"ASSESSMENT OF THE CORRELATION OF COGNITIVE FUNCTION AND PSYCHOMOTOR SKILLS WITH DURATION OF CLINICAL WORKING HOURS IN ORTHODONTIC POST-GRADUATE STUDENTS: AN OBSERVATIONAL STUDY"

By

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ABSTRACT

Introduction:

Orthodontics is a medical profession that requires fine motor skills, hand-eye coordination and is demanding in cognitive alertness at all times. Many Orthodontists work continuously for longer hours to meet their work requirements as well as their patient needs. This results in mental and physical fatigue and possibly decreased ability to deliver quality treatment and results. Continuous working can not only result in compromised treatment outcome, but also mental and physical burn-out for the clinician when such unhealthy practice is continued for a long period of time

Aim:

To assess if there is a correlation of cognitive function and psychomotor skills with duration of clinical working hours in orthodontic post-graduate students

Materials and methods:

Occupational therapy tests and standardized cognitive function tests were used to identify certain measures of dexterity and cognitive function of Orthodontic Post-graduate students during clinical working time, and it was compared to the measures of the same person after continuous clinical working. Data collected was then statistically analysed for significance.

Results

Before and after continuous clinical working measures were compared for different parameters between different time durations, was analysis was performed

using Paired t-test. This comparison showed statistically significant differences (p value <0.05) for all the parameters for pre (before) and post (after) comparison. For each test, correlations between different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two for most of the tests.

Conclusion:

This study concluded that there is statically significant decline in the Psychomotor skills and Cognitive function of the Clinician (Orthodontist) due to continuous working in a clinical setup.

It is imperative for the Orthodontist to identify the limits of the human body, and take appropriate action to avoid significant changes in their Psychomotor skills and cognitive function, to provide best possible Treatment, and avoid Mental burn-out for himself/herself and other deleterious effects on the clinician's health

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INTRODUCTION

Dentistry is a medical profession that requires fine motor skills, hand-eye coordination and is demanding in cognitive alertness at all times.[18,19] "Medline Medical Encyclopedia" defines Fine motor skills as *the ability to efficiently utilize the complex musculature of our hands with appropriate strength, dexterity, and coordination, in order to grasp, manipulate, and accomplish functional tasks.* While, "American Psychological Association" defines Cognitive Function as *the performance of the mental processes of perception, learning, memory, understanding, awareness, reasoning, judgment, intuition, and language***.**

Among dentistry, Orthodontics is one of the most demanding, especially in phase of treatment planning and bonding procedures. Few studies have attempted to identify a tool that can predict the mental and physical fatigue in medical operators, being dentists or surgeons, and furthermore assess their change in performance after continuous working.[1,2,3]

According to the "ICD -11 (International Classification of Diseases) for Mortality and Morbidity Statistics", Fatigue is_*a feeling of exhaustion, lethargy, or decreased energy, usually experienced as a weakening or depletion of one's physical or mental resource and characterized by a decreased capacity for work and reduced efficiency in responding to stimuli. Fatigue is normal following a period of exertion, mental or physical, but sometimes may occur in the absence of such exertion as a symptom of health conditions.*

In Simple terms, **Mental fatigue** is a temporary inability to maintain optimal cognitive performance, while **physical fatigue** is the temporary physical inability of muscles to perform optimally.

Finsterer J, Mahjoub SZ in his article titled “Fatigue in healthy and diseased individuals”[4], classified fatigue into two categories, Pathological and Non-pathological.

Pathological fatigue can be described as an overwhelming sense of tiredness at rest, exhaustion with activity, lack of energy that precludes daily tasks, or loss of vigor while non-pathological fatigue is typically brought about by prolonged exertion and diminishes with rest.[4,5]

Manual dexterity tests are regularly used in the field of occupational therapy to diagnose fine motor disorders of patients as well as the adaptability of healthy individuals to specific fine assembly jobs.[6] Over the past 80 years, many studies have been conducted by using the existing manual dexterity tests from occupational therapy to correlate between fine motor skills and mental fatigue. [6,7] The University of Hamburg, Germany demonstrated that the wire-bending test is an additional and valuable screening tool for dental school applicants.[8]

Manual skills form a big part of the capabilities required of future dentists and Orthodontists.

Many Orthodontists work continuously for longer hours to meet their work requirements as well as their patient needs. This results in mental and physical fatigue and possibly decreased ability to deliver quality treatment and results.

Continuous working can not only result in compromised treatment outcome, but also mental burn-out for the clinician when such unhealthy practice is continued for a long period of time. Furthermore, if not corrected, may compel the clinician to quit the profession or may lead to depression.

This study is a preliminary attempt to identify mental and physical fatigue in Orthodontic Post Graduate students when they are subjected to continuous clinical working hours.

In this, one-of-a-kind study done on Orthodontists, Occupational therapy tests and standardized cognitive function tests were used to identify certain measure of dexterity and cognitive function of an Orthodontist, and it was compared to the measure of the same person after being subjected to continuous clinical working. These tests were performed on 2 separate days to acquire 2 different sets of data in order to avoid confounding bias due to declined performance by chance, on that specific day.

Inter-operative comparisons were not done. Each person acting as their own control, helped in identifying the change (increase/decrease) in physical ability (dexterity) and cognitive function of person after continuous clinical working as an Orthodontist.

AIM AND OBJECTIVES

AIM:

To assess if there is a correlation of cognitive function and psychomotor skills with duration of clinical working hours in orthodontic post-graduate students.

OBJECTIVES:

- To assess if there is a correlation of cognitive function with duration of clinical working hours in orthodontic post-graduate students.
- To assess if there is a correlation of psychomotor skills with duration of clinical working hours in orthodontic post-graduate students.

HYPOTHESIS

NULL HYPOTHESIS:

There is no correlation of cognitive function and psychomotor skills with duration of clinical working hours in Orthodontic post-graduate students

ALTERNATIVE HYPOTHESIS:

There is a correlation of cognitive function and psychomotor skills with duration of clinical working hours in Orthodontic post-graduate students

REVIEW OF LITERATURE

1. **Petrut B, Berindan-Neagoe I, Feflea DI, Hogea M, Pasca S, Bujoreanu CE, Bschleipfer T.et al (2020):** determined the mental fatigue status of surgeons and how their abilities are affected through a regular workday. They included 3 senior urologists and 6 urology residents. In a set period of time, they assessed their fatigue through self-assessed fatigue, Samn-Perelli score, and Karolinska sleepiness scale score. They concluded that:
    - As the number of tasks increases, and as the surgeons advance to the end of the workday, they become more fatigued, reaction time ultimately increases, and attention and memory become slightly altered.
    - Their performance status and skills decrease as they perform more tasks or advance through the day.
2. **Marcora SM, Staiano W, Manning V et al (2009):** The main aim of their present study was to confirm experimentally the hypothesis that mental fatigue impairs physical performance in humans. To test this hypothesis, they measured tolerance to high-intensity cycling exercise after 90 min of the AX-continuous performance test in 16 healthy volunteers. This cognitive task required sustained attention, working memory, response inhibition, and error monitoring. They inferred that:
    - This study provided experimental evidence that mental fatigue limits exercise tolerance in humans through higher perception of effort rather than cardio-respiratory and musculo-energetic mechanisms
3. **Goode JH et al (2003):** This study attempts to demonstrate an empirical relationship between pilot schedules and aviation accidents. In the study, they

checked the distribution of pilot work schedule parameters for the accidents to that for all pilots to determine if the proportions of accidents and length of duty exposure were the same. They concluded that:

- The proportion of accidents associated with pilots having longer duty periods is higher than the proportion of longer duty periods for all pilots.

4. **Backman C, Gibson SC, Parsons J et al (1992):** They investigated the relationship between pegboard dexterity and applied dexterity by examining performance on the Nine-Hole Pegboard Test and on functional tasks from the Applied Dexterity section of the Arthritis Hand Function Test. Subjects were 395 adult volunteers, aged 20-79 years. The test results inferred that:

   - There is significant relationship between measure of pegboard dexterity and functional tasks requiring hand dexterity
   - It also states that Pegboard Test may be a useful screening tool for occupational therapists to determine the need for further evaluation of hand function and its impact on occupational performance.

5. **Martin JA, Ramsay J, Hughes C, Peters DM, Edwards MG et al (2015):** The aim of their study was to examine the associations between age, grip strength and dexterity. 107 adults completed a series of hand dexterity tasks (i.e. steadiness, line tracking, aiming, and tapping) and a test of maximal grip strength. They concluded that:

   - To measure grip strength handgrip dynamometer is an reliable, fast and easy method

6. **Ramos-Goicoa M, Galdo-Alvarez S, Diaz F, Zurron M et al (2016):** They recorded Event-related potentials from 84 adults with the aim of exploring the effects of aging (middle-aged and older groups) and cognitive status (healthy or with amnestic mild cognitive impairment) on the neural functioning associated with stimulus and response processing in a Stroop color-word task. They inferred that:
   - Stroop test is the neuropsychological test most commonly used to assess the different aspects of executive function, which measures selective attention, cognitive flexibility, resistance to interference from irrelevant information and inhibition of inappropriate responses
7. **Jensen AR, Rohwer Jr WD et al (1966):** concluded that, with multiple administrations, the Stroop test was probably more reliable than any other psychometric test.
8. **Padilha DM, Hugo FN, Hilgert JB, Dal Moro RG et al (2007):** The aim of their study was to evaluate whether the oral hygiene of institutionalized older people differs significantly between groups of participants with different degrees of hand function. Dental (Silness and Loe Index) and denture plaque (Modified Ambjornsen Plaque Index) scores were assessed as a measure of oral hygiene. Hand functions were assessed using the Jebsen-Taylor and the Purdue pegboard tests. They concluded that:
   - Dentate participants with poor hand function according to the Dominant Hand Purdue test had significantly more dental plaque after adjustment for age, sex, and cognitive status.
   - Complete denture wearers with poor hand function according to the Dominant Hand and Sum of Three Steps Purdue tests and the total

Jebsen-Taylor test also had significantly more denture plaque after adjustment.

9. **McGlashan HL, Blanchard CC, Sycamore NJ, Lee R, French B, Holmes NP et al (2017):** The study has demonstrated the efficacy of a simple touch-typing intervention in improving the fine motor skills of children who do not have a specific motor deficit, they also found strong evidence that the intervention game improved children's manual dexterity skills, this improvement did not generalize to the task-oriented approach (i.e., the sequence-learning tapping task).
10. **Gansky SA, Pritchard H, Kahl E, Mendoza D, Bird W, Miller AJ, Graham D et al (2004):** They wanted to determine if a predental school manual dexterity test predicts: subsequent grades in preclinical restorative courses and faculty perceptions of satisfactory performance in these skills that would indicate the student is ready to advance to the clinic. The study population in their study comprised of 244 applicants. The manual dexterity test consisted of a two-hour block-carving test. They concluded that:
    - The MDT did not appear to add information to the current admissions criteria

MATERIALS AND METHODS

STUDY DESIGN

A cross-sectional observational Study was conducted on Orthodontic Post-graduate students who are clinically working in institutes recognized by DCI

SOURCE OF DATA

- Data will be collected from postgraduate students during Orthodontic clinical working time, studying in postgraduate colleges recognised by the DCI

Ethical clearance:

Institute ethical clearance was obtained (Ethical Certificate No. 1483)

SAMPLE SIZE ESTIMATION

Sample size estimation done based on article by Perut B et.al., 2020 (Petrut B, Berindan-Neagoe I, Feflea DI, Hogea M, Pasca S, Bujoreanu CE, Bschleipfer T. Mental Fatigue Evaluation of Surgical Teams during a Regular Workday in a High-Volume Tertiary Healthcare Center. Urol Int. 2020;104 (3-4):301-308.)

The following was taken for estimation:

	Mean value of peak performance **(Mean 1)**	Smallest meaningful difference of more than 20% change in performance (Assumed by statistician)	Assumed mean for 20% change : **Mean 2**	Standard deviation 1(Assumed by statistician as 50% of mean1)	Standard deviation 2(Assumed by statistician as 50% of mean 2)	Estimated sample size
Reaction time (ms)	20	4	16	10	8	34
Attention score	-5	-1	-4	-2.5	-2	34
Memory score	-8	-1.6	-6.4	-4	-3.2	34

Software used: G Power sample size estimation software Version 3.1.9. 7

We assumed that 20% change in Reaction time, memory or attention will be clinically important. We also assumed that the standard deviations would be 50% of the mean values (as a general rule of thumb for normal distributions) since our original article did not specify any standard divisions. We also set the Alpha error at 5%, Beta error at 20%

As per the above, the estimated sample size is 34

PERMISSIONS OBTAINED

- Institutional ethical clearance. (Ethical Certificate No. 1483)

TOTAL BUDGET

- FUNDING: SELF
- EQUIPMENT COST: ₹ 10,000
- STASTICAL ANALYSIS COST: ₹ 5000
- TOTAL: ₹ 15,000

FUNDING DETAILS:

- No funding from any external source was required to conduct the study.
- I, took up the financial responsibility of my research and bore all the expenses incurred during the study.

METHODOLOGY

All the tests were performed on Orthodontic PGs studying Orthodontics in colleges recognized by DCI. Subjects were informed 1-2 days prior about the tests to be conducted, and they were requested to schedule patients continuously during the clinical working hours.

The subjects were explained about the tests and were given few minutes to familiarize with the equipment.

Baseline Data

This Baseline Data collected from each subject (Figure 1) included status of their sleep, exercise, food intake, and other such things which may have an effect on their dexterity and cognitive function.

Sample Collection

After the baseline data collection, the "Pre work" data was collected.

Each subject were allowed a maximum time of 10 minutes in between each patient.

After the subjects completed their clinical work, they were immediately requested to report for "post work" data.

All the data was recorded in physical sheets (Figures 1,2,3,4,5) as the tests were performed which was later compiled in Microsoft Excel software.

.

Baseline Data

Name: ______________________ Age: ________________________

Sex: ________________________

Sleep Data	
Did you sleep well yesterday night?	
Time of Sleep	Sleep Time: Wake Up Time:

Breakfast	
Did you have breakfast?	

Exercise	
Do you exercise regularly? If yes, approx how many hours a week?	
Have you done any exercise since morning?	

Medical History	
Are you on any medication? If yes, specify name and since when?	
History of recent illness/surgery	

Stimulants	
Did you take Coffee/Tea/Chocolate within last 6 hours?	

Other	
Alcohol/Nicotine/Any other Narcotic in last 24 hours?	

Figure 1: Sheet for collecting Baseline Data

Fatigue Scale

Samn Perelli Fatigue Scale		
Rank	**Description**	✓
1	Fully alert, wide awake	
2	Very lively responsive, but not at peak	
3	Okay, somewhat fresh	
4	A little Tired, less than fresh	
5	Moderately tired, let down	
6	Extremely tired, very difficult to concentrate	
7	Completely exhausted, unable to function effectively	

Figure 2: Fatigue scale given to the subjects before Pre and Post test sessions

Purdue Pegboard Score Sheet
For Model #32020

Quick Reference Means (normative population averages) in Parts

Occupational Area	Right Hand	Left Hand	Both Hands	Right + Left + Both	Assembly
Male & Female Applicants for Assembly Jobs*	17.86	16.60	14.38	48.81	43.58
Male & Female Applicants for Gen. Factory Work*	17.15	16.01	13.79	46.76	39.30
Male & Female Applicants for Production Work*	17.94	16.81	14.10	48.85	40.67
Female Applicants for Electronic Prod. Work*	18.47	16.77	14.53	49.84	43.76
Female Hourly Production Workers*	18.02	16.81	14.34	49.14	38.08
Male Hourly Production Workers*	16.45	16.31	13.37	46.11	36.89
Male Maintenance and Service Employees*	15.49	15.25	12.31	43.04	38.71
Female Applicants for Sewing Machine Operator: Three Trial Sum*	55.20	51.78	44.03	151.09	133.41

** Data taken from the Appendix A (Tables 8-15) in the original Purdue Pegboard Manual*

Subject Record

Name: ______________________ Dominant Hand: Right or Left

Reason for Administering: ______________________________________

____

Test Administrator Name: ____________________ Test Date:___/___/___

Scoring Grid Based on Number of Parts

	Trial One	Trial Two	Trial Three	Trial Average
Right Hand				
Left Hand				
Both Hands				
Right + Left + Both				
Assembly				

Figure 3: Sheet for recording perdue pegboard test data

O'Connor Finger Dexterity Test

Date:_______________

Name:_____________________________ Dominant Hand:___________________

Age:_______________________________ Gender:__________________________

Before Work

Shape	Time
1.	
2.	
3.	

After Work

Shape	Time
1.	
2.	
3.	

Hand Dynamometer

Before Work

Hand	Strength
Left	
Right	

After Work

Hand	Strength
Left	
Right	

Figure 4: Sheet for recording Finger dexterity and Hand dynamometer data

Steadiness Tester

Before Work

Number of errors	

After Work

Number of errors	

Colour Stroop Test

Before Work

Number of errors	

After Work

Number of errors	

Figure 5: Sheet for recording Steadiness Tester and Stroop Color Word Test Data

Steps:

Orthodontic Post graduate trainees

↓

•Assessment during their clinical working at

•Before the start of their clinical

•At the end of their clinical work

↓

Using standardized manual dexterity tests, cognitive function test, and fatigue scales

↓

Each person to be assessed on 2 seperate days, with the same criteria (paired test)

↓

The 2 sets of scores thus obtained for each participant will be statistically analysed for significant differences

↓

Data obtained is used for verification of the hypothesis

↓

Interpretation and presentation of results

Description of the Tests:

- COGNITIVE TESTS:
  - STROOP COLOUR WORD TEST
- PSYCHOMOTOR TESTS:
  - PURDUE PEGBOARD TEST
  - O'CONNOR FINGER DEXTERITY (TWEEZER) TEST
  - STEADINESS TESTER
  - HANDGRIP DYNAMOMETERS

1. STROOP COLOUR WORD TEST

Duration: 45 seconds
Purpose: By following the lines and as quickly as possible, name out loud the color of each word (not what the word says). When you reach the end of the page, start again from the beginning.

BLUE	YELLOW	BLUE	RED	BLUE
GREEN	YELLOW	RED	GREEN	YELLOW
GREEN	RED	GREEN	YELLOW	YELLOW
YELLOW	RED	YELLOW	GREEN	BLUE
BLUE	RED	YELLOW	YELLOW	GREEN
RED	BLUE	GREEN	YELLOW	GREEN
RED	YELLOW	BLUE	RED	GREEN
BLUE	GREEN	YELLOW	YELLOW	YELLOW
BLUE	RED	RED	YELLOW	RED
GREEN	BLUE	RED	GREEN	BLUE

Figure 6: Stroop colour word test sheet

Description of the Test (STROOP COLOUR WORD TEST):

- Subject is requested to speak out the colour of the word, instead of reading the alphabets.
- The concept behind it is, the brain is receiving 2 stimuli, one the word itself, and other the colour of the word. In a fraction of a second, the subject has to make a decision to speak the colour and not the word.
- This tests the cognitive function, and the decision-making ability of the brain

PURDUE PEGBOARD TEST

Figure 7: Perdue pegboard test board

Description of the Test (PERDUE PEGBOARD TEST):

2. Subject is given 30 seconds to place pegs on the board
3. In one attempt subject is requested to use only the dominant hand
4. In second attempt the subject is requested to use both hands together, 2 pegs have to picked up each using both hands, and then have to be placed simultaneously on the pegboard.
5. This tests the hand eye coordination, as well as hand dexterity.

6. O'CONNOR FINGER DEXTERITY (TWEEZER) TEST

Figure 8: O'Connor Finger Dexterity (Tweezer) Test board

Description of the Test (O'CONNOR FINGER DEXTERITY):

- It is different from the perdue pegboard test in a way that it assesses specifically the finger dexterity rather than the dexterity of the whole palm of the hand
- In relation to dentistry and Orthodontics, this test is significant because most of the work done is using hand instruments.
- This test is used to check the dexterity of the finger (while operating an instrument)

7. STEADINESS TESTER

Figure 9: steadiness tester machine

Description of the Test (STEADINESS TESTER):

- Subject is requested to hold the probe at the thin end of the horizontal rod, and move it to the thick end of the horizontal rod without touching the horizontal rod.
- The horizontal rod and the probe are electrically connected, and if there is a physical contact between the probe and the rod within the timer limit, it records a reading.
- This tests the stability/steadiness of the hand of the subject.

8. HAND-DYNAMOMETER

Figure 10: Hand Dynamometer (Digital)

Description of the Test (HAND-DYNAMOMETER):

- Subject is requested to sit, and position the arm in a forward position on the table.
- After that, subject is requested to squeeze the equipment in the hand as much as possible for 1 second and leave.
- It records the highest force exerted on the device in Kilograms.
- Test is repeated individually for the right and left hand.

STATISTICAL ANALYSIS

- Data obtained was entered and sorted in Microsoft Excel (v.2013).
- Statistical analysis was performed using Statistical package for social sciences (SPSS) software (IBM Corp) (v.21.0).
- Descriptive and inferential statistics was performed for all the different parameters assessed in the study.
- The Pre and post work comparison of different parameters between different time intervals was done using Paired samples t-test to assess significant differences.
- Pearson's correlation coefficient was performed to assess significant correlation between different parameters and time durations.
- All statistical tests were performed at 95% confidence intervals.
- A p value of less than 0.05 was considered as statistically significant in the study.

RESULTS

All subjects were randomized and given a subject code, and all data was tabulated in the "Microsoft Excel" sheet. Paired t-test and Pearson's correlation coefficient were used to compare different parameters of the same person before and after the clinical working. These tests were performed twice in 2 different sessions. There was an average of 1.8 hours break between both the sessions.

Following are the tests which were performed:

- COGNITIVE TESTS:
  - STROOP COLOUR WORD TEST
- PSYCHOMOTOR TESTS:
  - PURDUE PEGBOARD TEST
  - O'CONNOR FINGER DEXTERITY (TWEEZER) TEST
  - STEADINESS TESTER
  - HANDGRIP DYNAMOMETERS

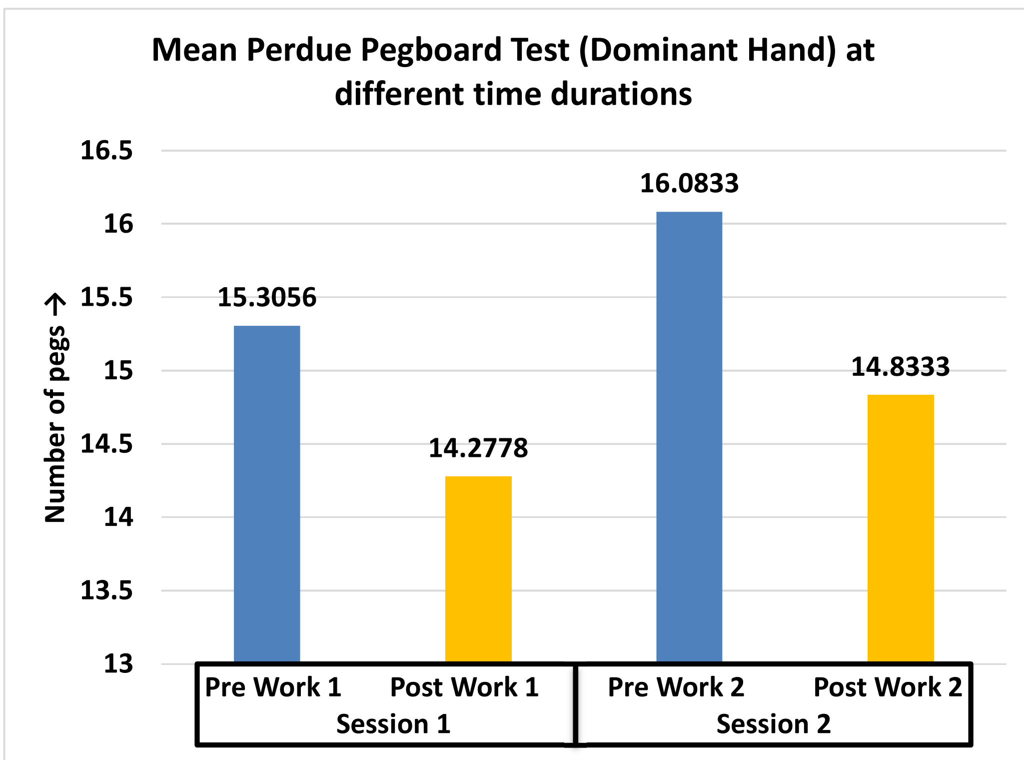
The result obtained are as follows:

Table 1 - Descriptive statistics: Mean (+ SD) of Perdue Pegboard Test (Dominant Hand) at different time durations

Perdue Pegboard Test (Dominant Hand)	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	11.00	19.00	15.3056	2.24015
Post work 1	36	10.00	18.00	14.2778	2.38580

Difference between pre and post work 1	36	-7.00	3.00	1.0278	1.85913
Pre work 2	36	13.00	20.00	16.0833	1.69664
Post work 2	36	12.00	19.00	14.8333	1.84391
Difference between pre and post work 2	36	-4.00	3.00	1.2500	1.33898

GRAPH 1: Mean Perdue Pegboard Test (Dominant Hand) at different time durations

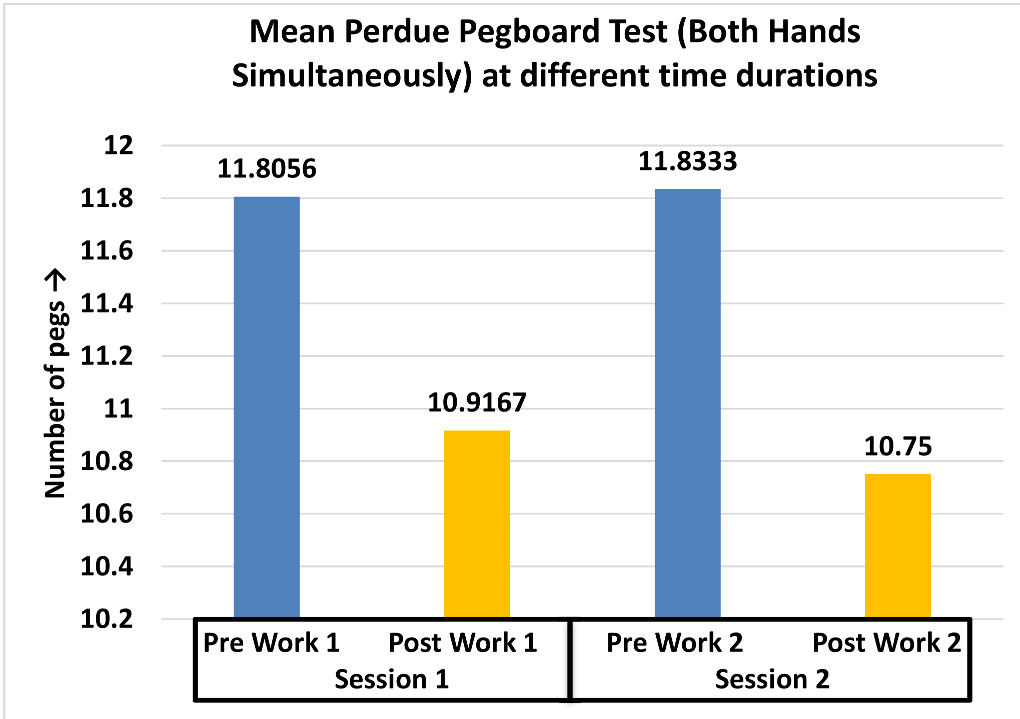


In graph 1, Y-axis denotes the number of pegs placed in 30 seconds time. Reduced number of pegs show reduced performance.

Table 2 - Descriptive statistics: Mean (+ SD) of Perdue Pegboard Test (Both Hands Simultaneously) at different time durations

Perdue Pegboard Test (Both Hands Simultaneously)	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	9.00	15.00	11.8056	1.61810
Post work 1	36	8.00	15.00	10.9167	1.48083
Difference between pre and post work 1	36	-2.00	3.00	.8889	1.08963
Pre work 2	36	9.00	16.00	11.8333	1.81265
Post work 2	36	8.00	14.00	10.7500	1.59239
Difference between pre and post work 2	36	-1.00	3.00	1.0833	1.02470

GRAPH 2: Mean Perdue Pegboard Test (Both Hands Simultaneously) at different time durations

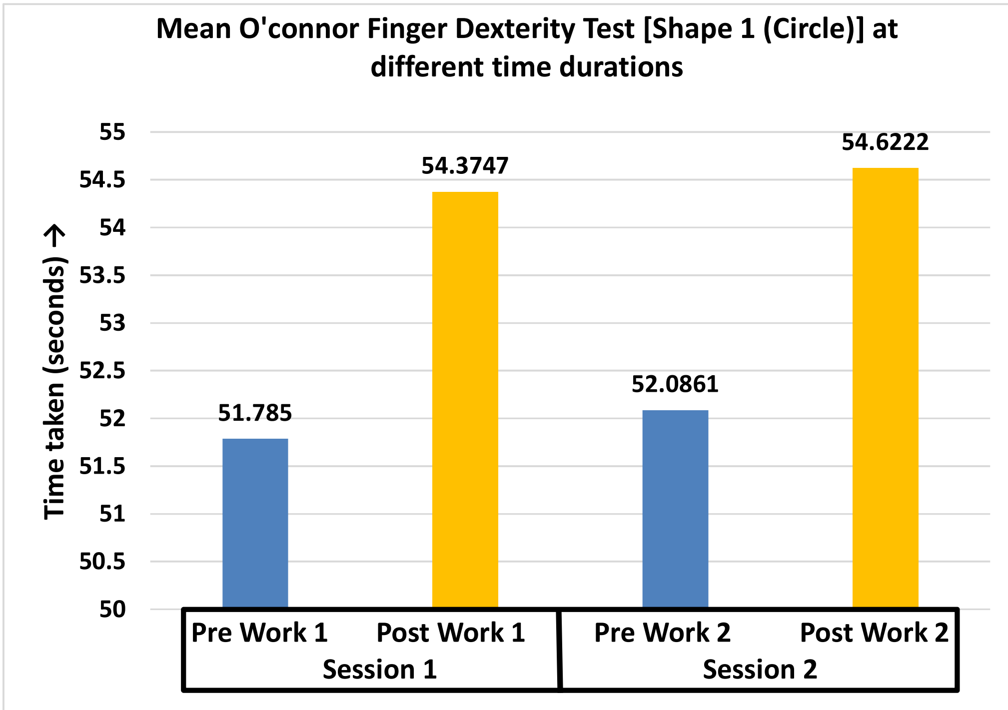


In graph 2, Y-axis denotes the number of pegs placed in 30 seconds time. Reduced number of pegs shows reduced performance.

Table 3 - Descriptive statistics: Mean (+ SD) of O'connor Finger Dexterity Test [Shape 1 (Circle)] at different time durations

O'connor Finger Dexterity Test [Shape 1 (Circle)]	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	42.36	56.90	51.7850	3.83367
Post work 1	36	43.40	62.40	54.3747	4.39700
Difference between pre and post work 1	36	-9.30	3.30	-2.5897	2.24882
Pre work 2	36	40.10	57.80	52.0861	4.44722
Post work 2	36	40.30	62.10	54.6222	4.96940
Difference between pre and post work 2	36	-6.20	3.30	-2.5361	2.15090

GRAPH 3: Mean O'connor Finger Dexterity Test [Shape 1 (Circle)] at different time durations

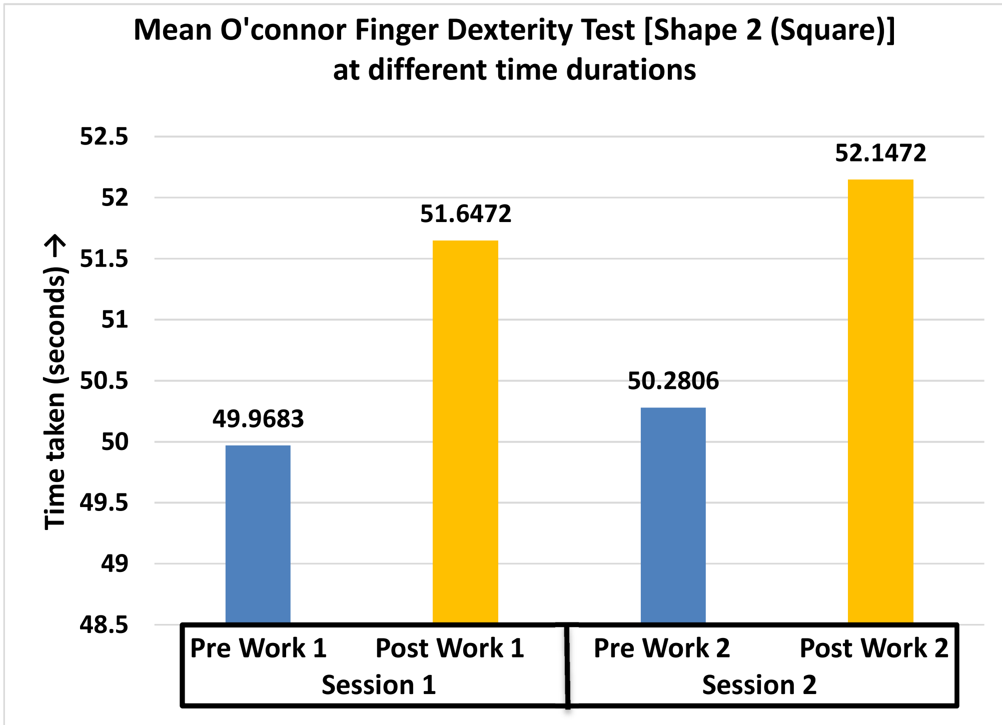


In graph 3, Y-axis denotes the time taken to make the circle shape. More time taken shows reduced performance.

Table 4 - Descriptive statistics: Mean (+ SD) of O'connor Finger Dexterity Test [Shape 2 (Square)] at different time durations

O'connor Finger Dexterity Test [Shape 2 (Square)]	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	40.60	63.20	49.9683	4.60846
Post work 1	36	41.60	65.90	51.6472	5.07855
Difference between pre and post work 1	36	-4.70	3.70	-1.6789	1.52654
Pre work 2	36	40.90	68.10	50.2806	5.36458
Post work 2	36	41.50	68.50	52.1472	5.21402
Difference between pre and post work 2	36	-6.50	.40	-1.8667	1.27257

GRAPH 4: Mean O'connor Finger Dexterity Test [Shape 2 (Square)] at different time durations

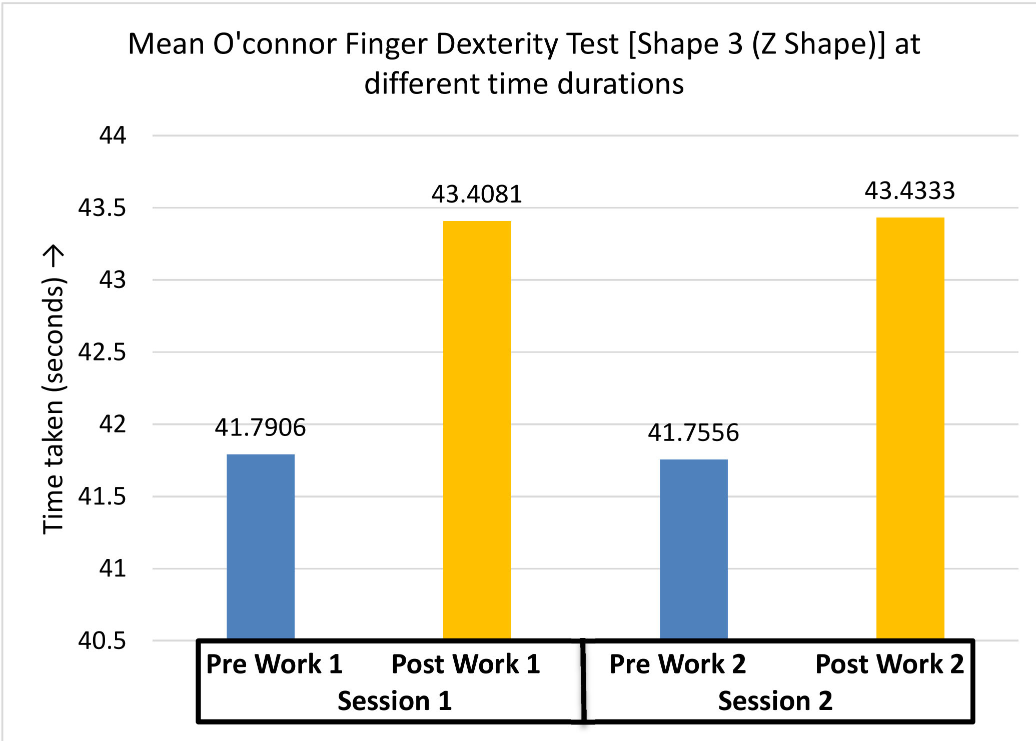


In graph 4, Y-axis denotes the time taken to make the square shape. More time taken shows reduced performance.

Table 5 - Descriptive statistics: Mean (+ SD) of O'connor Finger Dexterity Test [Shape 3 (Z Shape)] at different time durations

O'connor Finger Dexterity Test [Shape 3 (Z Shape)]	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	30.00	47.30	41.7906	4.47465
Post work 1	36	32.09	49.90	43.4081	4.07520
Difference between pre and post work 1	36	-5.10	3.60	-1.6175	1.81444
Pre work 2	36	31.50	48.20	41.7556	4.32946
Post work 2	36	33.40	49.60	43.4333	4.30807
Difference between pre and post work 2	36	-4.20	.30	-1.6778	1.04802

GRAPH 5: Mean O'connor Finger Dexterity Test [Shape 3 (Z Shape)] at different time durations

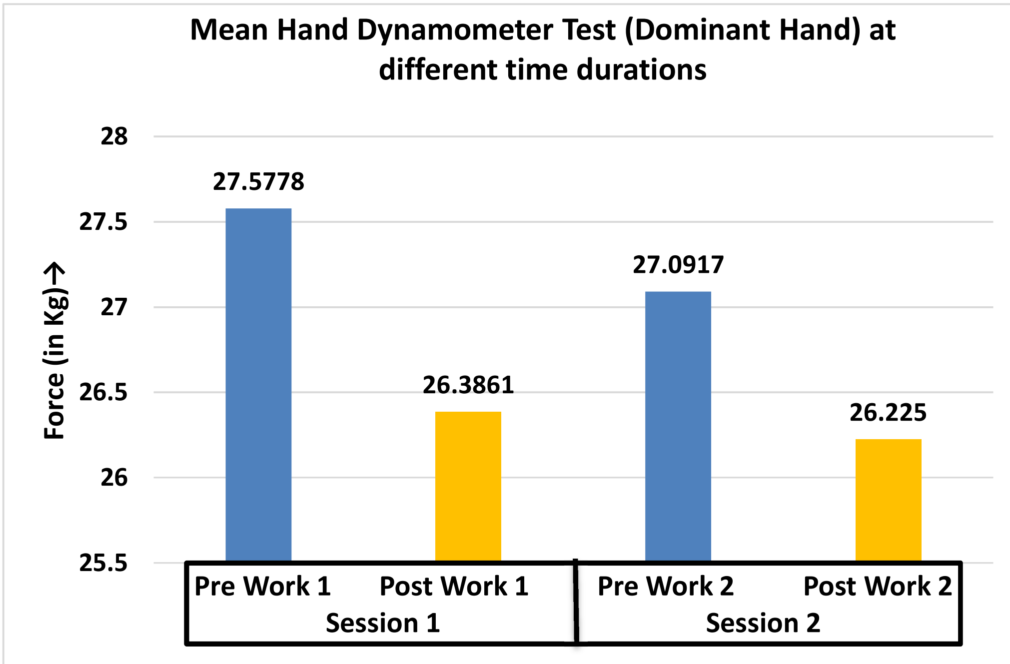


In graph 5, Y-axis denotes the time taken to make the Z shape. More time taken shows reduced performance.

Table 6 - Descriptive statistics: Mean (+ SD) of Hand Dynamometer Test (Dominant Hand) at different time durations

Hand Dynamometer Test (Dominant Hand)	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	20.00	47.90	27.5778	5.01085
Post work 1	36	18.80	41.70	26.3861	4.70739
Difference between pre and post work 1	36	-3.90	6.20	1.1917	1.62065
Pre work 2	36	20.50	45.60	27.0917	4.79859
Post work 2	36	19.10	44.20	26.2250	4.70400
Difference between pre and post work 2	36	-1.30	2.80	.8667	.72938

GRAPH 6: Mean Hand Dynamometer Test (Dominant Hand) at different time durations

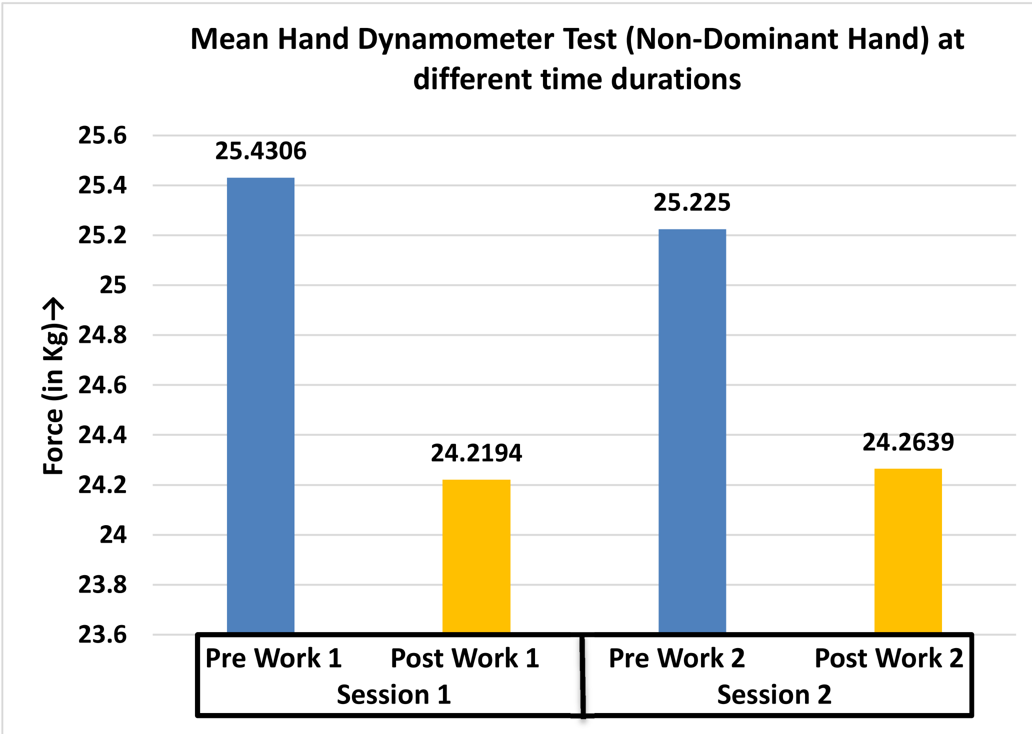


In graph 6, Y-axis denotes the force recorded (in Kg) during the test.

Table 7 - Descriptive statistics: Mean (+ SD) of Hand Dynamometer Test (Non-Dominant Hand) at different time durations

Hand Dynamometer Test (Non-Dominant Hand)	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	16.40	45.70	25.4306	4.70166
Post work 1	36	15.90	40.60	24.2194	4.27416
Difference between pre and post work 1	36	-.60	5.60	1.2111	1.30926
Pre work 2	36	16.00	44.60	25.2250	4.53679
Post work 2	36	15.10	41.30	24.2639	4.29393
Difference between pre and post work 2	36	-.90	3.40	.9611	.89739

GRAPH 7: Mean Hand Dynamometer Test (Non-Dominant Hand) at different time durations

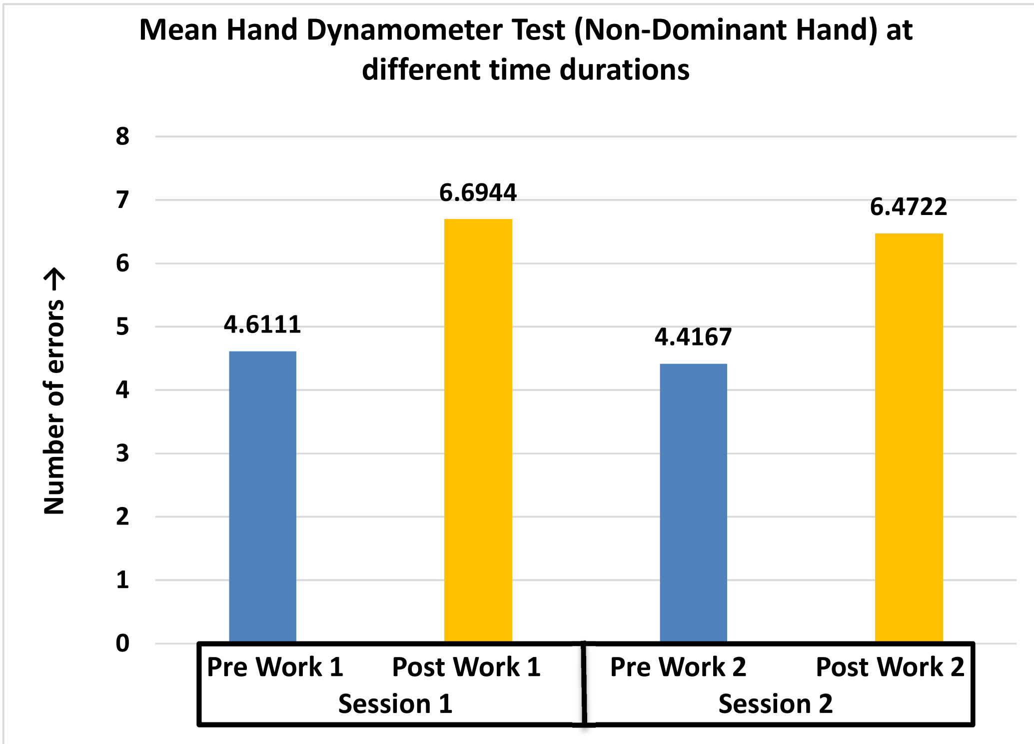


In graph 7, Y-axis denotes the force recorded (in Kg) during the test.

Table 8 - Descriptive statistics: Mean (+ SD) of Colour Word Stroop Test at different time durations

Colour Word Stroop Test	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	2.00	8.00	4.6111	1.66094
Post work 1	36	4.00	9.00	6.6944	1.75368
Difference between pre and post work 1	36	-4.00	.00	-2.0833	1.07902
Pre work 2	36	2.00	9.00	4.4167	1.79483
Post work 2	36	3.00	10.00	6.4722	1.85913
Difference between pre and post work 2	36	-7.00	1.00	-2.0556	1.39272

GRAPH 8: Mean Hand Dynamometer Test (Non-Dominant Hand) at different time durations



In graph 8, Y-axis denotes the number of errors made during the test. More number of errors show reduced performance.

Table 9 - Descriptive statistics: Mean (+ SD) of Steadiness Tester at different time durations

Steadiness Tester	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	.00	.00	.0000	.00000
Post work 1	36	.00	.00	.0000	.00000
Difference between pre and post work 1	36	.00	.00	.0000	.00000
Pre work 2	36	.00	.00	.0000	.00000
Post work 2	36	.00	.00	.0000	.00000
Difference between pre and post work 2	36	.00	.00	.0000	.00000

GRAPH 9: Descriptive statistics: Mean (+ SD) of Steadiness Tester at different time durations

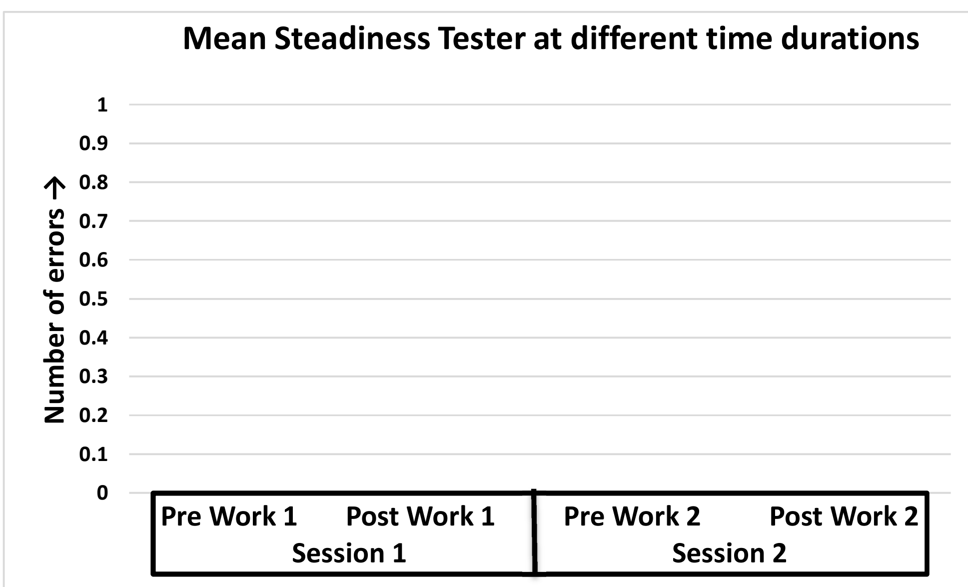
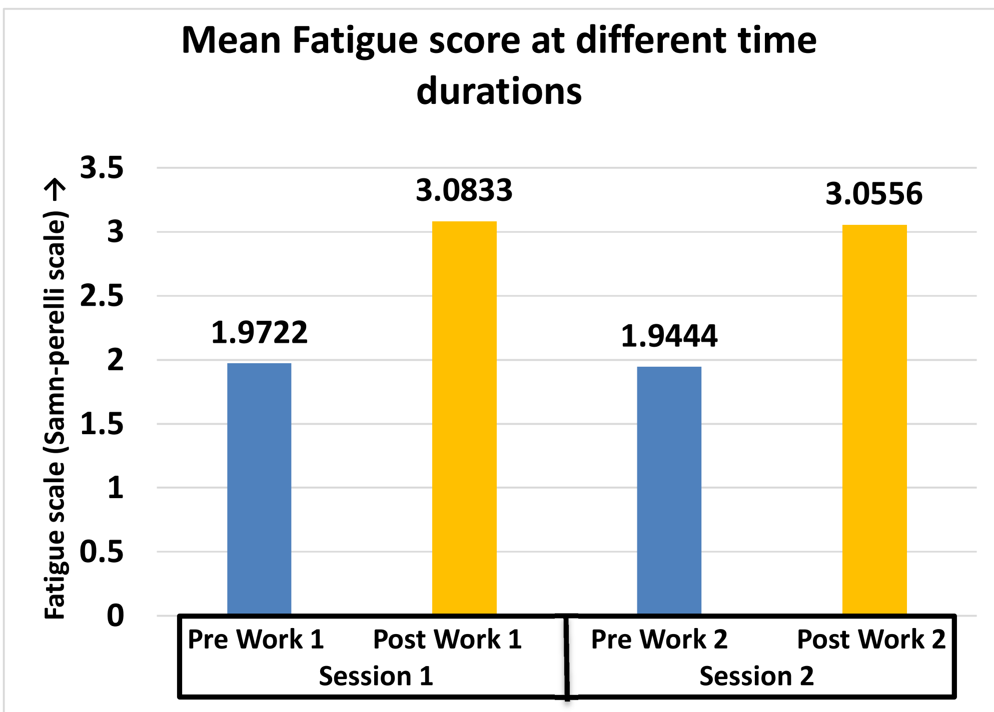


Table 10 - Descriptive statistics: Mean (+ SD) of Fatigue score at different time durations

Fatigue score	N	Minimum	Maximum	Mean	Std. Deviation
Pre work 1	36	1.00	6.00	1.9722	1.10805
Post work 1	36	1.00	6.00	3.0833	1.18019
Pre work 2	36	1.00	4.00	1.9444	.75383
Post work 2	36	2.00	6.00	3.0556	.95452

GRAPH 10: Descriptive statistics: Mean (+ SD) of Fatigue score at different time durations



In graph 10, Y-axis denotes the fatigue score given by the subject. Higher score shows greater feeling of tiredness/exhaustion

Table 11 – Pre and post comparison of different parameters between different time durations

Parameters	Pre vs Post work comparison	Mean difference	t value	df	p value
Perdue Pegboard Test (Dominant Hand)	Pre work 1 - Post work 1	1.02778	3.317	35	.002*
	Pre work 2 - Post work 2	1.25000	5.601	35	.000*
Perdue Pegboard Test (Both Hands Simultaneously)	Pre work 1 - Post work 1	.88889	4.895	35	.000*
	Pre work 2 - Post work 2	1.08333	6.343	35	.000*
O'connor Finger Dexterity Test [Shape 1 (Circle)]	Pre work 1 - Post work 1	-2.58972	-6.910	35	.001*
	Pre work 2 - Post work 2	-2.53611	-7.075	35	.021*
O'connor Finger Dexterity Test [Shape 2 (Square)]	Pre work 1 - Post work 1	-1.67889	-6.599	35	.003*
	Pre work 2 - Post work 2	-1.86667	-8.801	35	.010*
O'connor Finger Dexterity Test [Shape 3 (Z Shape)]	Pre work 1 - Post work 1	-1.61750	-5.349	35	.000*
	Pre work 2 - Post work 2	-1.67778	-9.605	35	.000*

Hand Dynamometer Test (Dominant Hand)	Pre work 1 - Post work 1	1.19167	4.412	35	.011*
	Pre work 2 - Post work 2	.86667	7.129	35	.031*
Hand Dynamometer Test (Non-Dominant Hand)	Pre work 1 - Post work 1	1.21111	5.550	35	.000*
	Pre work 2 - Post work 2	.96111	6.426	35	.000*
Colour Word Stroop Test	Pre work 1 - Post work 1	-2.08333	-11.585	35	.001*
	Pre work 2 - Post work 2	-2.05556	-8.856	35	.013*
Fatigue score	Fatigue score Pre work 1 - Fatigue score Post work 1	-1.11111	-5.111	35	.000*
	Fatigue score Pre work 2 - Fatigue score Post work 2	-1.11111	-7.513	35	.000*

*p value<0.05 statistically significant

Interpretation – In our study, Pre (before clinical work) and post (after clinical work) comparison of different parameters between different time durations was performed using Paired t-test. This comparison showed statistically significant differences (p value <0.05) for all the parameters for pre and post comparison.

Correlations between different parameters assessed in the study and time duration

*p value<0.05 statistically significant

Table 12: Pearson Correlation-Perdue Pegboard Test (Dominant Hand)

Perdue Pegboard Test (Dominant Hand)		Time interval 2
Time interval 1	Pearson Correlation	.720**
	p value	.000*
	N	36

Interpretation – In our study, Correlations between Perdue Pegboard Test (Dominant Hand) at different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two.

Table 13: Pearson Correlation-Perdue Pegboard Test (Both Hands)

Perdue Pegboard Test (Both Hands Simultaneously)		Time interval 2
Time interval 1	Pearson Correlation	.162
	p value	.345
	N	36

Interpretation – In our study, Correlations between Perdue Pegboard Test (Both Hands simultaneously) at different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two.

Table 14: Pearson Correlation- O'connor Finger Dexterity Test [Shape 1 (Circle)]

O'connor Finger Dexterity Test [Shape 1 (Circle)]		Time interval 2
Time interval 1	Pearson Correlation	.511**
	p value	.001*
	N	36

Interpretation – In our study, Correlations between O'connor Finger Dexterity Test [Shape 1 (Circle)] at different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two.

Table 15: Pearson Correlation- O'connor Finger Dexterity Test [Shape 2 (Square)]

O'connor Finger Dexterity Test [Shape 2 (Square)]		Time interval 2
Time interval 1	Pearson Correlation	.371*
	p value	.026*
	N	36

Interpretation – In our study, Correlations between O'connor Finger Dexterity Test [Shape 2 (Square)] at different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two.

Table 16: Pearson Correlation- O'connor Finger Dexterity Test [Shape 3 (Z-shape)

O'connor Finger Dexterity Test [Shape 3 (Z Shape)]		Time interval 2
Time interval 1	Pearson Correlation	.692**
	p value	.000*
	N	36

Interpretation – In our study, Correlations between O'connor Finger Dexterity Test [Shape 3 (Z shape)] at different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two.

Table 17: Pearson Correlation- Hand Dynamometer Test (Dominant Hand)

Hand Dynamometer Test (Dominant Hand)		Time interval 2
Time interval 1	Pearson Correlation	.627**
	p value	.001*
	N	36

Interpretation – In our study, Correlations between Hand Dynamometer Test (Dominant Hand) at different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two.

Table 18: Pearson Correlation- Hand Dynamometer Test (Non-Dominant Hand)

Hand Dynamometer Test (Non-Dominant Hand)		**Time interval 2**
Time interval 1	**Pearson Correlation**	.603**
	p value	.020*
	N	36

Interpretation – In our study, Correlations between Hand Dynamometer Test (Non-Dominant Hand) at different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two.

Table 19: Pearson Correlation- Colour Word Stroop Test

Colour Word Stroop Test		**Time interval 2**
Time interval 1	**Pearson Correlation**	.244
	p value	.152
	N	36

Interpretation – In our study, Correlations between Colour Word Stroop Test at different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two.

Table 20: Pearson Correlation- Steadiness Tester

Steadiness Tester		Time interval 2
Time interval 1	Pearson Correlation	-
	p value	-
	N	36

Correlation can't be performed for Steadiness Tester because both the groups means are same (equal to 0)

Table 21: Pearson Correlation- Fatigue Score

Fatigue score		Time interval 2
Time interval 1	Pearson Correlation	.503**
	p value	.002*
	N	36

Interpretation – In our study, Correlations between Fatigue score at different time durations was assessed using Pearson's correlation coefficient. There was a significant correlation noted (p value<0.05) between the two.

All the parameters assessed showed significant correlation (except steadiness tester) between the decline in the psychomotor skills and cognitive functions with continuous clinical working. This was in consistence with the hypothesis of the study

DISCUSSION

Orthodontic treatment is often related to burn-out for the patient, but rarely we talk about burn-out of the Orthodontist. As Dentists/Orthodontists, we are at a very high risk for many problems which may include respiratory infections (recently covid), risk of needle prick injury/sharp injury, chronic lower back pain, lower back vertebral disc derangement and few other problems. One of the least discussed, but most common type of problem faced is fatigue. Chronic fatigue can result in many problems, such as sleep disturbances, psychological disturbance, depression, anxiety, and most importantly burn-out of the doctor.[1,7,9,11]

In this study, we had hypothesized that continuous clinical working may result in change in psycho-motor skills (dexterity) and also change in cognitive function (mental ability) of the orthodontic post-graduate students. This was in consistence with few other studies on different professions [9,10,11]

To measure these parameters, we short-listed a few psychomotor and cognitive function tests based on the available scientific literature.

A systematic review done by RYAN CAUSBY, titled "*USE OF OBJECTIVE PSYCHOMOTOR TESTS IN HEALTH PROFESSIONALS"*, identified Purdue Pegboard Test, and O'connor finger dexterity test as effective tools for assessment of psychomotor skills in subjects working in medical and dental profession.[12]

To identify the effect of fatigue in orthodontists, we decided to use these standardized psychomotor tests which included: **Purdue Pegboard Test, O'connor Finger Dexterity Test, Steadiness Tester and Handgrip Dynamometer Test**, and **Stroop colour word test** as cognitive function test.

Perdue Pegboard Test

In this study, The Perdue Pegboard test was performed twice in one session, one with only the dominant hand, and other with both hands simultaneously. Since, general dentistry and Orthodontics often require the operator to perform tasks which demand working with both hands simultaneously, this test can be used as a good analogue to test the hand-eye coordination of the subject when using both the hands simultaneously. Since, use of both hands simultaneously also demands more cognitive resources, it is one of the tests which can be placed analogously with the decline in the treatment delivering capacity of the clinician.

Figure 11 (A) Perdue pegboard test with dominant hand

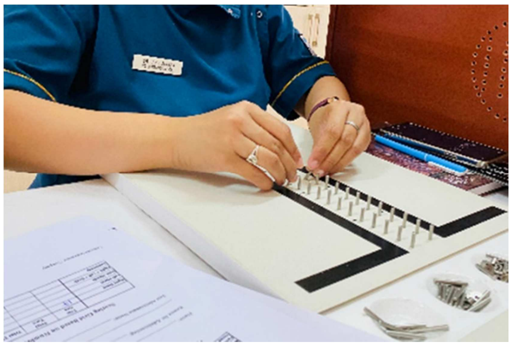


Figure 11 (B) Perdue Pegboard test with both hands simultaneously

O'connor Finger Dexterity (Tweezer) Test

Practice of orthodontics is a special skill which requires use of hands and fingers in a very specific skillful manner which requires high precision (bracket placement, wire placement) at most times. It was presumed that finger dexterity (while using an instrument to accomplish a task instead of using hands directly) can differ significantly from hand dexterity. Dexterity is mainly influenced by muscle mass[13]. This can be used to explain why finger dexterity can be different from hand dexterity due to lesser mass of muscles in fingers. Hence, we employed different tests for Hand Dexterity (Perdue Pegboard Test) and Finger Dexterity (O'connor Finger Dexterity Test), respectively.

To evaluate Finger dexterity, we used the O'connor finger dexterity test, which uses a tweezer for holding pegs and placing them in designated holes, and the time taken for accomplishing the task is noted. In this study, we requested the subjects to make 3 different shapes on the test board which were a circle, a square and a Z shape. These tasks can determine the degree of control of the instrument by the subject, and hence an important factor to be considered when it comes to Orthodontics

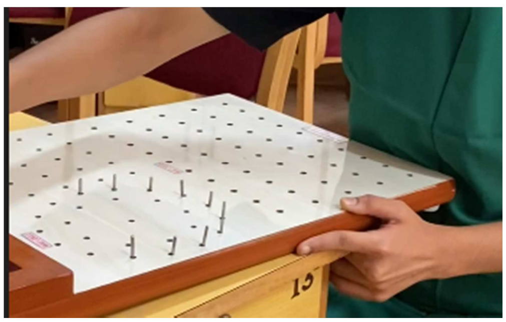


Figure 12 (A) Subject making a circle shape on the O'Connor finger dexterity test board

Figure 12 (B) Subject making a square shape on the O'Connor finger dexterity test board

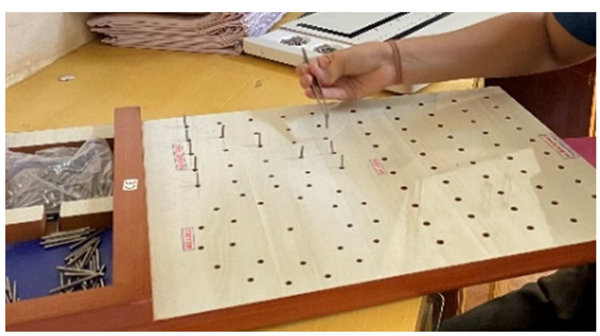


Figure 12 (C) Subject making a Z shape on the O'connor finger dexterity test board

Hand Dynamometer Test

Along with precision skills, Orthodontic pliers need palm strength to operate. Frequent compression of the palm muscles while using pliers can result in muscle fatigue and may result in decreased ability to operate the pliers.

To evaluate this, we incorporated hand dynamometer to check the palm strength before the clinical work and after clinical working. There was a statistically significant decline in the palm strength of the subjects after the clinical work. This could be linked with the fatigue in the palm muscles due to continuous operation of Orthodontic instruments.

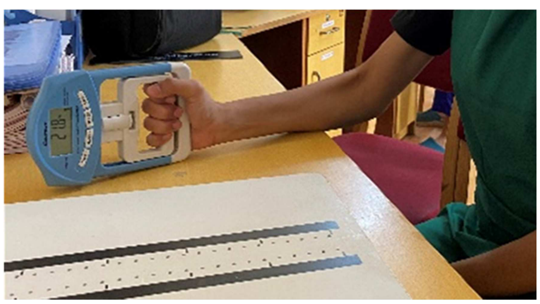


Figure 13 (A) Hand-dynamometer testing (Dominant hand)

Figure 13 (B) Hand-dynamometer testing (Non-dominant hand)

Steadiness Tester

To check hand tremors and stability of the hand the "steadiness tester machine" was used. In this test, we noted that all subjects got a score of zero, which denoted that no subject in the study presented with severe tremors or instability in the palms and hands. This machine can be used for patients who are suffering from psychomotor diseases. Other devices, such as Tremometer, may prove to be more useful in such situations.

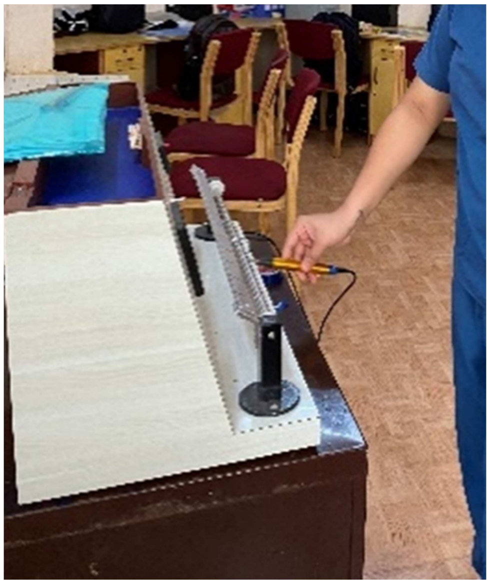


Figure 14: Subjects performing Steadiness test with dominant hand

Stroop Colour Word Test

Stroop colour test is an age old test for Cognitive function test.[16,17] This test relies on the basic idea of the brain to be able to make a decision in fraction of a second about the 2 different stimuli it is being presented with. Once the subject starts to read the colour coded names, the brain has to swiftly make a choice to speak out the colour, and not to read out the name.

This requires focus, attention and decision making. By employing this test, before and after clinical working of the same subject, we could evaluate the decline of cognitive function of the subject. An article published by **Federica Scarpina** titled "*The Stroop Color and Word Test*" stated that the stroop effect is a determinant of cognitive function, and is a reliable means to predict the functioning of the brain.[14] Hence, this can be analogous to the Orthodontist's need to possess the appropriate alertness, and make crucial indispensable decisions to deliver uncompromised treatment to the patient.

Figure 15: Subject performing Stroop colour word test

Baseline Data

Factors such as sleep, stimulants, narcotics and history of illness were all taken as baseline data. This data was used to ensure that there are no confounding factors which can affect the fatigue or the performance of the subject on that particular day.

The results are consistent with the hypothesis, that there is a statistically significant decline in the ability of the Orthodontist after continuous hours of clinical work. This decrease in the ability can be attributed to fatigue caused by the clinical working. To eliminate the factor of chance, the test was performed for the same subject on two separate days to see if the data obtained in both days is in alignment with the hypothesis.

After continuous clinical working, the subjects were compared with their own data which was obtained before they started their work for the day. Each person acting as their own control, was another strength of the study eliminating the intra-operator differences in working. Standardization of procedure and clinical working time duration was not possible simply because of its impracticality, since working time of same procedure may vary drastically among different operators. Yet to ensure continuous working, subjects were requested to keep more number of appointments on the test days. An allowance of maximum 10 minutes was considered normal for a clinician to allow for switching from one patient to another, if more than that, the sample was eliminated. Moreover, samples which reported improper sleep, any health abnormality, or consummation of intoxicating substances within last 24 hours were also eliminated. This was done to remove the confounding factors which may change the baseline fatigue of the subject on that particular day.

Scope of the Study

This study seeks to identify the change in psychomotor skills and cognitive function of the Orthodontist. More-over this preliminary study can be used to identify the break/rest needed by the orthodontists during the clinical working in order to perform at the best of their capability without compromising in treatment quality**,** and also to maintain the mental and physical health of the clinician.

Furthermore, the tests used in this study can be used as a screening process for students who wish to pursue Orthodontics and Dentistry. By statistically establishing a minimum requirement for dexterity, and screening the students joining these courses, we might be able to shift the overall central tendency of these students towards higher dexterity.

Another important extension of this study can be assessment of dexterity and cognitive function, and then putting in place an exercise regime for maintaining and improving the same.

Hannah L. McGlashan et al. found strong evidence that the intervention of interactive online typing game improved the manual dexterity skills of children aged

8-10 years.[15] This suggests that children performing certain goal oriented tasks might show faster development in psychomotor skills than those who do not.

Jason A. Martin et al in his article titled "Age and Grip Strength Predict Hand Dexterity in Adults" said that strength had little predictive value to the variance of steadiness, suggesting that other factors may have influence on steadiness. An alternative explanation for the poor steadiness and dexterity with increased age could be a consequence of the control of hand muscle force, known to fluctuate more in older adults, which are thought to involve changes in average motor unit force output. They speculate that increased grip strength will be associated with fewer fluctuations in muscle force during movement execution, allowing for faster, more fluent, less variable and more stable successful successive movements. The research also showed that steadiness and hand dexterity performance was better explained by age than strength, and an interaction between age and strength on steadiness hand dexterity showed that mean to older adults were particularly influenced by strength. Furthermore, changes in muscle mass with increased age has been linked to changes in peripheral and central nerve conduction. The presence of fluctuations in muscle force during a movement influences the capacity to produce the intended movement correctly, causing compensations within the movement.[13]

They also noticed that individuals who regularly practice rapid, coordinated, goal directed movements, such as expert musicians, appear not to display the same age related decrements of dexterity that are typical of age matched non-musical adults. Hence they suggested that regular exercise is possibly sufficient to maintain rapid, coordinated, goal directed dexterous actions.[13]

This suggests that a specific exercise routine might prove beneficial to maintain and even improve the dexterity and fine motor skills of an Orthodontist.

In future, there is scope for doing another study to compare orthodontic clinicians with controls (not working in clinical setup) to evaluate changes in psychomotor skills over the period of time. Additionally, a randomized control trial can be used to see if specific exercise routine can help maintain and improve these skills in Orthodontists.

CONCLUSION

This study concluded that there is statistically significant decline in the Psychomotor skills and Cognitive function of the Clinician (Orthodontist) due to continuous working in a clinical setup based on the tests performed in this study.

The decline is these factors could not be linked to the type of procedure performed by the subject, but it is presumed that few taxing procedures may have more prominent effect on these Psychomotor skills and cognitive function.

There is further scope to conduct observational studies to identify the optimal continuous clinical working time without any significant decline in these Psychomotor skills and cognitive function, and to identify specific exercises which can be used to increase the performance of the clinician, reduce fatigue, and alter the rate of decline of psychomotor skills with age.

It is imperative for the Orthodontist to identify the limits of the human body and take appropriate action to avoid significant changes in these skills, to provide best possible treatment, and avoid mental burn-out for himself/herself and prevent other deleterious effects on the clinician's health.

Furthermore, this study can form a foundation for developing a screening process for students aspiring to be orthodontists and dentists.

LIMITATIONS OF THE STUDY

- Study is done only among post-graduate students pursuing Orthodontics. Sexual dimorphism was not checked.
- The clinical work time, and procedures performed could not be standardized due to its impracticality.
- Study is only a “cross-sectional observational study” with no long-term follow-up and no intervention to help overcome fatigue.

SUMMARY

Surgeons and doctors are subjected to long clinical working hours with less or minimal breaks, especially in the early phase of their career, both Medical and Dental professionals alike. Since orthodontics is a skill-based specialty which is a physically and mentally demanding profession, it is important to identify these factors in orthodontic clinicians.

This study hoped to identify if there is any decline or change in the Psychomotor skills and cognitive function of orthodontic post-graduate students due to continuous clinical working time. Hence, we conducted a series of Psychomotor tests and cognitive function tests before the start of clinical working and after they had finished the clinical working for that session.

These results showed statistically significant decline in all the tests after continuous working hours. This decline can be attributed to mental and physical fatigue experienced by the clinician due to continuous clinical working, and few other general factors such as sleep, food habits, etc. because of which it is not possible for the clinician to deliver the best quality of treatment to the patient at all times. At the same time such fatigue on a long-term might impact the physical and mental health of the clinician.

There is further scope to conduct observational studies to identify the optimal continuous clinical working time without any significant decline in these Psychomotor skills and cognitive function, and to identify specific exercises which can be used to increase the performance of the clinician, reduce fatigue, and alter the rate of decline of psychomotor skills with age.

It is imperative for the orthodontist to identify the limits of the human body, and take appropriate action to avoid significant changes in these skills, to provide best possible treatment, and avoid mental burn-out for himself/herself and other deleterious effects on the clinician’s health.

Furthermore, this study can form a foundation for developing a screening process for students aspiring to be orthodontists and dentists.

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ANNEXURE – I

ETHICAL CLEARANCE

Research and Ethics Committee
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KLE University

KLE UNIVERSITY

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Sl. No. : 1483

CERTIFICATE

This is to Certify that the synopsis titled Assessment of the correlation of cognitive function and psychomotor skills with duration of clinical working hours in Orthodontic Post-graduate students: An Observational study. *Submitted by*

Dr. _ ______________________ *P. G. Student /*

Staff, Guided by __________ *from Department of* Orthodontics and dentofacial Orthopedics. *has been critically evaluated by committee members and granted ethical clearance to conduct the above mentioned study*

Date : 5/5/24

Member Secretary
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

MEMBER SECRETARY
Research & Ethical Committee
KLEVK Institute of Dental Sciences
BELAGAVI.

Chairman
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

Chairman
Research and Ethical Committee
KLE VK Institute of Dental Sciences
Belgaum

ANNEXURE- II

BIOSTATISTICS CLEARANCE CERTIFICATE

KLE V.K. Institute of Dental Sciences
(A Constituent unit of KLE Academy of Higher Education & Research
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Biostatistics Clearance Certificate

This is to certify that the Biostatistics aspect of the Dissertation / Research work of **Post Graduate Student**, under the guidance of M.D.S, **Professor, Department of Orthodontics and Dentofacial Orthopaedics**, entitled **"ASSESSMENT OF THE CORRELATION OF COGNITIVE FUNCTION AND PSYCHOMOTOR SKILLS WITH DURATION OF CLINICAL WORKING HOURS IN ORTHODONTIC POST-GRADUATE STUDENTS: AN OBSERVATIONAL STUDY"** has been done under my guidance and considered satisfactory.

Dr. Asawari Shidhore
Name & Signature of Biostatistician

Place: Belagavi

Date: