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# Effect of Classical Hathayoga on executive functions among corporate employees

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***Abstract***

Background: In the fast-paced and demanding corporate world, the need for strategies to enhance cognitive abilities, particularly executive functions, has garnered increasing attention. Yoga, a holistic practice originating from ancient Eastern traditions, has gained popularity as a potential intervention to address the cognitive demands placed on modern professionals. The objective of this study was to determine whether classical hata yoga practice enhances the executive functions resulting in improved cognitive functions and reduction in perceived stress levels.

**Material and Methods:** One hundred corporate employee subjects who had enrolled in a six months classical hatayoga practice. Their ages ranged between 24 and 50 years (group average ±S.D., 31.04±4.5 years). Those who have any chronic illness and mental illness, and those who are not willing to participate were excluded. Classical hata yoga practice was given for six months, 1hours/daily 5 days a week. At baseline and following six months, all participants completed SLCT, DLST, DVT and PSS.

**Results:** Classical hata yoga practice showed significant change in both SLCT and DLST scores, increase (P-value< 0.000) in total attempted score, significant increase (P-value<0.000) in net score, significant reduction in wrongly attempted score (P-value<0.00) in yoga group compared to the non-significant improvements of control group, also there was significant change in total time taken and wrong attempts (P-value<0.00) of DVT in Yoga group compare to the control group, PSS scores were also significantly reduced (P-value<0.00) in Yoga group compared to control group, there was a significant improvement in all the variables of yoga group compare to the control when compared between groups through Mann–Whitney test.

**Conclusions:** The six months classical hata practice was successful in enhancing the executive functions and reducing perceived stress among corporate employees.



***Keywords: Executive function (EF), Perceived stress (PSS), Classical hata yoga, Cognitive functions, SLCT, DLST, DVT.***

**Introduction:**

In the contemporary fast-paced and competitive world of business, the demand for employees to excel and make prompt decisions has reached unprecedented levels. The possession of robust executive functions is critical for employees to effectively handle workloads, make well-informed decisions, and maintain productivity. Nevertheless, the rigorous nature of corporate positions can generate elevated levels of stress and mental exhaustion, thus detrimentally impacting executive functions (GR Lyall, 2019). These functions are indispensable for cognitive processes of a higher order, such as problem-solving, decision-making, attention control, and goal-directed behavior, which are vital for achieving optimal performance in the workplace (Ganesan K & Steinbeis N, 2022). Consequently, incessant pressure and stress can adversely affect executive functions (McManus E, Talmi D, Haroon H & Muhlert N, 2022). One potential solution to counteract these challenges is the adoption of yoga. Yoga has experienced a surge in popularity as a comprehensive practice that fosters physical and mental well-being (Paudel D, 2023). In recent times, there has been a burgeoning interest in comprehending the effects of yoga on cognitive functions, particularly executive functions, among employees in the corporate sector. It is imperative to conduct research on yoga's potential to enhance executive functions among corporate employees, as this can significantly augment their performance and well-being. Excessive levels of stress and pressure can negatively influence cognitive abilities and overall performance. Yoga, with its manifold physical and mental health advantages, can serve as a remedy for these challenges. However, there is a dearth of research on its specific effects on executive functions, such as attention, working memory, and decision-making abilities. Consequently, there is mounting interest in exploring alternative methods to enhance executive functions among corporate employees, with yoga emerging as a prominent intervention. The objective of this research is to investigate the potential benefits of yoga in enhancing executive functions among employees in the corporate sector and its implications for enhancing workplace productivity and overall well-being. By scrutinizing existing literature and conducting a comprehensive analysis, this study seeks to provide valuable insights into how the integration of yoga into corporate wellness programs can positively influence cognitive abilities and contribute to a healthier work environment. Furthermore, comprehending the relationship between yoga and executive functions can enable organizations to develop targeted interventions and strategies to optimize employee performance and job satisfaction.

**MATERIAL AND METHODS**

One hundred corporate employee subjects who had enrolled in a six months classical hatayoga practice. Their ages ranged between 24 and 50 years (group average ±S.D., 31.04±4.5 years). We have fully explained the potential risks and benefits in the study before written informed consent was provided by participants, the study was approved by the ethics committee of the institution, Lakulish yoga university, located in Ahmadabad, Gujarat, India. The selection criteria included: Subjects who are in normal health status, Both genders, Age ranging 24 to 49, Those who are working in a corporate sector, willing to participate were included. Those having Age range >49 years and less than < 24 years, currently practicing yoga based practices, going through any kind of medication, who did not sign informed consent form, who did not fill up the questionnaires(pre/post) were excluded from the study. In this study we adopted a purposive sampling method to recruit the subjects who were undergoing six months of Classical Hata yoga practice in a corporate company, Ahmadabad, both genders, Age group 24 to 28 years, two group pre-post design was used. All the subjects were assessed for executive functions (attention, concentration, processing speed, short term & working memory) and perceived stress at the baseline and after six months, using standard assessment tools. Data was analysed using SPSS version 16. Within group differences was calculated by applying suitable statistical tests.

**Intervention**

All the subjects underwent a six months of classical hata yoga program: program consisted of one sessions each day, 5 days a week. participant practiced shithilikarana vyayamas (loosening practices) followed by yogasanas and relaxation techniques with pranayama practices. The concepts were taken from the classical hata yoga scripture of Lakulish yoga tradition (Swamy Rjarshimuni, 2007), one of the oldest schools of hata yoga in India. Yoga is defined as mastery over the modifications of mind (Chitta Vritti Nirodhah-definition of yoga by Patanjali). It helps to remove the unnecessary surges of neuromuscular activation resulting from heightened stress responses that may contribute to aging. Classical Hatha Yoga, is based on the knowledge, development, and balance of psychophysical energies in the body and can, therefore, be referred to as the "psychophysical yoga." The three main elements used in Hatha Yoga to attain its purposes are the body, the physical part of man; the mind, the subtle part; and the element that relates the body with the mind in a special way, the breath. Classical Hatha Yoga offers special techniques for each one of these elements. For the physical part, or body, it offers the asanas ("postures"), techniques for physical conditioning, called kriyas ("actions"), mudras ("seals"), bandhas ("locks"), as well as techniques for total and conscious physical relaxation. (William, Steinberg & Petronis, 2003) Thus, the combination of body, mind, and breath control forms a natural basis for the psychophysiologic effects of Classical Hatha Yoga, as examined in this study. Although numerous styles of Hatha yoga exist, the majority of studies included in this manuscript utilized the Iyengar style of yoga. The Iyengar method of Hatha yoga is based on the teachings of the yoga master B.K.S. Iyengar. (William, Steinberg & Petronis, 2003)

**Outcome measures**

**SLCT –Six letter cancellation test**

Cancellation tests require visual selectivity and a repetitive motor response. A six-letter cancellation test was administered to assess functions such as selective and focused attention, visual scanning, and the activation and inhibition of rapid responses. The six letter cancellation test has been used in similar type of design on Indian population (Natu & Agarwal, 1997).The six letter cancellation task worksheet consists of an array of random alphabets, A-Z, in 14 rows and 22 columns. Participants were asked to sit with the worksheet distributed to each one. The instructions are given asking them to cancel as many target digits as possible in the specified time. They are asked to cancel as their wish whether horizontally, vertically, or selecting a particular letter one at a time randomly in the row. Finally, after knowing the test instructions they are asked to start the test, each test was conducted for 90 seconds on a standard stopwatch

**DLST- Digit letter substitution test**

Substitution test contains flexibility at mind level, visual scanning, attention and psychomotor speed of processing information. It is used with same type of design on Indian population (Natu & Agarwal, 1997). DLST worksheet consists a row of random digits,1-9, in 8 rows and 12columns. The coding sheet contains instructions about the test with example of substituting a specific letter for specific digit 1-9, the same code is applicable to entire test. Subjects were instructed to make their choice of letter substitution process, whether horizontally, vertically, or selecting a particular digit randomly in the row one at a time. In given time of 90 seconds' substitute as many target digits as possible.

**DVT – Digit vigilance test**

Vigilance or sustained attention Sustained attention was measured using a digit vigilance test (DVT) of proven validity and reliability (Kelland & Lewis, 1996), which consisted of the numbers 1 to 9 arranged randomly in rows. Each sheet had 50 rows with 30 digits per row. The participants were instructed to cancel only 2 digits (6 and 9) as quickly as they could. They were asked not to: (i) cancel other digits or (ii) miss any of the target digits (6 and 9). The total time taken to complete the test and the number of errors made were noted. The DVT data was collected before and after the 45 days classical hata yoga training, The digit vigilance task was scored using the standard method (Dixit et al, 2012). The total time taken to complete the test (in minutes) and number of errors made were noted for analysis. The subjects were asked to cancel out digits 6 and 9. The time to complete the test along with the number of correct responses and errors was noted

**PSS - Perceived Stress Assessment**

Perceived stress scale (PSS) developed by Sheldon Cohen was used for the purpose of assessing perceived stress of the participants in this study. The Perceived Stress Scale (PSS) is the most widely used psychological instrument for measuring the perception of stress. It is a measure of the degree to which situations in one's life

are appraised as stressful. Items were designed to tap how unpredictable, uncontrollable, and overloaded respondents find their lives. The scale also includes a number of direct queries about current levels of experienced stress. Because levels of appraised stress should be influenced by daily hassles, major events, and changes in coping resources, predictive validity of the PSS is expected to fall off rapidly after four to eight weeks. The PSS is related to measure stress, depression and anxiety (Cohen et al., 1983). 10-item version of PSSC Scale showed adequate internal consistency such as a Cronbach's alpha of .67 (D. Y. P. Leung et al., 2010).

## RESULTS

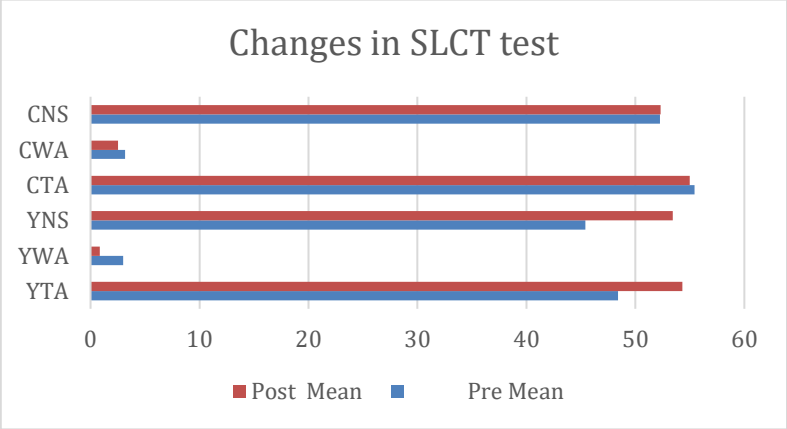
There was a significant improvement in executive functions and reduction in perceived stress levels among Yoga group compare to the control group, SLCT scores of yoga group showed significant increase (P-value<0.000) in total attempted score, Similarly, significant increase (P-value<0.000) in net score, significant reduction in wrongly attempted score (P-value.0.000), SLCT scores of control group showed non significant changes (P-value>0.36) in total attempted score, Similarly, non-significant increase (P-value>0.10) in net score, non-significant reduction in wrongly attempted score (P-value>0.61), also between group comparison on SLCT scale showed a significant improvement in yoga group (P<0.00) compare to control group.

**Table 1**: Changes in SLCT scores for Yoga Group and Control group

| SLCT | Pre | | Post | | | |
|---|---|---|---|---|---|---|
| Variables | Mean | Standard Deviation | Mean | Standard Deviation | % Change in Mean | p value (with in group) |
| YTA | 48.4 | 20.87 | 54.3 | 21.25 | 12.19% | 0.000 |
| YWA | 2.98 | 2.86 | 0.86 | 1.18 | 60.40% | 0.000 |
| YNS | 45.42 | 20.13 | 53.44 | 20.98 | 17.65% | 0.000 |
| CTA | 55.44 | 14.16 | 55 | 13.32 | 0.79% | 0.368 |
| CWA | 3.18 | 2.67 | 2.52 | 1.72 | 45.9% | 0.105 |
| CNS | 52.26 | 13.37 | 52.32 | 13.05 | 0.11% | 0.611 |

*significant at P<0.05, ** significant at P<0.01, ***significant at P<0.00 (paired sample test and Wilcoxon Signed Ranks Test) SLCT: Six letter cancellation test, YTA: Yoga group Total attempted, YWA: Yoga group Wrongly attempted, YNS: Yoga group Net scores. CTA: Control group Total attempted, CWA: Control group Wrongly attempted, CNS: Control group Net scores.

**Graph 1:** Changes in SLCT scores for Yoga Group and Control group




DLST scores of yoga group showed significant increase (P-value<0.000) in total attempted score, Similarly, significant increase (P-value<0.000) in net score, significant reduction in wrongly attempted score (P-value<0.000), DLST scores of control group showed non significant changes (P-value>0.08) in total attempted score, Similarly, non-significant increase (P-value>0.06) in net score, non-significant reduction in wrongly attempted score (P-value>0.10), also between group comparison on DLST scale showed a significant improvement in yoga group (P<0.00) compare to control group.

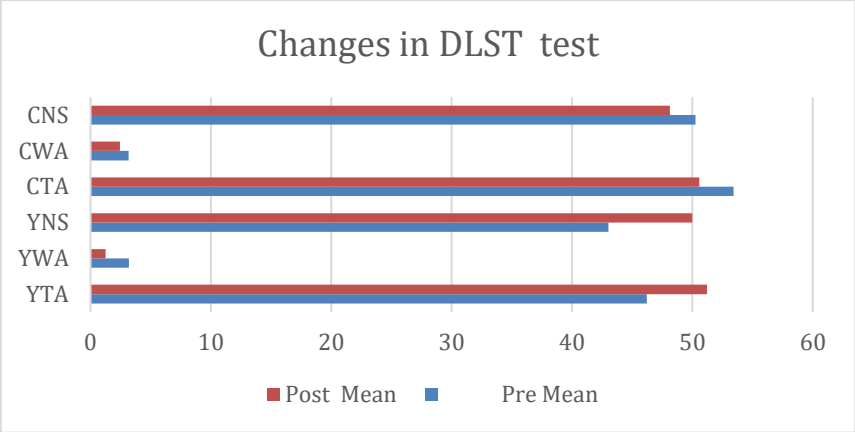
**Table 2:** Changes in DLST scores for Yoga Group and Control group

| DLST | Pre | | Post | | | |
|---|---|---|---|---|---|---|
| Variables | Mean | Standard Deviation | Mean | Standard Deviation | % Change in Mean | p value (with in group) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **YTA** | 46.22 | 18.28 | 51.22 | 15.39 | 10.81% | 0.000 |
| **YWA** | 3.2 | 2.76 | 1.24 | 1.29 | 61.25% | 0.000 |
| **YNS** | 43.02 | 17.36 | 49.98 | 15.62 | 16.17% | 0.000 |
| **CTA** | 53.42 | 12.9 | 50.58 | 13.62 | 5.31% | 0.08 |
| **CWA** | 3.16 | 2.68 | 2.44 | 1.46 | 53.7% | 0.06 |
| **CNS** | 50.26 | 12.67 | 48.14 | 13.45 | 4.21% | 0.10 |

*significant at P<0.05, ** significant at P<0.01, ***significant at P<0.00 (paired sample test and Wilcoxon Signed Ranks Test) DLST: Digit letter substitution test, YTA: Yoga group Total attempted, YWA: Yoga group Wrongly attempted, YNS: Yoga group Net scores. CTA: Control group Total attempted, CWA: Control group Wrongly attempted, CNS: Control group Net scores.

**Graph 2:** Changes in DLST scores for Yoga Group and Control group




DVT scores of yoga group showed significant reduction (P-value<0.000) in time taken, Similarly, significant reduction in errors (P-value<0.000), DVT scores of the control group also a showed significant reduction (P-value<0.03) in time taken, Similarly, significant reduction in errors (P-value<0.05), but between group comparison on DVT scale showed a significant improvement in yoga group (P<0.01) compare to control group.

**Table 3**: Changes in DVT scores for Yoga Group and control group

| **DVT** | **Pre** | | **Post** | | | |
|---|---|---|---|---|---|---|
| **Variables** | **Mean** | **Standard Deviation** | **Mean** | **Standard Deviation** | **% Change in Mean** | **p value (with in group)** |
| **Y Time (Min.)** | 10:44 | 3:48 | 8:14 | 1:38 | 22.03% | 0.000 |
| **Y Errors** | 6.42 | 3.19 | 3.1 | 1.8 | 51.71% | 0.000 |
| **C Time (Min.)** | 10:21 | 3:23 | 9:09 | 2:41 | 10.9% | 0.031 |
| **C Errors** | 6.38 | 3.123 | 5.76 | 2.98 | 9.71% | 0.054 |

*significant at P<0.05, ** significant at P<0.01, ***significant at P<0.00 (paired sample test and Wilcoxon Signed Ranks Test) DVT: Digit vigilance test, Y Time: Yoga group total time taken to finish the task, Y Errors: Yoga group Wrongly attempted, C Time: Control group total time taken to finish the task, C Errors: Control group Wrongly attempted.

**Graph 3:** Changes in DVT scores for Yoga Group and control group

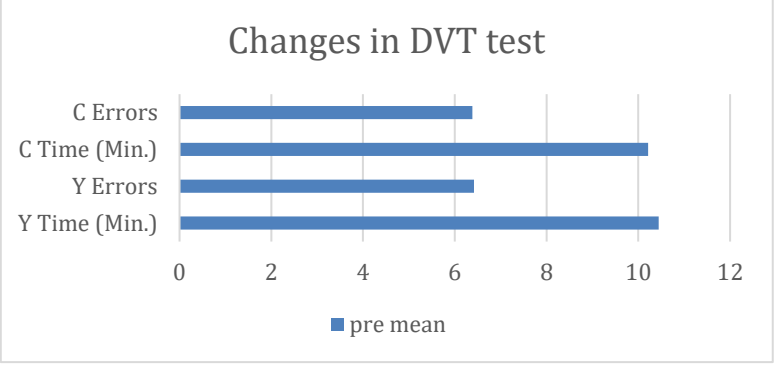
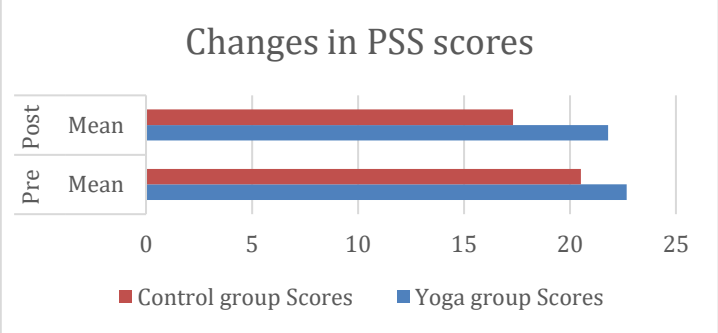


**Table 4:** Changes in PSS scores for Yoga group and Control Group

| PSS | Pre | | Post | | | |
|---|---|---|---|---|---|---|
| Total Scores | Mean | Standard Deviation | Mean | Standard Deviation | % Change in Mean | p value (with in group) |
| Yoga group Scores | 22.68 | 4.71 | 21.8 | 5.23 | 3.8% | 0.19 |
| Control group Scores | 20.52 | 5.64 | 17.32 | 6.34 | 15.59% | 0.000 |

PSS scores of yoga group showed significant reduction (P-value<0.000) in stress scores, PSS scores of the control group showed no significant reduction (P-value<0.19) in in stress scores, between group comparison on PSS scores showed a significant improvement in yoga group (P<0.01) compare to control group.
*significant at P<0.05, ** significant at P<0.01, ***significant at P<0.00 (paired sample test and Wilcoxon Signed Ranks Test) PSS: Perceived stress scale scores.

**Graph 4:** Changes in PSS scores for Yoga group and Control Group




**Discussion:**

Yoga has a positive impact on executive functions by modulating the hypothalamus-pituitary-adrenal (HPA) system and restoring sympathetic-parasympathetic balance. Prolonged activation of the HPA system can lead to cognitive deficits during aging due to increased cortisol concentrations. Mind-body techniques like yoga play a pivotal role in ameliorating stress levels and preventing cognitive decline with age. Regular yoga practice is an effective strategy to counteract the deleterious effects of chronic stress on the brain, preserving cognitive functions (Gothe N P, Keswani R K & McAuley E, 2016). Yoga's influence extends to neurological changes at both structural and functional levels. Research has shown distinct gray matter volume differences in the left hippocampus in experienced yoga practitioners compared to controls. Functional MRI results also showed less activation in the dorsolateral prefrontal cortex in yoga practitioners during the encoding phase of the Sternberg task. These findings suggest a profound association between regular long-term yoga practice and differential structure and function of specific brain regions crucial for executive functions, particularly working memory (Gothe N P, Hayes J M, Temali C & Damoiseaux J S, 2018). Yoga positively influences executive functions involving intricate changes at both neurochemical and neural connectivity levels. Studies have shown notable improvements in cognition and emotional well-being associated with meditation and yoga. Experienced yoga practitioners exhibit a peak in the brain chemical GABA, a neurotransmitter linked to anxiety control, after performing 60 minutes of yoga postures. Yoga was found to be more effective in improving mood and reducing anxiety compared to other physical exercises (Jarvis M, 2017). A randomized controlled study by Lin J et al. (2015) investigated the efficacy of yoga for cognitive impairments and unraveled the neural mechanisms underlying these effects. The 12-week intervention revealed significant improvements in working memory, verbal acquisition, and attention in the yoga group. Seed-based functional connectivity using the posterior cingulate cortex (PCC) as a seed and cortical thickness analyses demonstrated notable changes in neural connectivity and increased thickness in the postcentral gyrus. Yoga has emerged as a promising avenue for enhancing executive functions, particularly in the context of cognitive aging. Recent literature suggests that yoga and contemplative practices may counteract some of the effects of aging on brain functional connectivity. A study comparing resting-state functional connectivity of the medial prefrontal cortex (MPFC) and posterior cingulate cortex-precuneus (PCC-Precuneus) in long-term elderly yoga practitioners and age-matched yoga-naive controls found that the yoga group, comprised of Hatha Yoga practitioners with a minimum of twice-weekly practice for at least 8 years, exhibited greater intra-network anteroposterior brain functional connectivity within the DMN, specifically between the MPFC and the right angular gyrus (AGr), compared to the control group. This finding suggests that regular yoga practice in elderly women may

contribute to improved functional connectivity within key brain regions associated with executive functions, offering valuable insights into the potential role of yoga in fostering a healthier cognitive aging process (Santaella D F et al., 2019). Yoga, encompassing posture-holding exercises (asana), breathing techniques (pranayama, Kriya), and meditation practices (Sahaj), has emerged as a holistic approach with diverse mental health benefits. Numerous studies have reported a reduction in anxiety and enhanced cognitive performance following yoga interventions (Mitra S, Mitra M, Saha M & Nandi D K, 2020). Comparative studies between yoga practitioners and non-practitioners consistently show cognitive advantages among those engaged in regular yoga practice (Desai R, Tailor A & Bhatt T, 2015). For older adults, yoga has shown potential in improving cognition by enhancing stress regulation and neurocognitive resource efficiency. Specific yoga practices, such as Yoga Nidra, have demonstrated effectiveness in inducing relaxation, decreasing sympathetic activation, and alleviating stress and neuropsychiatric symptoms in individuals with migraines (Shashikiran H C et al., 2022). Integrated yoga approaches, combining meditation and pranayama, have been linked to increased overall brain wave activity, contributing to improved cognitive functions (De A & Mondal S, 2020). Additionally, Pranayama practices, such as bhramari pranayama, have been shown to shorten response time in audio and visual reactions, indicating an improvement in information processing and reflexes. This highlights the potential of yoga, including specific breathing techniques, in fostering cognitive enhancement, particularly in domains such as reaction time, making it a valuable tool for optimizing cognitive function, especially for adolescents (Kuppusamy M et al., 2020). Yoga's positive impact extends to motor learning, body awareness, and pain reduction by influencing specific brain areas like the insula, amygdala, and hippocampus (Rivest-Gadbois E & Boudrias M H, 2019). Hence, Yoga's impact on executive functions is complex, involving neurochemical modulation, structural and functional neurological changes, and stress response modulation. This suggests yoga's potential as a holistic strategy for enhancing cognitive performance and overall well-being, including among corporate employees.

## Conclusion

Present study indicates that the six months classical hata yoga practice was successful in enhancing the performance in executive functions tasks and reduction in perceived stress among corporate employees, provides evidence that classical hatayoga practice is the feasible modality to enhance the mental wellbeing through improving the executive functions and reducing the perceived stress of the corporate employees. However, future studies should be done with larger sample size and with a robust research design to confirm the findings of present study.

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