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Original Research Article

A Hospital Based Comparative Evaluation of Hand Grip Strength & Fine Motor Skills in Skilled & Non-Skilled Persons

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Abstract

Aim: The aim of the present study was to assess the hand grip strength & fine motor skills in skilled & non skilled persons.

Methods: The present study was conducted in the Department of Physiology. We recruited 100 healthy adults aged 20–40 years who had no difficulties in following the researcher's instructions, who had sufficient muscle strength to conduct the given task, and who were without limitations in the range of motion of the joints.

Results: There were no significant between-group differences in the general characteristics ($p > 0.05$). There were no significant between-group differences in the pre-intervention CMT time (experimental, 59.62 ±15.02 s; control, 61.91 ±15.14 s; $p > 0.05$) and post-intervention CMT time (experimental, 51.67 ±9.73 s; control, 50.30 ±14.50 s; $p > 0.05$). In the experimental group, the CMT time significantly improved from 59.62 ±15.02 s to 51.67 ±9.73 s ($p < 0.05$); similarly, the CMT time in the control group significantly improved from 61.91 ±15.14 s to 50.30 ±14.50 s ($p < 0.05$). There were no significant between-group differences in the pre-intervention PPT time (experimental, 58.13 ±10.86 s; control, 58.30 ±7.80 s; $p > 0.05$) and post-intervention PPT time (experimental, 52.80 ±6.31 s; control, 54.58 ±6.23 s; $p > 0.05$). In the experimental group, the PPT time significantly improved from 58.13 ±10.86 s to 52.80± 6.31 s ($p < 0.05$). In the control group, the PPT time significantly improved from 58.30 ±7.80 s to 54.58 ±6.23 s ($p < 0.05$).

Conclusion: Fine motor skill such as FT & PDT improves by decreasing the muscle strength in skilled persons when compared to non-skilled persons.

Keywords: hand grip strength, fine motor skills, skilled persons, non-skilled persons

Introduction

Hand anthropometry finds extensive application across multiple domains, including ergonomics, biomechanics, product design, forensic science, and medical research. It plays a vital role in tailoring products, tools, and interfaces to accommodate diverse hand sizes, thereby enhancing usability and comfort. [1] The study of hand anthropometry yields valuable insights into the physical characteristics and functional capabilities of the hand, enabling the design of products and environments that optimize comfort, usability, and performance. [2] In addition, it helps establish correlations between hand dimensions and essential parameters such as grip strength, dexterity, and fine motor skills. Such knowledge has significant implications in fields such as rehabilitation, sports science, and occupational therapy. Hand anthropometry data aid in establishing normative values, creating ergonomic hand models, evaluating hand function and abilities, and assisting forensic identifications based on handprints or fingerprints. [3,4]

Hand-related brain cortical excitability can be increased through mirror training. This training method involves visual feedback and was first introduced to treat phantom pain in patients with upper extremity amputation. [5] In this training method, positive visual feedback involving observation that the dominant hand movement reflected on the mirror is the movement of the non-dominant hand facilitates functional restoration of the nondominant hand. [6] Mirror training has also been used for patients with neurological damage such as stroke [7] and athletes with musculoskeletal injuries. [8] Although the beneficial effects of this training method have been reported, the mechanisms underlying the motor-function improvement and pain relief remain unclear [9], with the mirror neuron system being considered to be neurologically related. [10]

A decrease in hand function may also result from changes in the peripheral nervous system, such as a reduction in nerve conduction velocity, sensory perception, or the excitation–contraction coupling of motor units. [11,12] It has been suggested that a lower tolerance to muscle fatigue in the elderly is associated with changes in both muscle and the central nervous system. [13] In addition, impaired sensory perception is considered to be responsible for reduced sensorimotor performance. [14] Altogether, the complex age-related changes in the physiology of the human brain and entire central nervous system are manifested by a decrease in perception and cognitive ability, slowed motor activity, and a loss of various motor skills. [15] Furthermore, the ability to repeat movements at a high frequency is largely dependent on how the central nervous system regulates antagonistic muscle groups and the mechanism of muscle activation and inhibition. These aspects are also influenced by the aging process, where again a quicker onset of fatigue has been observed in the elderly. Even activities requiring relatively little strength have seen the elderly use a proportionately greater number of motor units than younger individuals. [16]

The aim of the present study was to assess the hand grip strength & fine motor skills in skilled & non skilled persons.

Materials and Methods

The present study was conducted in the Department of Physiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India for one year. We recruited 100 healthy adults aged 20–40 years who had no difficulties in following the researcher’s instructions, who had sufficient muscle strength to conduct the given task, and who were without limitations in the range of motion of the joints.

Inclusion Criteria

- Males & Females
- Subjects aged 20 – 40 yrs
- Computer operators
- No History of systemic disorders
- No History of medication

Exclusion Criteria

- Subjects aged < 18 and > 40 yrs
- Non computer operators
- Other systemic disorders
- History of medication
- Parameters recorded

Height & Weight

- recorded by using Stadiometer & Digital weighing balance.

- Body Mass Index

- calculated by using a formula Weight in Kgs / Height in meter square.

- Maximum Voluntary Contraction

- recorded by using Hand grip dynamometer.

- Finger Tapping

- recorded by using Computerized finger tap recorder.

- Pin Dexterity Test

- recorded by using Modified O’Connor dexterity apparatus (in house built and calibrated).

Data Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows version 22.0. Statistical significance was set at < 0.05. An independent sample t-test was conducted for between-group comparisons of differences between pre- and post-intervention values. A paired-sample t-test was conducted for intra-group comparisons of differences between pre- and post-intervention values.

Results

Table 1: Demographics

Characteristics	Skilled persons N=50	Non-skilled persons N=50	P Value
Gender			
Male	30	28	0.820
Female	20	22	
Age (years)	28.92 ±4.06	30.34 ±4.04	0.640
Height (cm)	168.82± 9.71	169.00 ±7.63	0.604
Weight (kg)	67.28 ±12.88	66.98 ±14.35	0.765
Dominant hand (L/R)	2/48	3/47	0.314

There were no significant between-group differences in the general characteristics (p > 0.05).

Table 2: Coordination

Characteristics	Skilled persons N=50	Non-skilled persons N=50	P Value
Pre	59.62 ±15.02	61.91 ±15.14	0.400
Post	51.67 ±9.73	50.30 ±14.50	0.800
t	3.541	5.346	
p	0.001	<0.001	

There were no significant between-group differences in the pre-intervention CMT time (experimental, 59.62 ±15.02 s; control, 61.91 ±15.14 s; p > 0.05) and post-intervention CMT time (experimental, 51.67 ±9.73 s; control, 50.30 ±14.50 s; p > 0.05). In the experimental group, the CMT time significantly improved from 59.62 ±15.02 s to 51.67 ±9.73 s (p < 0.05); similarly, the CMT time in the control group significantly improved from 61.91 ±15.14 s to 50.30 ±14.50 s (p < 0.05).

Table 3: Dexterity

Characteristics	Skilled persons N=50	Non-skilled persons N=50	P Value
Pre	58.13 ±10.86	58.30 ±7.80	0.900
Post	52.80 ±6.31	54.58 ±6.23	0.160
t	5.616	4.500	
p	<0.001	<0.001	

There were no significant between-group differences in the pre-intervention PPT time (experimental, 58.13 ±10.86 s; control, 58.30 ±7.80 s; p > 0.05) and post-intervention PPT time (experimental, 52.80 ±6.31 s; control, 54.58 ±6.23 s; p > 0.05). In the experimental group, the PPT time significantly improved from 58.13 ±10.86 s to 52.80± 6.31 s (p < 0.05). In the control group, the PPT time significantly improved from 58.30 ±7.80 s to 54.58 ±6.23 s (p < 0.05).

Discussion

In daily life, most individuals predominantly use one hand, which determines whether an individual is right- or left-handed. Asymmetric behaviour of frequently using the dominant hand more than the non-dominant hand decreases the relative dexterity and training level of muscles in the non-dominant hand as well as the cortical excitability of the non-dominant motor cortex [17]; moreover, Sperry [18] suggested that asymmetric use of the dominant hand causes uneven use of the verbal, analytical, inferential, partial, conscious, temporal, and continuous functions in the left brain hemisphere as well as the non-verbal, conceptual, intuitive, total, and unconscious functions in the right brain hemisphere. In other words, using both dominant and non-dominant hands allows even use of different brain regions. Researchers across various fields have utilized hand anthropometry to enhance their work, including sports, glove manufacturing, and the design of handles, keyboards, and computer mice with specific technical specifications. [19] These measurements are pivotal in determining the most suitable models that promote optimal performance with minimal strain and consistent efficiency.

There were no significant between-group differences in the general characteristics (p > 0.05). There were no significant between-group differences in the pre-intervention CMT time (experimental, 59.62 ±15.02 s; control, 61.91 ±15.14 s; p > 0.05) and post-intervention CMT time (experimental, 51.67 ±9.73 s; control, 50.30 ±14.50 s; p > 0.05). In the experimental group, the CMT time significantly improved from 59.62 ±15.02 s to 51.67 ±9.73 s (p < 0.05); similarly, the CMT time in the control group significantly improved from 61.91 ±15.14 s to 50.30 ±14.50 s (p < 0.05). There were no significant between-group differences in the pre-intervention PPT time (experimental, 58.13 ±10.86 s; control, 58.30 ±7.80 s; p > 0.05) and post-intervention PPT time (experimental, 52.80 ±6.31 s; control, 54.58 ±6.23 s; p > 0.05). In the experimental group, the PPT time significantly improved from 58.13 ±10.86 s to 52.80± 6.31 s (p < 0.05). In the control group, the PPT time significantly improved from 58.30 ±7.80 s to 54.58 ±6.23 s (p < 0.05). Matsuo et al [20] investigated haemodynamics using near-infrared spectroscopy during self-feeding using chopsticks with dominant and non-dominant hands. Using chopsticks with the dominant hand yielded significantly more vivid motor imagery than with the non-dominant hand. This suggested that the motor imagery task involving skilled control of chopsticks allowed greater vividness than that involving unskilled control as well as affecting the haemodynamic response. Specifically, this means that the task contributes to brain activity. Numerous studies have investigated motor imagery during simple tasks; however, motor imagery during complex tasks (including self-feeding with chopsticks) in clinically meaningful daily activities remains unclear. This suggests a theoretical background for our observed improved coordination and dexterity of the non-dominant hand and indicates the clinical significance of our findings. In our study, the experimental and control groups performed relatively familiar hand movements using the dominant and non-dominant hands, respectively. Kirby et al [21] conducted an fMRI study to compare activation by the dominant and non-dominant hands in normal adults. They found that the non-dominant hand group recruited more visual and motor brain domains than the dominant hand group during a joystick task; additionally, training of the non-dominant hand yielded relatively greater brain activity than training the dominant hand. Contrastingly, training of the dominant hand yielded bilateral stimulation, long-term persistence, and after-effects.

Munn et al [22] reported that cross-training of one extremity affected the other extremity or other non-exercising body parts, which promoted muscle activity. Additionally, Carson [23] reported increased motor domain excitability of the corresponding cerebral hemisphere with the use of the dominant upper extremity for training and improved function. Carroll et al [24] showed that this mechanism is structured in a hierarchical and loose manner within an extensive network distributed through the frontal lobe of the cerebral cortex, which is involved in the planning and execution of autonomous movement. Furthermore, they showed that unilateral motor learning is connected to the brain stem through the corpus callosum between motor areas, which affects motor learning on the other side. Taken together, mirror training could lead to the effects of cross-training on the directly used dominant hand, which increases the excitability of the contralateral cerebral hemisphere. This, consequently, influenced the activation of the non-dominant hand and improved coordination and dexterity.

Conclusion

Fine motor skill such as FT & PDT improves by decreasing the muscle strength in skilled persons when compared to non skilled persons.

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