Journal of Human Kinetics volume 17, 2007, 15-24

The Influence of Strength Exercises on Hand Tapping in Women Aged 20 to 70 Years

by

Tomasz Głowacki[1], Teresa Zwierko[2], Wiesław Osiński[3]

The aim of this research was to determine the differences in hand tapping of female subjects at different levels of motor development, and the influence of fatigue inducing strength exercises on this ability. The research was conducted on 34 female subjects aged 65-70 years ($\bar{x}$ =68.03±2.62) and 30 young female students of the institute of physical education ($\bar{x}$ =21.0±1.5). Maximum frequency of movements was measured with the MLS machine included in the Vienna Test System. A participant was to tap a 40mmx40mm square with a stylus as fast as possible for 32 seconds. Then the participants carried out a strength exercise for 30 secs (Rikli, Jones 2001). Then immediately after the exercise the tapping test was carried out. Each participant performed the routine (strength exercise (30 secs) and the tapping test) 5 times. Older women were observed to have significantly lower results after the first effort, and the subsequent efforts induced smaller and smaller variances. In the younger group the rate of decrease in tapping results did not change across the efforts. Significant differences in the ability to perform movements with maximum frequency were found between the studied groups. Age is a significant factor influencing these differences. The analysis of the results did not show any significant differences in the types of variances, between the groups of older and younger women.

Key words: *strength exercises, tappimg, women*

1 - Msc., Institute of Physical Education, Higher Vocational State School, Leszno ul. Mickiewicza 5

2 - Ph.D., Institute of Physical Culture, University of Szczecin, Al. Piastów 46 b. 6

3 - Prof. Ph.D. hab., Department of Methodology and Theory of Physical Education, Academy of Physical Education, Poznań, ul. Królowej Jadwigi 27/39

Introduction

The ability to perform the movement with maximal frequency is dependent in great extent to efficiency of the central nervous system governing the antagonistic muscle groups and the fast switching between activation and inhibition (Sozański and Witczak 1981). Existing data show that development of maximal frequency movements has its maximum between 6 and 20 years, while between the ages of 20 and 25 it stabilizes. The dynamics of involution shows similar tendencies to the progressive period, however greater individual dispersion was observed (Szopa 1988, Żak 1991). It was also clearly stated, that the character of involutionary changes is strictly related to the biological process of ageing. Christianson (2004) researched 86 male and female subjects aged between 16 and 70 years and showed statistically significant differences in finger tapping results between age groups.

It is common that among older subjects a faster rate of fatigue in complicated tasks appears as a result of the decrease in quality of their co-ordination processes. The rate of fatigue in older adults may be also correlated with weakening of muscle function related to muscle mass decrease. Repeatedly, even in actions requiring relatively small forces, subjects engaged a proportionally greater amount of motor units in relation to younger subjects (Celichovski 1999b).

The main aim of this research was to determine differences in hand tapping of female subjects at different levels of motor development, and the influence of fatigue inducing strength exercises on this ability.

Material and methods

The research was conducted on 34 female subjects aged 65-70 years ($\bar{x}$=68.03±2.62) and 30 young female students of the institute of physical education ($\bar{x}$=21.0±1.5). The youngest subject in the "older group" was 65, according to Spiriduso border value for the category he named "young elderly" (1995a). The random selection of students was based on the opinion that the age of subjects eliminates the influence of developmental factors to very high degree. The central and peripheral nervous system is, at this age, anatomically and functionally formed and stabilized. Both groups were specifically comprised of subjects without sporting experience and additional physical activities. The average body height of the older group was equal to 156.38±6.45 cm while the students measured 166.27±5.85 cm. Body mass was respectively equal to 70.85±12.57 kg and 61.84±8.30 kg.

The research was conducted in January of 2005 at The Laboratory of Motor Diagnostics at The Institute of Physical Education, Komenski Higher Vocational School, Leszno. All subjects provided their written consent regarding their participation in the research and were allowed do resign at any stage of the measurements. The Bioethical Commission of The Medical Academy in Poznań expressed their written consent to conduct the presented research.

An ability to perform movements at maximum frequency was examined with MLS (Motorische Leisstung Serie) apparatus, series 020669/01, included in the Vienna Test System (dr G. Schuhfried, Austria). The MLS consists of a 300x300x15 mm plate (brass and aluminum), with holes, a groove and contact surfaces, and also two styli on either side, connected to the plate with two cables (Fig. 1).

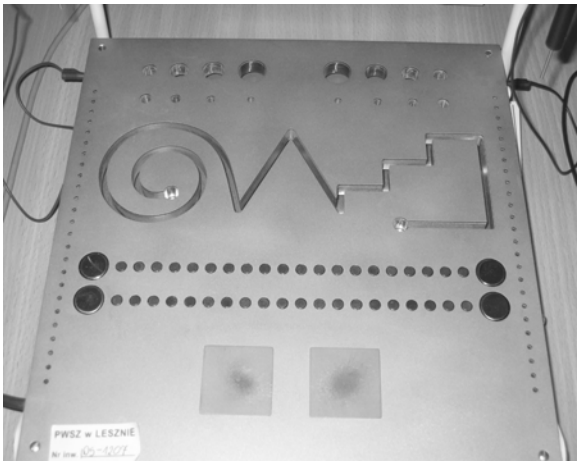

Fig. 1

MLS apparatus (Motorische Leisstung Serie).

Each of the participants was prepared for the main task by participating in pre-tests that allowed them to familiarise themselves with the apparatus and the nature of the task.

The first stage of study included a tapping test, conducted after the participants had experienced a period of rest. Each subject was asked to tap a 40mmx40mm square with a vertically handled stylus as quickly and as often as possible for 32 seconds whilst the number of taps was measured.

Before the first effort-inducing exercise participants took part in a warm-up led by a fitness instructor, based on an eight minute stretching routine by Rikli and Jones (2001).

Each participant then carried out a physical exercise for 30 secs. They were asked to sit on a chair (Fig. 2) with their feet flat on the ground, then lifted

a 2.27kg load, bending only at the elbow (Rikli, Jones 2001). Immediately after the strength exercise was finished, the tapping test was carried out.

Each subject performed the routine (strength exercise - 30 secs) and the tapping test) 5 times. Both tests were carried out with the dominant hand.

Fig. 2

Effort-inducing exercise (Rikli, Jones 2001).

To confirm the significance of differences between the groups the ANOVA analysis of variances was used. The differences within the groups were measured with post-hoc Tukey's test (HSD).

Results

The analysis showed significant effort-induced changes in the maximum frequency tapping performed by the participants (Table 1).

Multiple effort significantly changed the results of the tapping tests in both groups of women examined. (F=7.71, p≤0.001).

Table 1

Mean results of the tapping tests before and after subsequent efforts

	Tapping (number of taps)						
Group	rest $\bar{x}_S \pm SD$	effort 1 $\bar{x}_1 \pm SD$	effort 2 $\bar{x}_2 \pm SD$	effort 3 $\bar{x}_3 \pm SD$	effort 4 $\bar{x}_4 \pm SD$	effort 5 $\bar{x}_5 \pm SD$	F
older women	165.38 ± 34.09	156.32 ± 30.39	156.29 ± 36.12	156.88 ± 36.30	157.85 ± 32.41	154.32 ± 32.32	7.71**
younger women	213.38± 34.32	210.87± 34.89	208.29± 32.53	209.87± 32.94	204.12± 30.65	203.90± 29.74	

** $p \leq 0.001$

The post-hoc analysis shows significant differences between the results obtained initially, and after the very first effort, when the values dropped on average by 9.059 taps ($p \leq 0.01$). The following tapping tests did not continue to change in a significant manner. The results after the 2nd, 3rd, 4th, and the 5th efforts increased on average in comparison with earlier measurements, but they were not statistically significant. In the younger group, the results subsequent to the effort tests, did not differ significantly either (Table 2 and Fig. 3).

Table 2

Changes in tapping after subsequent efforts

	Tapping (number of taps)				
group	effort 1 change d_{1-S}	effort 2 change d_{2-1}	effort 3 change d_{3-2}	effort 4 change d_{4-3}	effort 5 change d_{5-4}
older women	-9.06*	-0.03	+ 0.59	+ 0.97	-3.53
younger women	-2.516	-2,580	+1.580	-5.741	-0.225

** p ≤0.01*

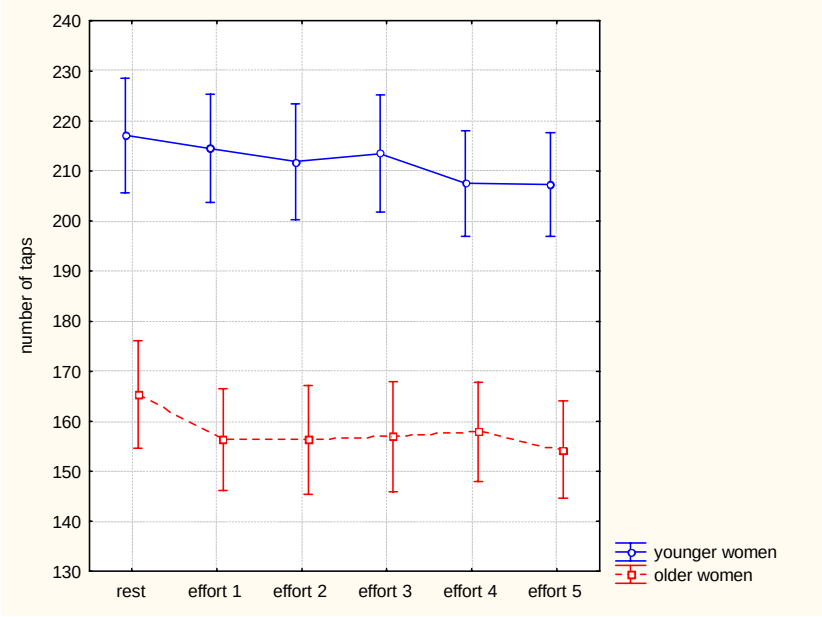

Fig. 3

Tapping results during rest and after subsequent efforts

The analysis of variances between the groups shows significantly lower results in the older group than in the younger one (F=55.71, p≤0.001). Therefore age significantly influenced the differences between the groups (Table 3). However, post-hoc tests do not confirm significant differences between the types of variances in the group of older women, compared to the the younger group. In no case was a difference between variances of the results found in compared groups after subsequent efforts.

Table 3

Differences of results of the tapping tests before and after subsequent efforts in compared groups

Test	Difference rest $\bar{x}_S$	Difference effort 1 $\bar{x}_1$	Difference effort 2 $\bar{x}_2$	Difference effort 3 $\bar{x}_3$	Difference effort 4 $\bar{x}_4$	Difference effort 5 $\bar{x}_5$	F
Tapping (number of taps)	48.00	54.55	52.00	52.99	46.27	49.58	55.71**

** *p≤0.001*

Discussion

It is widely accepted that tapping is a good way of examining the ability of the central nervous system and its effectors. In the five subsequent measurements, the mean number of taps was significantly lower in the group of older women than in the younger ones. Our own studies confirmed a strict relationship between the ability to perform movements at maximum frequency, and the age of the examined individuals (Heaton et al. 1986, Ardila i Roselli, 1989).

In the study by Christianson (2004) significant differences in dominant hand tapping were observed between the group of 25-39 year olds and 55-70 year olds. In the non-dominant hand test, the elderly group (55-70) performed significantly fewer taps ($\bar{x}$=46.4±7.3) than the 16-24 year old group ($\bar{x}$ = 50.8±5.9), 25-39 y.o. ($\bar{x}$ = 52.3±6.3), and 40-54 y.o. ($\bar{x}$ = 50.0±5.89). Ylikowski et al. (1998), in their study on 113 adults, aged from 55 to 80, reported significant differences (p≤0.001) in the results of a finger tapping test between groups of elderly subjects in the below specified age categories: 55-60, 65-70 and 75-85 years old. The results of both left and right hands significantly decreased with age.

A computer analysis of five 10sec tapping tests, carried out by Cousins et al. (1998) among 18 years olds and 75 year olds, shows that the elderly have a longer response initiation time and response duration time, and significantly longer response time of a finger tap compared to younger people.

Bodwell et al. (2003), using EMG (electromyography) of forearm muscles, analysed the results of 12 various unilateral finger tapping tasks in young (n=20) and older people (n=20). The study indicated that the faster movement rate, cognitive distraction and fatigue showed significant differences between the groups.

The analysis of own results shows that five subsequent efforts induced a statistically significant decrease ($p \leq 0.001$) in tapping results, both in older and younger women. The analysis of variances, however, shows a different course of effort-induced changes in the group of older women. Older women's performance was significantly decreased, immediately after the first exercise. Along with the consecutive trials, the variances decreased and the results became more and more regular and stable. In turn, young women did not significantly increase the number of taps after their subsequent efforts.

In the study by Waskiewicz (2002), anaerobic effort (3-subsequent Wingate tests) resulted in linearly decreasing results in the bimanual tapping test performed by young men (22.4±1.3 years). The differences were significant, except for the penultimate and the last exercise, where changes in the frequency of movements were smaller and statistically insignificant.

Vanneste et al. (2001) observed the tapping results over 5 days of an experiment carried out amongst young (from 20 to 30 years) and elderly people (from 60 to 76 years). The tapping was performed at the participants' own preferred rate and the elderly group had significantly and consistently lower results than the younger subjects, whereby the elderly people seemed to keep a more steady rate of tapping over the five days of the experiment. In the second task of the aforementioned test (synchronized-tapping and continuation task), the subjects performed tapping synchronously to a given tempo (interresponse times 300, 400, 500, 600 and 700 msecs) and continued the task for a prolonged time. In both groups the variance increased along with the rate of the given tempo. There were no significant differences between both groups. The studies show a slower tempo of internal timing processes in older individuals, however the study did not show relatively great variances of results between the study groups.

The aforementioned reports and this study suggest that the different character of the effort-induced changes within groups, results from the well-known biological processes of aging, such as a decrease in the mass and strength of muscles, lower nerve responsiveness, reduction in contractions of muscles, and numerous changes at cellular and enzymatic levels (Budzinska 2005).

Lexell (1997) argues that the most important factor leading to sarcopenia is the degeneration of the neural system. The disappearance of alpha-

mononeurons leads to the atrophy of muscle components, displaying that the process of degeneration starts after the age of 60.

The process of aging is accompanied by the reduction of the active cells in the most vital organs, especially brain and muscles, and gradual decrease in those organs' efficiency and adaptational mechanisms. A parallel decrease in neural and muscular coordination and demyelinization of neural fibers contribute to the impairmant of motor fitness (Celichowski 1999a). Studies carried out on young adults confirm the influence of the neurolgical state on the ability to perform movements with maximum frequency. Elazary et al. (2003) report that the observed phenomenon of tapping acceleration is strictly related to the age of the examined individuals. Ylikowski et al. (2000) confirm a significant realtionship between the tapping results and extrapyramidal signs present in the elderly.

Spirduso (1995b) in their analysis of perfoming 25s finger tapping task in people of 60 and 70 years of age, reported 5 periods of variances in results. The first five seconds of the test was characterized by steady improvement, and could be treated as warm up. In the next 5 seconds maximum frequency was reached, and in the subsequent 5s periods the results decreased due to fatigue. One of the signs of fatigue was a longer press time.

Conclusions

1. In consequence of 5 efforts, an ability to perform movements with a maximum frequency decreased significantly both in the group of older women and in the group of younger ones.
2. The rate of changes differed between the groups. Older women were observed to have significantly lower results after the first effort, and the subsequent efforts induced smaller and smaller variances. In the younger group the rate of decrease in tapping results did not change across the efforts.
3. Significant differences in the ability to perform movements with maximum frequency were found between the studied groups. Age is a significant factor influencing these differences.
4. The analysis of the results did not show any significant differences in the types of variances, between the groups of older and younger women.

References

Ardila A., Roselli M. 1989. Neuropsychological characteristics of normal aging. Developmental Neuropsychology, 5: 307-320.

Bodwell J.A., Mahurin R. K., Waddle S., Price R., Cramer S.C. 2003. Age and features of movement influence motor overflow. Journal of the American Geriatrics Society, 51: 17-35.

Budzińska K. 2005. Wpływ starzenia się organizmu na biologię mięśni szkieletowych. Gerontologia Polska, 13 (1): 1-7. (in Polish).

Celichowski J. 1999a. Wpływ starzenia się organizmu na cechy i czynność jednostek ruchowych. Zeszyty Naukowe AWF Poznań, 47/48: 153-164. (in Polish).

Celichowski J. 1999b. Zmiany cech jednostek ruchowych związane ze starzeniem się organizmu a aktywność ruchowa. Medycyna Sportowa, 98:13. (in Polish).

Christianson M.K. 2004. Development and standardization of computerised finger tapping test: Comparison with other finger tapping instruments. New Zealand Journal of Psychology, 6: 34-42.

Cousins M.S., Corrow C., Finn M., Salamone J.D. 1998. Temporal measures of human finger tapping: Effects of age. Pharmacology Biochemistry and Behavior, 59 (2): 445-449.

Elazary As., Attia R., Bergman H., Ben-Pazi H. 2003. Age-related accelerated tapping response in healthy population. Percept. Mot. Skills. 96(1): 227-235.

Heaton R.K., Grant I., Matthews C.G. 1986. Differences in neuropsychological test performance associated with age, education and sex. In Neuropsychological assessment of neuropsychiatric disorders (eds. Grant I, Adams K.M.). New York:100 -119.

Lexell J. 1997. Evidence for nervous system degeneration with advancing age. Nutr;127 (Suppl.5): 1011-1013.

Rikli R.E., Jones C.J. 2001. Senior Fitness Test Manual. California State University in Fullerton.

Sozański H., Witczak T. 1981. Trening szybkości. Sit, Warszawa. (in Polish).

Spirduso W. W. 1995a. Physical dimensions of aging. Champaign: Human Kinetics Publisher.

Spirduso W. W. 1995b. The effects of complexity, practice, warm-up and fatigue on finger-tapping in younger and older women. Journal of aging and physical activity, 3 (4): 360-372.

Szopa J. 1988. Zmienność podstawowych cech somatycznych i funkcjonalnych dorosłych mieszkańców Krakowa w przedziale wieku 19-62 lat, z uwzględnieniem zróżnicowania społeczno-zawodowego. Materiały i Prace Antrop., 109:73-103. (in Polish).

Waśkiewicz Z. 2002. Przebieg procesu koordynowania ruchów człowieka pod wpływem anaerobowych wysiłków fizycznych. AWF Katowice. (in Polish).

Vanneste S., Pouthas V., Wearder J.H. 2001. Temporal control of rhythmic performance: A comparison between young and old adults. Experimental Aging Research, 27: 83-102.

Ylikoski R., Ylikoski A., Erkinjuntti T., Sulkava R., Keskivaara P., Raininko R., Tilvis R. 1998. Differences in neuropsychological functioning associad with age, education, neurological status, and magnetic resonance imaging findings in neurologically healthy elderly individuals. Applied Neuropsychology, 5, (1): 1-14.

Ylikoski R. 2000. The relatiomship of neuropsychological functioning with demographic characteristics, brain imaging findings, and health in elderly individuals. University of Helsinki.

Żak S. 1991. Zdolności koordynacyjne dzieci i młodzieży z populacji wielkomiejskiej na tle wybranych uwarunkowań somatycznych i aktywności ruchowej. Wyd. Monograficzne. AWF Kraków, 43. (in Polish).

Corresponding Author:

Tomasz Głowacki, Msc.
Institute of Physical Education,
Higher Vocational State School,
Leszno ul. Mickiewicza 5
e-mail: sekretariatiwf@pwsz.edu.pl
Phone: +48 65 5287852, Fax: +48 65 529 60 76

Authors submited their contribution of the article to the editorial board.
Accepted for pinting in Journal of Human Kinetics vol. 17/2007 on march 2007.