytime dysfunction and general quality of sleep) was significantly improved after training intervention. On the other hand, it was shown that speed processing and Selective attention of participants were significantly improved after training. These results highlight the potential of the strength training to improve the sleep indexes and psychomotor characteristics in elderly males.

As shown in result section, there was also a decrease in WHR, PBF of exercise group after training intervention. This can be a logical reason for sleep improvement in experimental group as Taheri et.al (2017), Martin er al (2016) reported that fat mass decline especially internally is positively associated in better sleep quality (Martín et al., 2016; Taheri & Irandoust, 2017). In other words, decreasing the visceral fat of subjects can be effective in improvement of sleep indexes and consequently betterment of attention in the investigated subjects. moreever, according to the theory of preserving the energy of the body, exercise can improve the circadian rhythms and increase adenosine levels in the body by which sleep is more regulated (Reid et al., 2010). On the other side, doing regular exercise results in more growth hormone secretion which play the key role in quality and quantity of sleep and prevents weak performance over the day (Reid et al., 2010).

In a study, sleep latency was improved following exercise therapy, but no change was occurred in other factors including sleep duration, sleep efficiency, sleep disturbance, and daytime functioning(Yang, Ho, Chen, & Chien, 2012). Age difference and different kinds of training protocols may be a reason for the different results. The Results indicated the positive effects of strength training on all variables of sleep index. it is possible that exercise therapy applied in the daytime may increase melatonin secretion thus maintain longer periods of more optimal sleep quality. In agreement to our study, a large body of research demonstrates that poor sleep quality affects psychomotor abilities(Ellis, Walczyk, Buboltz, & Felix, 2014), so, Its highly expected that each intervention that is capable of sleep improvement, can increase the attention and concentration. One of the possible mechanisms for improvement of psychomotor performance in training group may be due to augmentation of oxygen uptake, inhibition of vascular inflammatory processes, Rheological alterations in blood (Mazzulla et al., 2015). Gorelick et al (2011) reported that regular strength exercises promote vascularization in the body and enhance essential nutrient supply to the brain. Therefore, it can be considered as a a nonpharmacological intervention to bring vascular, cognitive, and neuro-motor benefits to the elderly population. Comparatively few studies have examined the effect of resistance training on attention/concentration and sleep as opposed to aerobic exercise, and fewer still have examined the effect of resistance training on older participants sleep. Singh and colleagues emphasized a positive effect of strength training on sleep quality of depressed aged subjects at the age of 71.3 ± 1.2 years (Singh, Clements, & Fiatarone, 1997). Our results are in consistent with Singh et al. (1997) and indicate that regular strength training can improve sleep in aged people. Babaei et al (2013) reported that the exercise can act as an enhancer of brain-derived neurotrophic factor that substantially improves cognitive performance in aged people. Based on her report, neurotrophic signals (both at the central and peripheral systems) would be released in the bloodstream after exercise and lead to improvement in cognitive performance. All in all, much variability is found in the research literature relating to the effect of exercise on sleep problems and cognitive performance. The results variability may be due to age differences, a time-of-day training effect and different protocols of raining. This may make it difficult to generalize the extent to which conclusions can be generalized. Other limitation is the low number of participants attending in the study. It must be noted that their psychological states such as stress, anxiety, and arousal are vital issues that must be taken into consideration into future studies.

Routinely, when considering sleep disturbances, subjective measures such as the PSQI have been used in the absence of objective indices. Objective effort and subjective effort appear to result from different sources. Subjective effort may reflect personality variables rather than sleep (Engle-Friedman, Riela, & Strothers, 2008). Future research can overcome the limitations of the present study by measuring objective measures. There is a high accordance rate between physiological measures such as polysomnography and self-reports of sleep tendencies that must be taken into consideration in future studies. Besides, sleep differs between weekdays and weekends (Jones & Callen, 2008). Its recommended to study the sleep and psychomotor performance of elderly in both states.

Conclusively, psychomotor performance and sleep quality are interrelated, so regular strength exercise can be applied to alleviate sleep quality and consequently attention and concentration in the elderly.

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Conflict of Interests

None was declared.

References

Arnold, P., & Bautmans, I. (2014). The influence of strength training on muscle activation in elderly persons: a systematic review and meta-analysis. *Experimental Gerontology, 58*, 58-68.

Babaei, P., Azali Alamdari, K., Soltani Tehrani, B., & Damirchi, A. (2013). Effect of six weeks of endurance exercise and following detraining on serum brain derived neurotrophic factor and memory performance in middle aged males with metabolic syndrome. *Journal of Sports Medicine and Physical Fitness, 53*(4), 437-443.

Baron, K. G., Reid, K. J., & Zee, P. C. (2013). Exercise to improve sleep in insomnia: exploration of the bidirectional effects. *Journal of Clinical Sleep Medicine, 9*(8), 819-824. doi:10.5664/jcsm.2930

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193-213.

Ellis, S. K., Walczyk, J. J., Buboltz, W., & Felix, V. (2014). The relationship between self-reported sleep quality and reading comprehension skills. *Sleep Science, 7*(4), 189-196. doi:10.1016/j.slsci.2014.12.001

Engle-Friedman, M., Riela, S., & Strothers, E. (2008). Objective and subjective effort as a function of sleep and energy. *Sleep and Hypnosis, 10*(2).

Foley, D., Ancoli-Israel, S., Britz, P., & Walsh, J. (2004). Sleep disturbances and chronic disease in older adults: results of the 2003 National Sleep Foundation Sleep in America Survey. *Journal of Psychosom Reserch, 56*(5), 497-502. doi:10.1016/j.jpsychores.2004.02.010

Gorelick, P. B., Scuteri, A., Black, S. E., Decarli, C., Greenberg, S. M., Iadecola, C., . . . Seshadri, S. (2011). Vascular contributions to cognitive impairment and dementia: a statement for healthcare professionals from the american heart association/american stroke association. *Stroke, 42*(9), 2672-2713. doi:10.1161/STR.0b013e3182299496

Jones, K., & Callen, F. (2008). Sleep, energy and self rated cognition across 7 nights following recreational ecstasy/MDMA use. *Sleep and Hypnosis, 10*(1), 26.

Kirk-Sanchez, N. J., & McGough, E. L. (2014). Physical exercise and cognitive performance in the elderly: current perspectives. *Clinical Interventions in Aging, 9*, 51-62. doi:10.2147/cia.s39506

Martín, I. S. M., Gudalewska, P., Rosa, L. d. l. C. d. l., Fernández, M. G., Gamarra, A. M., Rivera, B. M., . . . Vilar, E. G. (2016). Influence of Body Composition on Sleep in People Who Exercise. *Sleep and Hypnosis*, 2-7. doi:10.5350/Sleep.Hypn.2016.180102

Mazzulla, S., Schella, A., Gabriele, D., Baldino, N., Sesti, S., Perrotta, E., . . . de Cindio, B. (2015). Oxidation of human red blood cells by a free radical initiator: effects on rheological properties. *Clinical Hemorheology and Microcirculation, 60*(4), 375-388. doi:10.3233/ch-141841

Ong, N. C. H. (2015). The use of the Vienna Test System in sport psychology research: A review. *International Review of Sport and Exercise Psychology, 8*(1), 204-223.

Reid, K. J., Baron, K. G., Lu, B., Naylor, E., Wolfe, L., & Zee, P. C. (2010). Aerobic exercise improves self-reported sleep and quality of life in older adults with insomnia. *Sleep Med, 11*(9), 934-940. doi:10.1016/j.sleep.2010.04.014

Shanb, A. A., & Youssef, E. F. (2014). The impact of adding weight-bearing exercise versus nonweight bearing programs to the medical treatment of elderly patients with osteoporosis. *Journal of Family Community Medicine, 21*(3), 176-181. doi:10.4103/2230-8229.142972

Singh, N. A., Clements, K. M., & Fiatarone, M. A. (1997). A randomized controlled trial of the effect of exercise on sleep. *Sleep, 20*(2), 95-101.

Taheri, M., & Irandoust, K. (2017). The Exercise-Induced Weight Loss Improves Self-Reported Quality of Sleep in Obese Elderly Women with Sleep Disorders. *Sleep and Hypnosis*. doi:10.5350/Sleep.Hypn.2017.19.0134

Terpening, Z., Lewis, S. J., Yee, B. J., Grunstein, R. R., Hickie, I. B., & Naismith, S. L. (2015). Association between Sleep-Disordered Breathing and Neuropsychological Performance in Older Adults with Mild Cognitive Impairment. *Journal of Alzheimer's Disease, 46*(1), 157-165. doi:10.3233/JAD-141860

Yang, P. Y., Ho, K. H., Chen, H. C., & Chien, M. Y. (2012). Exercise training improves sleep quality in middle-aged and older adults with sleep problems: a systematic review. *Journal of Physiotherapy, 58*(3), 157-163. doi:10.1016/s1836-9553(12)70106-6