EFFICACY OF BRAIN TRAINING VIDEOGAMES AND BRAIN GYM EXERCISES ON EXECUTIVE FUNCTIONS IN OVERWEIGHT INDIVIDUALS

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ABSTRACT
The purpose of this study was to study efficacy of brain training videogames and brain gym exercises on executive functions in overweight individuals. Materials and Methods: We have conducted an experimental study using a popular brain training game (Brain Age) and a cross body movement therapy (Brain Gym). 60 subjects were recruited based on their BMI (24.9Kg m⁻²-29.9Kg m⁻²) and equally been divided into two groups (Brain Age & Brain Gym). Participants in both the groups go through an intervention for 15 minutes per day, 5 days a week, for 4 weeks. Measures of executive functions (Set shifting, Hand Eye co-ordination, working memory and visuospatial ability) taken before and after the training protocol by neuropsychological test Trail Making (TMT A and TMT B). Results: The mean age, height weight and BMI (body mass index) of Brain Age (Group A) and was 25.36±2.96 year, 168.37±6.80 cm, 75.20±6.17 kg and 26.38±1.18 kg/m² respectively. The mean age, height weight and BMI (body mass index) of Brain Gym (Group B) was 26.53±2.63 year, 168.20±7.73 cm, 75.93±8.71kg and 26.95±1.22 kg/m² respectively (Table1). Conclusion: Overweight further leads to obesity, which is leading cause of various hazardous sufferings. This study produced scientific evidence demonstrating that the Brain Training Videogame had beneficial effects on execution. This study concluded that executive functions (working memory, processing speed, visuospatial ability and sustained attention) are affected in young adults with elevated Body Mass Index. In this study we focused on neural issues related to overweight. Brain training videogame (Brain Age) has significant effect on executive functions enhancement as compared to Brain Gym Exercises. Brain Training Videogame (Brain Age) said to be very effective for future use in clinical and educational aspects

Keywords: BMI, Brain Gym, Brain Age, Executive Functions, Videogames

I. INTRODUCTION
Overweight and obesity are chief clinical and community health loads worldwide. Health experts describe “Overweight” as an extra volume of body weight that comprises muscles, bone, fat and water (Sharma et al. 2017). According to World Health Organization (WHO) obesity is well-defined as disproportionate fat amassing that may harm health (Qavam et al. 2015). The growing pervasiveness of obesity and overweight in several populations are challenging and can lead to numerous diseases with medical penalties. Overweight children have been witnessed to do unwell in schools. Some children with elevated BMI always feel uneasy and possess focus on their weight instead of paying attention in classes. This is a disruption that interferes with children's involvement in societal and educational activities and can affect school performance in a harmful way (Uzogara, 2017).

In few parts of the USA, it has been stated that people with raised BMI perceived as lazy, thoughtless and deficient will power to regulate food intake. This adverse sensitivity of people got into verbal and physical stabbing, humiliated, discriminated and other harmful attitude that can have psychological concerns on the
sufferer. Weight discernment has associated with high circulating levels of C-reactive protein (CRP), a recognized bio-marker for inflammation and many diseases (Uzogara, 2017).

BMI is used as a measuring tool to measure person’s body mass ration as per the height and weight of an individual, to categories them as underweight, normal, overweight and obese. By 2030, the total number of overweight and obese adults is projected to be 1.30 billion and 575 million persons without adjusting for worldly trends (Kelly et al. 2008). Obesity is seen as initial wave of non-communicable disease called “New World Syndrome”, creating massive public health and socioeconomic liability all over the world (Kalra and Unnikrishnan, 2016, Kalra & Unnikrishnan, 2012). Recent studies have shown poor executive functioning in overweight and obese people who includes impaired voluntarily self-organised task oriented actions that are poor attention, impaired alertness, memory issues, impaired reaction time, spatial deficits, processing speed etc (Qavam et al. 2015).

In frontal lobe the Prefrontal cortex has been considered as ‘home’ for Executive Functions because this section of the brain is mainly involved in the high-level, top-down governor of impulses that are produced from in different places in the brain. Areas which are involved in executive functioning are Medial Pre frontal cortex, dorsolateral pre frontal cortex, orbitofrontal cortex and cingulate cortex. These areas are connected with other regions of brain such as brain stem and sub cortical areas. They collectively set the executive profile of individual. As a child becomes overweight and obesity is about to have its beginning in childhood, the hasty brain development is occurring at its best, elevated BMI affect organization of developing brain. ‘Ghrelin’ formed in the stomach induce hunger response by conveying message to the hippocampus to enhance food intake and low serum ‘Ghrelin’ indicates obesity. In case of overweight leading to obesity there is diminish appetite regulating hormones and materials produced by adipose tissues resulting in obesity related biomarkers that affects executive functions (Miller et al. 2015).

Playing Video games is the most common and supreme widespread relaxation activities. Total 59% of people in United States of America play video games (Fissler et al. 2015). Total 91% of children age 9-17 play videogames and in overall 99% of boys and 94% of girls in US play video games (Grenic et al. 2014). The resource-petition discrepancy model of intellectual flexibility adopts that neurocognitive loads which are superior to the brain’s efficient supply encourage favourable neuro plastic change. It is presumed that this supply-demand mismatch needs to be extended to stun the inertia and indolence of plasticity Games can pose prolonged neurocognitive burdens on working memory, processing speed, and episodic memory. For example, games that profoundly bang executive control processes are believed to encourage positive plastic changes in these cognitive processes and the core prefrontal network (Fissler et al. 2015). Playing video games with precise neurocognitive demands such as Super Mario 64 (Nintendo) raised the area of gray matter in hippocampal region, dorsolateral prefrontal cortex and cerebellum bilaterally (Grenic et al. 2014).

Studies reveal that the brain training games can progress decision-making functions and meting out speed in healthy young population and healthy elder people (Oie et al. 2014). These games can be easily played accommodatingly or competitively, by you, with other actually present players, or with bundles of other online players and they can be played on several devices from consoles such as Nintendo’s, Sony PlayStation, CPUs and mobile phones (Grenic et al. 2014). Brain Gym is a part of the Learning Kinesiology program. Learning Kinesiology means, “To pull out learning, with movement”. An innovative movement based program that expands neural communication all over the mind and body to benefit us access and attain out maximum potential in learning and any of the other life skills (Hafez, 2017). Brain Gym Exercises are exercises which provide body – mind integration or say movement based exercises, mainly the cross body movements of head, eyes and limbs. The regular training of these brain gym exercises helps in activation and amalgamation of different brain areas especially the corpus callosum as it is important to maintain the sharing of thoughts between the right and the left hemisphere (Cancela et al. 2015).

II. MATERIALS AND METHODS

We have conducted an experimental study using a popular brain training game (Brain Age) and a cross body movement therapy (Brain Gym). 60 subjects were recruited based on their BMI (24.9Kg m⁻²-29.9Kg m⁻²) and equally been divided into two groups (Brain Age & Brain Gym). Participants in both the groups go through an intervention for 15 minutes per day, 5 days a week, for 4 weeks. Measures of executive functions (Set shifting, Hand Eye co-ordination, working memory and visuospatial ability) taken before and after the training protocol by neuropsychological test Trail Making TMT A and B.
III. RESULTS

The mean age, height weight and BMI (body mass index) of Brain Age (Group A) and was 25.36±2.96 year, 168.37±6.80 cm, 75.20±6.17 kg and 26.38±1.18 kg/m² respectively. The mean age, height weight and BMI (body mass index) of Brain Gym (Group B) was 26.53±2.63 year, 168.20±7.73 cm, 75.93±8.71 kg and 26.95±1.22 kg/m² respectively (Table 1).

Table 1. Mean ±SD of Age, height weight and BMI of Brain Age (Group A) and Brain Gym (Group B)

<table>
<thead>
<tr>
<th>Variable(s)</th>
<th>N</th>
<th>Age, (year)</th>
<th>Height (cm)</th>
<th>Body weight (kg)</th>
<th>BMI (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain Age (Group A)</td>
<td>30</td>
<td>25.36±2.96</td>
<td>168.37±6.80</td>
<td>75.20±6.17</td>
<td>26.38±1.18</td>
</tr>
<tr>
<td>Brain Gym (Group B)</td>
<td>30</td>
<td>26.53±2.63</td>
<td>168.20±7.73</td>
<td>75.93±8.71</td>
<td>26.95±1.22</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>25.94±2.79</td>
<td>168.29±7.27</td>
<td>75.56±7.44</td>
<td>26.67±1.20</td>
</tr>
</tbody>
</table>

The P value of Height between group A (Brain training video game) & group B (Brain Gym exercise) was .930 (P > 0.05). There was no significant difference in mean height between the two groups (Table 2).

The P value of weight between group A (Brain training video game) & group B (Brain Gym exercise) was .738 (P > 0.05). There was no significant difference in mean height between the two groups (Table 2).

The P value of body mass index (BMI) between group A (Brain training video game) & group B (Brain Gym exercise) was .075 (P > 0.05). There was no significant difference in BMI between the Group A (Brain Training Game) and Group B (Brain Gym Exercises) (Table 2).

Table 2. Independent t test for comparison of Height, Weight and Body Mass Index (BMI) between (Group A) and Brain Gym (Group B)

<table>
<thead>
<tr>
<th>Variable(s)</th>
<th>Group(s)</th>
<th>T value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height(cm)</td>
<td>Brain Age (Group A)</td>
<td>0.089</td>
<td>0.930</td>
</tr>
<tr>
<td></td>
<td>Brain Gym (Group B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>Brain Age (Group A)</td>
<td>0.376</td>
<td>0.738</td>
</tr>
<tr>
<td></td>
<td>Brain Gym (Group B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>Brain Age (Group A)</td>
<td>0.089</td>
<td>0.930</td>
</tr>
<tr>
<td></td>
<td>Brain Gym (Group B)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The pretest and posttest value for the Executive Functions for group A was 43.44 ± 10.89 (Mean ± SD) and 33.23 ± 10.11(Mean ± SD) respectively and for group B it was 43.50 ± 15.00 (Mean ± SD) and 40.26 ± 13.16 (Mean ± SD) respectively. Paired t-test was done within group A and group B for the executive functioning, to check the changes within group. P value was .000 (P<.05) for Group A and for group B .012 (P<.05) indicates significant difference within the two groups A and B after the intervention (Table 3).

Table 3. Paired t-test within Group A and Group B for Executive Functions

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre (Mean ±SD)</th>
<th>Post (Mean ±SD)</th>
<th>Mean Difference (Mean ± SD)</th>
<th>P value</th>
<th>T value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>43.44 ± 10.89</td>
<td>33.23 ± 10.11</td>
<td>10.20 ± 9.50</td>
<td>.000</td>
<td>5.88</td>
</tr>
<tr>
<td>Group B</td>
<td>43.50 ± 15.00</td>
<td>40.26 ± 13.16</td>
<td>3.23</td>
<td>.012</td>
<td>2.68</td>
</tr>
</tbody>
</table>

The pretest and posttest Mean Difference for the Executive Functions in group A and Group B was 10.20 ± 9.50 (Mean ± SD). Paired t-tests were done within group A (Brain Training Videogame) and group B (Brain Gym Exercises) for the executive functioning, to check the changes within group. Pre intervention the p value was .984 (P<.05) for Group A and for group B .024 (P<.05) indicates significant difference within the two groups A and B after the intervention.

It showed Mean Difference of 10.20 ± 9.50 (Mean ± SD) in Group A (Brain Training Videogame) and 3.23 ± 6.63 (Mean ± SD) in group B (Brain Gym Exercises). The p value for group B and group A was...
This showed significant difference of pre and post intervention values in Group A and group B but group A (Brain Training Videogame) showed more significant difference as compared to group B (Brain Gym exercises) (Table 4).

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Group A (Mean ± SD)</th>
<th>Group B (Mean ± SD)</th>
<th>T Value</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Intervention</td>
<td>43.44 ± 10.89</td>
<td>43.50 ± 15.00</td>
<td>0.020</td>
<td>0.984</td>
</tr>
<tr>
<td>Post-Intervention</td>
<td>33.23 ± 10.11</td>
<td>40.26 ± 13.16</td>
<td>2.32</td>
<td>0.024</td>
</tr>
<tr>
<td>Mean Difference (Post-Pre)</td>
<td>10.20 ± 9.50</td>
<td>3.23 ± 6.63</td>
<td>3.30</td>
<td>0.002</td>
</tr>
</tbody>
</table>

IV. DISCUSSION

This study examined the executive functions (processing speed, hand eye coordination, working memory and visuospatial ability) in two different overweight groups of age 20-30 years with BMI (25-29.9 Kgm⁻²). It displayed that there was a significant difference in executive functions after both the interventions in Group A (Brain Training Videogame) and Group B (Brain Gym Exercises). But group A showed more significant improvement in executive functions than group B.

Focus of this study was on BMI (25-29.9 Kgm⁻²) which indicated overweight as per the WHO. Executive functions in overweight young adults of age 20-30 years were below average as per the assessment by neuropsychological test TMT A and B. In one of the study by Willeumier et al. 2011, it has been given that elevated BMI is linked with reduced prefrontal cortex integrity and reduced cerebral blood flow.

It has been said that the proper functioning of prefrontal cortex and other cerebral cortex areas are completely interlinked with good executive functioning. Obesity also leads to thickening and hardening of brain arteries.²

In this study group A (Brain Training Videogame), overweight individuals have gone through an intervention for 15 minutes a week, 5 days per week, for 4 weeks with 2 relaxation days per week. The results showed an advantageous transferable effect of Brain Training Videogame (Brain Age) on various executive functions (working memory, visuospatial ability, hand eye coordination and set shifting) in younger adults. This group showed significant difference of 10 (Spyridaki et al. 2016). These findings are consistent with previous study by Nouch Rui et al. 2013 who have stated that commercial brain training game (Brain Age) has shown significant transfer effects on executive functions as compared to non-brain training game (Tetris). Brain training game was not projected to use as a regular working out method. In BrainAge, components of calculation and reading is there. To perform these processes of calculation and reading in the frontal lobe is the main hub. Prefrontal cortex and pericuneus is the main area to be responsible for this purpose. When a person played Brain training videogame (Brain Age), the prefrontal cortex got activated.

This study showed that Group B (Brain Gym exercises) after an intervention for 15 minutes a day, 5 days a week for 4 weeks showed mild improvement in executive functions. Results showed meandifference of 3 (Cheke et al. 2016). only. Brain Gym Exercises had showed only little significant improvement of executive functions in overweight young adults. In one of the previous studies by Cancela et al. (2015) stated that Brain Gym is not enough to enhance cognitive performance in older adults as it showed similar results as of water-based and land-based exercises. Only a few differences in cognitive functions have been seen after 6 week protocol of brain gym exercises. Brain gym protocol was not having any aerobic component. Brain gym should incorporate with another exercise protocols to enhance executive functions and its another domains (Cancela et al. 2015).

The most important finding of this study was to rule out whether Brain Training Videogame (Brain Age) expressively improved executive functions - working memory, processing speed, visual-spatial ability or Brain Gym Exercises improved executive functions in younger adults. In both the groups, group A (Brain Training Videogame) and group B (Brain Gym Exercises) there was a significant variance in prepost intervention results. Group A showed significant difference of 10 (Cheke et al. 2016).

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REFERENCES


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