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The Effects of a Mindfulness Therapy Program on Core Symptoms of Children with ADHD Disorder

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Abstract

The objectives of this study were to develop and assess the effects of the mindfulness program on core symptoms of Attention-Deficit/Hyperactivity Disorder (ADHD) in children with ADHD quasi-experimental research was adopted in this study. Thirty-six children ages 9-12 years with ADHD participated in this study. Participants were divided into an experimental group (n=20) and control group (n=16). The experimental group participated in the mindfulness program weekly lasting 1 hour for ten sessions. Data collection tools included (SNAP-IV), Executive Function Assessments (Stroop Color and Word Test, Children's Color Trails Test (CCTT), and Quantitative Electroencephalography (qEEG). Data was analyzed by percentile, mean, Pair t-test and Independent t-test. Within the experimental group, there was a significant reduction at .001 of the score from SNAP-IV and a significant difference at .05 of the score from Stroop Color and Word Test before and after attending the intervention. The qualitative of EEG (qEEG) with regards to the Delta wave frequency also showed a significant reduction while the score from CCTT showed a difference but was not statistically significant. Between the experimental group and control group, a significant difference was found in the scores from the Stroop Color and Word Test. Differences shown in scores between the groups from the SNAP-4, CCTT, and qEEG were not statistically significant.

Keywords: ADHD, Executive function, Mindfulness, Therapy

Introduction

Neuroscience data has provided a clearer answer to the question "How does mindfulness training affect the symptoms of ADHD?" Neuropsychology states that mindfulness training is associated with higher cognition, is related to attention, and is similar to supports self-regulation. These functions are all linked to the working processes of the nervous system and the brain. The anterior cingulate cortex which functions in decision making and emotional regulation, is also associated with the prefrontal cortex and other structures, such as the insula, which is responsible for feelings of compassion for others. The Tempore-Paralympic Junction acts to recognize behavior and feelings (Hölzel et al., 2011). Hypothesis of ADHD, based on neurological and brain evidence, suggests that it is caused by impaired functioning of the nervous system and brain. Electroencephalography shows that there

is a deregulation of brain waves of patients with ADHD. Researchers found that the brain waves of children with ADHD appear to be similar to brain waves of younger children rather than their actual age (Clarke, Barry, McCarthy, & Selikowitz, 2001). There is the study of Quantitative EEG in Children and Adults With Attention Deficit Hyperactivity Disorder: Comparison of Absolute and Relative Power Spectra and Theta/Beta Ratio found that ADHDchildren increased absolute power of slow waves (theta and delta), whereas adults exhibited no difference (Markovska-Simoska & Pop-Jordanova, 2016). The most studies of QEEG in ADHD population confirm elevated levels of slow wave power in frontal region lobe deactivation, in comparison to normal children (Norvilitis, 2012). Now The Food and Drug Administration have approved a medical device using the electroencephalogrupa (EEG) theta/beta ratio (tbr) to help assess pediatric attention defict/ hyperactivity disorder. Tbr is reported to be higher in ADHD, with increased theta and decreased beta (Sangal & Sangal, 2014).

ADHD treatment requires several methods (Multiple modality Treatment) including medication and psychosocial intervention. Psychosocial treatment gives importance to promoting the potential of families, schools and patients to deal with the problems or symptoms of ADHD. Psychostimulant medication remains the first treatment that a doctor will consider. However, treatment should be combined with other therapies (ADHD: Clinical Practice Guideline for the Diagnosis, Evaluation, and Treatment of Attention -Deficit/Hyperactivity Disorder in Children and Adolescents," 2011; Taylor et al., 2004). Approximately 70-80% of patients will respond to medication (National resource Center on ADHD, 2016). However, 10-30% of patients with ADHD, both children and adults, may be unresponsive to stimulants. Some patients may not tolerate adverse reactions caused by medication, such as not eating, sleeping problems, irritated mood, etc. Barkley et al. (2011) as cited in Banashewski et al. (2004). Therefore, although medication is an important means of treatment, parents have concerns about its long-term effects on children with ADHD, especially in younger children (Berger, Dor, Nevo, & Goldzweig, 2008). Accordingly, medication is the last resort for some parents (Charach, Yeung, Volpe, Goodale, Dosreis, 2014)

Research from different countries reports the positive effects of mindfulness training on the brain and mental health. For example, mindfulness training improves the performance of the brain for working memory tasks (Chambers, Lo, & Allen, 2007), increases self-control, reduces aggression (Singh et al., 2014) and helps deal with stress (Tang et al., 2009). A study on adolescents, aged 11-15 years and diagnosed with ADHD, who had mindfulness training for one and a half hours per week for 8 consecutive weeks with their parents, showed reduced behavioral problems and increased ability of Executive Functions (Van der Oord, Bögels, & Peijnenburg, 2011) Data from clinical studies on Neuro-Anatomy and Neuropsychology in children with ADHD shows that there is a malfunction of the Prefrontal Cortical Network, causing problems with the ability for self-regulation, and symptoms of ADHD (Barkley, 2012). Mindfulness improves Executive Functions (Black, Semple, Pokhrel, & Grenard, 2011; Tang, Yang, Leve, & Harold, 2012), helps with constraint (Papies, Barsalou, & Custers, 2011), reduces inappropriate thinking patterns (Kiken & Shook, 2011), improves cognitive processes, and develops understanding of self and others (Hofmann, Sawyer, Witt, & Oh, 2010). In conclusion, mindfulness training helps with concentration, and develops Executive Functions and self-regulation. In 2015, Rajanagarindra Institute of Child Development developed a mindfulness therapy program for children with ADHD in Thailand. The program consists of 10 sessions of 60 minutes per session. Children or

volunteers who participate in the program meet weekly with the therapist.

Objectives

To study the effects of the Mindfulness Therapy Program on core symptoms of Attention -Deficit/Hyperactivity Disorder (ADHD) in children with ADHD.

Methods

Study Design

This study adopted the method of Experimental Research. Participants were a group of children diagnosed with ADHD between the ages of 9 and 12 years at the Rajanagarindra Institute of Child Development. The research team called for volunteers from July to November 2015 and fifty were registered. After examination of their suitability, 48 participants qualified for the study and were randomly divided into 2 groups: an Experimental Group and a Control Group, with 24 participants in each group. During the data verification process, findings were decreased to 36 participants for data analysis due to EEG data in 12 participants having excessive artifacts. The study was conducted in the year 2016.

Volunteer Inclusion criteria was as follows:

1.Had been diagnosed with ADHD. (Attention Deficit Hyperactivity Disorder) according to DSM – IV by a doctor at Rajanagarindra Institute of Child Development

2.Had no other serious illnesses that affected practice of the Mindfulness Therapy Program for ADHD

3.Showed one of the symptoms of being hyper active, impulsive and inattentive, using SNAP – IV, assessed by parents during the sample selection process

4.Used services at Rajanagarindra Institute of Child Development

5. Had 80 ≥ Average IQ, evaluated using standard psychological assessment

6.Was studying in Prathom (primary school) 4 – 6, and/or aged between 9 – 12 years

7.Able to participate in all sessions of the Mindfulness Therapy Program for ADHD.

8.Had parents' consent to participate in the Mindfulness Therapy Program for children with ADHD and could continue the activities at home.

9.Wasn't receiving any other treatment, other than medication, while participating in the Mindfulness Therapy Program for children with ADHD

Procedure

The researcher collected participants' registration information and evaluated their suitability based on participant inclusion criteria. After that, a random sample of participants received treatment from the therapist. One therapist took charge of 4 participants. Those in the Experimental Group received treatment first. The Control Group, which also had 24 participants, received normal medication during the 10 sessions (10 weeks) that the Experimental Group were doing the Mindfulness Therapy Program, Upon completion of the Mindfulness Therapy Program by the Experimental Group, the Control Group then participated in the same Program.

Research tools

Research tools for the study were as follows:

a. A Mindfulness Therapy Program for Children with ADHD which had been through a research and development process by experts, and had IOC validity at 0.82 with the mean score of the interdisciplinary review of the program before training the therapist for all 10 sessions at the highest level ($\bar{x}$ = 4.75) and the mean score of the therapist's comments after the program at the highest level ($\bar{x}$= 4.49). The Mindfulness Program applies the Buddhist principle of Mindfulness (Sati) and trains children to become more aware of their behavior, and helps them to overcome, or refrain from habits. There are 10 sessions;

1) Introduction to Sati training; the children were encouraged to have self-confidence and success with the Sati Game; Doing the opposite to what they used to do.

2) Acceptance and effort; the children's experiences were reviewed and they learned that whatever they do, it does not mean they will be like that all of their lives. They just need to accept it and try to improve by "practice and practice"; children were trained in breathing meditation during the session.

3) Self Exploration with Sati; the children explored themselves "Who they were; Who they really wanted to be". The children were able to examine their symptoms of ADHD disorder by using the "counting backwards by ones from 100 to 0 method", by expanding Sati.

4) Emotional coping by Sati; the children imagined back to an unsatisfactory experience (the therapist used a fable) which was identified by breathing mindfulness.

5) Mindful Walking; walking with step counting.

6) Mindful Listening. The children were trained by breathing mindfulness to know how to listen, what they were listening to, and how to continue with listening practice at home.

7) Mindful Speaking; the children explored talking styles, did number counting meditation, and changed their talking style.

8) Mindful reading; the children were trained in 4 steps of mindful reading; awareness of breathing for a while, stopping everything that is not involved with reading, paying attention to reading, and not giving up - even if something bothers them.

9) Mindful for life; children applied the mindful method to daily life at home and school.

10) Summary: this session reviewed all the methods learned and included an evaluation test. This Mindfulness Therapy Program was composed of the following core activities; a mindfulness game, number countdown mindfulness, breathing mindfulness, motion mindfulness and comprehensive mindfulness in daily life.

b. Data record of Sample basic information

- Personal basic information such as gender, age, education level, intelligence quotient

c. Tools used to assess the symptoms and behavior of ADHD: Screening Scale for symptoms of ADHD: Swanson, Nolan, and Pelham IV Scale (SNAP-IV) assessed by parents, Thai translation version by Nattathorn Pitthayaratsathien. The Scale consists of 3 sections, 26 questions in total. Questions 1-9 assess inattention (SNAP-Inatt), questions 10-18 assess symptoms of hyperactivity/impulsivity (SNAP-H/Im) and questions 19-26 assess symptoms of oppositional defiance (SNAP-Odd), with each question rated by the Likert method at 4 levels (0 = not at all; 1 = a little; 2 = fairly; 3 = very). Scores of each domain are calculated.

d. Tools for assessment of Executive Functions:

Stroop Color and Word Test (Children's Version for Ages 5-14) developed by Charles, Golden, Shawna, Freshwater & Zarabeth (2003). It is a Neuropsychology Test, used to assess Prefrontal lobe function for Executive Function, which can assess Verbal processing speed, Inhibition and Selective attention.

Children's Color Trails Test (CCTT) developed by Llorente et al. (2009). It is a Neuropsychology Test used to assess children aged 8 – 16 years for ability in Prefrontal lobe function of Executive Function. CCTT-1 is used to assess sustained attention, while CCTT-2 is used to assess sustained attention, divided attention and Inhibition – Disinhibition.

e. Electroencephalography; EEG Quantitative Electroencephalography (qEEG) is a device that detects brain waves and converts data into numbers. The study employs an 'ANT Nuero' portable qEEG, Model: eegoTMsports (Figure 1), with 32 Electrode Plate (cap). Participants are instructed to sit up straight in a chair with eyes open and resting, while looking at a target at eye level for 5 minutes. After that, they are asked to sit with eyes closed and rest for 5 minutes, and then to practise

mindfulness for 10 minutes, in total 20 minutes. Placement of the cap on the participant's head followed standard positioning of the International 10/20 System. The positions are numbered and lettered to identify the brain area for each section as follows:

F refers to Frontal lobe
FP refers to Frontal pole
T refers to Temporal lobe
C refers to Central lobe
P refers to Parietal lobe
O refers to Occipital lobe

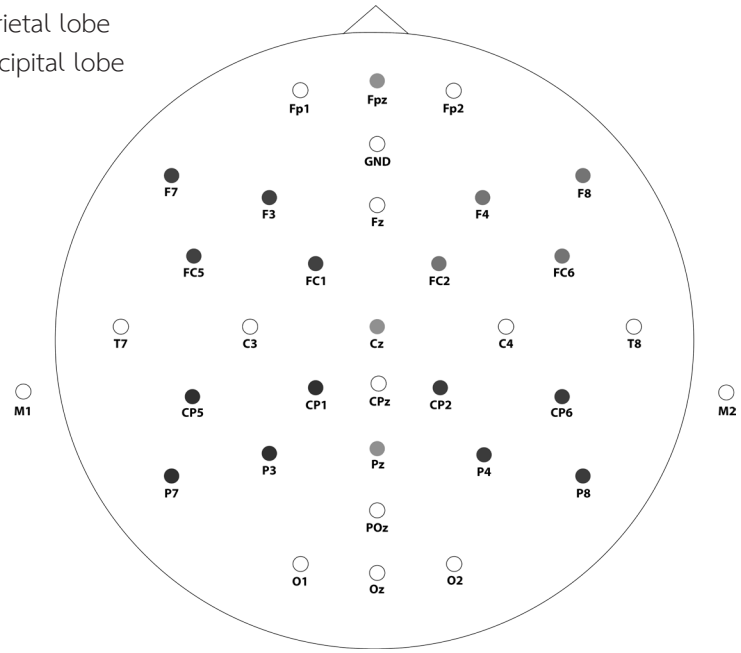

Figure 1: shows the electronic positioning on the head. Even numbers represent the right side (2, 4, 6, 8) and odd numbers represent the left side (1, 3, 5, 7, 9)

Preparation of Participants

Before the participants were examined, children and parents were given advice on the EEG procedure, the device was explained to them, and they were asked whether they were ready to begin. The children were advised to shampoo their heads before the examination. The examiner disconnected all electrical outlets and turned off the lights in the room. The participants were reminded not to fall asleep.

EEG Data Collection

Electroencephalographic data of the participants was examined in detail, starting with analysis of brain wave raw data during eyes-closed resting, eyes-open resting, mindfulness practice, as well as other artifacts, such as electrical signals from muscle or eye movement. Artifact data was left out, in order to obtain electrical signal data, generated by brain function, for analysis. The analyzed brain wave raw data was further analyzed by dividing it into a sub-range of about 2,000 milliseconds or 2 seconds per 1 epoch. An average was calculated to obtain the average EEG in each area of the head. Then the FFT (fast fourier transform) method, which is a

mathematical process that converts the signal into a frequency domain, was used for analysis and management of EEG frequency. This gave the researcher the average amplitude of brain waves in each frequency. It may be used as a power score to show the difference more clearly. The results of the above-described brain waves are shown in numerical values for the brain waves in each frequency, including the power score of the brain waves in each area or shown in the form of topographic brain mapping (TBM), to demonstrate the height or power of different areas of the brain in 5 frequency ranges, including Delta waves (frequency 0-4 Hz), The data waves (frequency 4-8 Hz), Alpha waves (frequency 8-12 Hz), Beta waves (frequency 13-30 Hz), and Gamma waves (frequency 25-more than100 Hz). This study designates four frequencies; namely, Delta waves (frequency 0.5-4 Hz), Theta waves (frequency 4.5 – 8 Hz), Alpha waves (frequency 8.5-12 Hz), and Beta waves (frequency 12.5 – 30 Hz).

qEEG interpreter

qEEG was analyzed and interpreted by Assistant Professor Dr. Vorasith Siripornpanich. Institute of Molecular Biosciences (MB) Mahidol University. (First class honors) Diploma Thai Board of Pediatrics and Pediatric Neurology.

Protection of human subjects

This study included human subjects, there fore the researchers carefully conducted the research with regards to respect, beneficence and consideration of the participants by the following procedure; During the participants' inclusion period, they received information through the website, letters, invitations and announcements, and were allowed to make an independent decision to sign up for the program. The research team provided information in a straightforward manner. Before children participated in the project, the researcher issued an Informed Consent Form for their parents to sign which consisted of two parts; Part 1: Project Proposal and Part 2: Voluntary Consent. The researcher thoroughly explained the purpose of the research, the research procedure, the benefits that would arise from participation in the research, and the rights of participants in the research. Researchers openly answered any questions from participants who had the right to withdraw from the research at any time without having to give a reason. Refusal to participate in this research did not affect their treatment or other rights. In addition, any research data that was included in the study, such as audio and video data from digital cameras, data analysis and reporting of information for academic purposes, is to be kept confidential and only disclosed with consent of the participants. The researcher prepared a consent form for participating children, in the same manner as their parents, however, the language was adjusted to a simpler and more appropriate level for elementary/primary school children. The screening period was divided into groups; the researchers informed participants that they would be divided into 2 groups, with one group participating in the program first and that duration of the program would be about 10 weeks, after which the second group would then participate in the same program.

During the data collection period, the personal data of participants was received solely by the researcher, who used codes instead of participants' real names. There was no publication of the original manuscript of participants' names in the therapy program. In the instance of data storage, a separate computer was used which required two passwords. The passwords were only kept by the lead researcher and research secretary. Moreover, the folder which contains the history, symptoms, and behaviors of the participants also required a password. Video data was stored in closed lockers. Information, discussions, or publication of information were only done as an overview of the research. The researcher keeps

the participants' personal information confidential. No reference is made to the participants by name in any reports related to this research, except in cases of data disclosure for the benefit of research development, such as research team disclosure or reporting for academic purposes. However, participants must sign the Informed Consent Form before disclosure of their information. Research data documents are maintained in a locker. Only two people have a locker key to access the data; namely, the lead researcher and the research secretary. All participants' data will be destroyed within 2 years of the end of the research. Video and audio data recorded with a digital camera, was stored on a Digital Video Disc. Only the lead researcher and research secretary can access this data. At the end of the research, all data recorded on the Digital Video Disc will be neither disclosed nor destroyed. In the instance of participants wanting access to their data, they can inform the research team, according to their legal rights as participants. Findings are reported as an overview and participants' information is not disclosed. However, the researcher presented the proposal through the Human Research Committee Review Board, prior to conducting the research.

Data collection

The research team collected data (Pre-Post test) by the following method:

Table 1: Shows the tools used to gather data before and after the experiment.

Tools for collecting data	Before	After
Basic data of Volunteers	✓	
Symptoms of ADHD from SNAP IV	✓	✓
Executive Functions Test - Stroop Color and Word Test (Children's Version for ages 5-14) - Children's Color Trails Test (CCTT) for ages 8 – 16 years	✓	✓
Quantitative Electroencephalography (qEEG)	✓	✓

Data Analysis

Analysis of the data was done using:

1. To study the general characteristics of participants who practiced the Mindfulness Therapy Program, and the control group, by finding the percentage of diagnoses of ADHD and ADHD with comorbidity, education, treatment, and medians of IQ and age.

2. To compare the ability in Executive Functions and behaviors indicating symptoms of ADHD, before and after the Mindfulness Therapy Program by comparing the statistical difference of the Non-parametric model using the Wilcoxon Signed Ranks test.

3. To compare the ability in Executive Functions and behaviors indicating symptoms of ADHD, after the Mindfulness Therapy Program, between the experimental group and the control group, by comparing the statistical difference of the Non -parametric model using the Mann-Whitney U Test.

4. To compare EEG power scores, before and after the Mindfulness Therapy Program, using a Pair t – test, and to compare EEG power scores between the experimental group and the control group, using an Independent t – test.

Results

Table 2 shows general information of participants of the same average age group. The IQ of the experimental group is slightly higher than that of the control group. The experimental group shows more Learning disability disorder than the control group.

Table 2: Shows general characteristics of participants in the Mindfulness Therapy Program and the control group. N = 36

	Experimental G. N = 20	Control G. N = 16
Diagnosis		
ADHD	60 % (12)	75 % (12)
ADHD with LD	40 % (8)	25 % (4)
Age [year: Mean(SD)]	9.8 % (1.15)	9.9 % (1.20)
IQ [Mean (SD)]	102.1 % (15.66)	100.44 % (10.24)

Figure 2 compared the evaluated ADHD behavior scores (SNAP-IV) before and after the therapy program of the experimental group (EG), and between the experimental group and the control group (CG). There were statistically significant differences in all aspects of ADHD behavior scores in the experimental group. In terms of evaluation of Executive Functions, there was a significant difference in the color – word test when comparing EG and CG. It was found that the group who received the therapy program had better behavior scores than the other group, however, there was no statistical significance, as shown in Figure 2.

Figure 2: shows comparison of ADHD behavior scores (SNAP-IV) of the experimental group (Pre – Post Test), and between the experimental group and the control group (* $p < .05$, ** $p < .01$)

Figure 3 compared scores in Executive Functions (EF) from Stroop Color and Word, and Children's Color Trails Test (CCTT), before and after the therapy program of the experimental group. It was found that the scores of Executive Functions increased after the program. There was a statistically significant difference in the color-word test, which indicated that children who received the therapy program improved in Inhibit conflict responses.

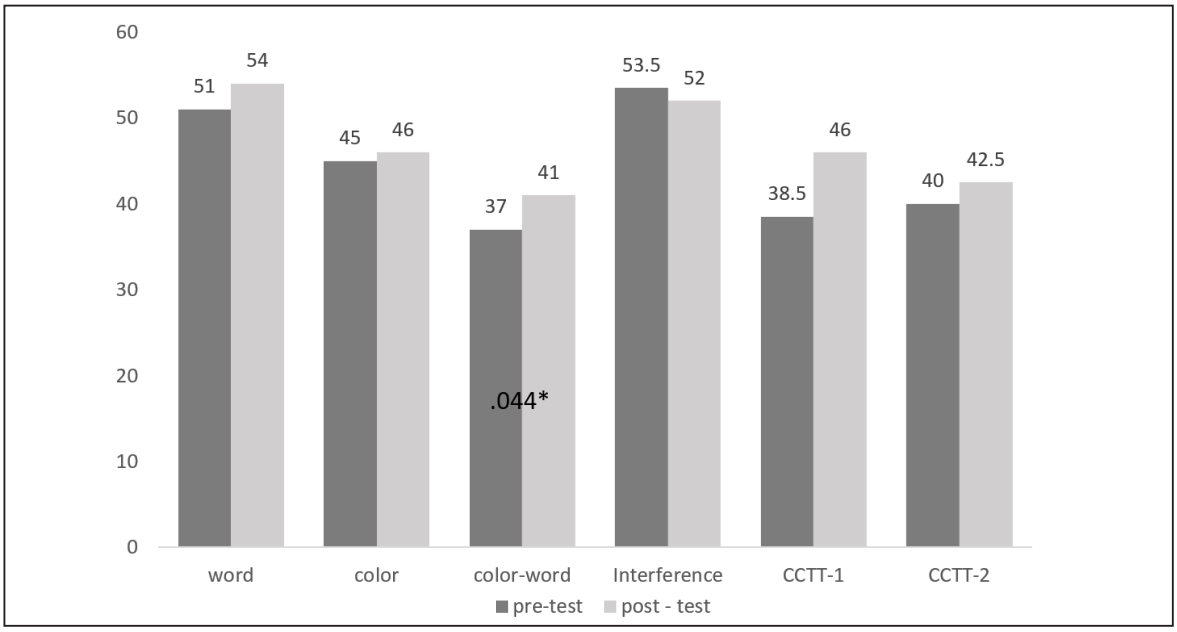

Figure 3: shows scores of Executive Function (EF) assessed by Stroop Color and Word, and Children's Color Trails Test (CCTT), before and after the therapy program of the experimental group (* p < .05, ** p < .01)

Figure 4 compares ability in Executive Functions (EF) and behaviors indicating symptoms of ADHD, after receiving the Mindfulness Therapy Program, between the experimental group and the control group. It found that the score of the experimental group was higher than the control group, however, there was no statistical significance.

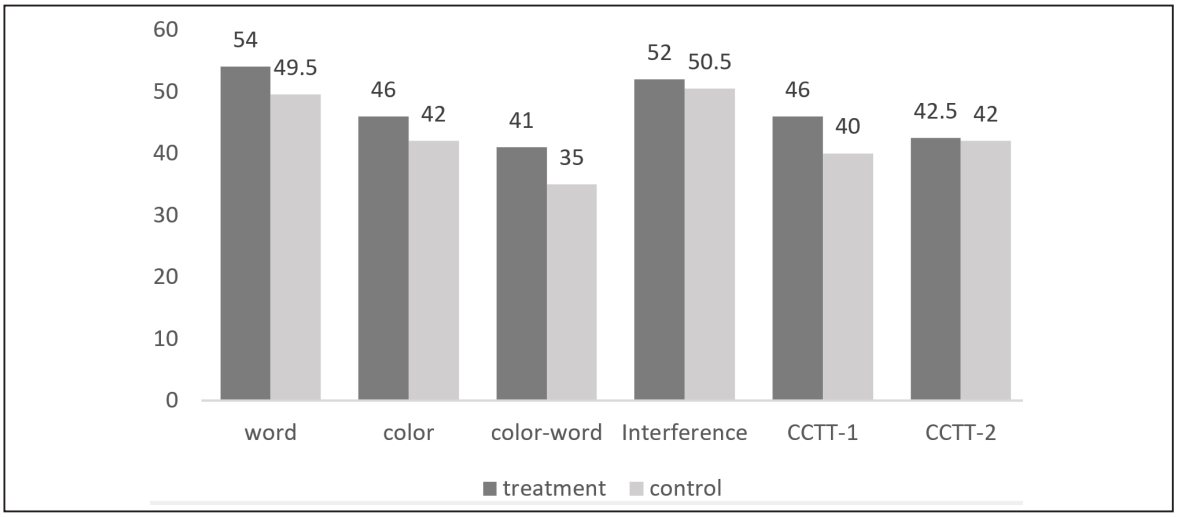

Figure 4: Compares the ability in Executive Functions (EF) and behaviors indicating symptoms of ADHD, after receiving the Mindfulness Therapy Program, between the experimental group and the control group (* p < .05, ** p < .01)

Results of qEEG

The qEEG in this study used a 32-electrode cap and categorized the electrode positions for analysis into 5 positions as follows; (1) Left anterior, consisting of F7, F3, FC5, FC1 (2) Right anterior, consisting of F8, F4, FC6, FC2 (3) Left posterior, consisting of CP1, CP5, P3, P7 (4) Right posterior, consisting of CP2, CP6, P4, P8 and (5) Midline consisting of FPz, CPz, Pz. The results showed significant changes in Delta waves during the eye-closed period. It found that delta waves were reduced after the mindfulness therapy program in 3 areas of the brain; namely, left anterior, right anterior and midline. Furthermore, there is a clear reduction in the power score of Delta waves in the left posterior and right posterior areas but there were no statistically significant differences. Power score data of Delta waves, before and after the mindfulness therapy program, is shown in Table 3 and Figure 5. When comparing the EEG power score of both groups, it found that the experimental group showed a decrease in the average EEG power score but there were no statistically significant differences, as shown in Table 3.

Table 3: Shows the average EEG power score of volunteers who received the Mindfulness Therapy program for children with ADHD (Experimental group), for Delta waves in 3 conditions; Eyes-open, Eyes-closed, and Breathing Meditation. N = 17

Brain area	Average Delta power (μV2)								
	Eyes-open			Eyes-closed			Breathing Meditation		
	Pre test Mean(SD)	Post test Mean(SD)	*p*-value	Pre test Mean(SD)	Post test Mean(SD)	*p*-value	Pre test Mean(SD)	Post test Mean(SD)	*p*-value
Left anterior	134.58 (66.56)	105.80 (52.49)	.09	144.85 (65.01)	102.44 (52.40)	.01**	118.04 (46.13)	111.54 (48.22)	.54
Right anterior	117.05 (55.76)	89.86 (45.36)	.07	123.40 (53.23	94.04 (57.85)	.04*	103.35 (41.00)	99.87 (48.98)	.74
Left posterior	84.39 (43.22)	70.47 (53.08)	.20	75.00 (35.28)	67.38 (51.93)	.42	64.41 (25.08)	69.88 (47.28)	.56
Right posterior	88.97 (48.64)	70.15 (46.68)	.11	82.85 (40.13)	69.01 (51.52)	.18	70.23 (29.73)	72.67 (49.13)	.81
Midline	139.22 (61.82)	117.93 (58.85)	.23	160.97 (73.79)	107.61 (49.91)	.01**	134.46 (48.63)	120.10 (47.91)	.19

* $p < .05$, ** $p < .0$

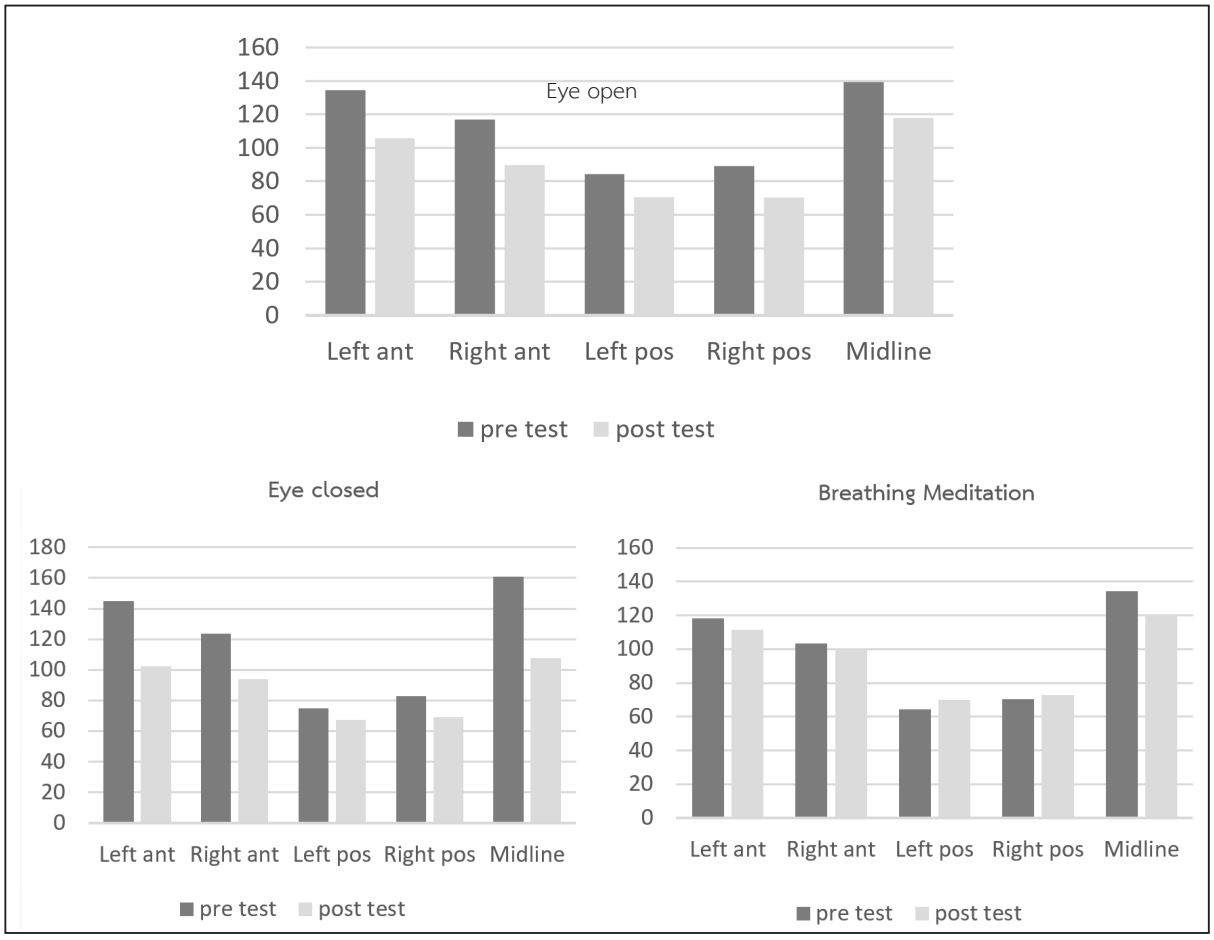

Figure 5: Displays data of Table 3 in charts.

Discussion

The data from these three assessments revealed significant changes in the group that had been practicing the Mindfulness Therapy Program for children with ADHD. Parents used the screening scale (SNAP-IV) to assess ADHD symptoms, before and after the Mindfulness Therapy Program. Results showed significant improvement of children's behaviors in relation to inattention, hyperactive / impulsive behavior, and oppositional defiance. In particular, oppositional defiant behavior improved significantly. When comparing the experimental group and control group, the behavior scores of ADHD were similar. This study corresponds to studies in other countries which indicate that the mindfulness therapy program is beneficial for reducing the symptoms of ADHD in children diagnosed with ADHD. A meta-analytic review was used to determine whether or not the mindfulness therapy program was applicable to children with ADHD. It has been shown to be useful and effective in reducing the symptoms of ADHD. (Cairncross & Miller, 2016) It is noteworthy that application of the concept of mindfulness practice in the public health profession has gained a lot of attention abroad. Specifically, such practice is used to treat and / or prevent psychiatric disorders and mental health problems. Most Mindfulness

Therapy Programs are applied from a mindfulness training approach to manage stress, based on the MBSR program and the Mindfulness Therapy Program, with thought management based on the MBCT program. The Mindfulness Therapy programs for children with ADHD used abroad are also based on the concept of the two programs. They are used with school children who are diagnosed with ADHD between the ages of 8-12 years. The parents are the assessors. However, in other countries the programs are used with parents at the same time and results showed that they reduce symptoms of ADHD significantly. (Singh et al., 2009; Van der Oord et al., 2011). Nevertheless, the design of Mindfulness Therapy Programs for children with ADHD used in the study, focuses on training children directly rather than their parents.

The study shows that there was a statistically significant change in Executive Functions, specifically for inhibitory control using the STROOP Test and Color Word Unit. When comparing the two groups, it was shown that there were statistically significant changes of the Color Unit, and the qEEG detected changes in Delta waves at the Left-Right Anterior. This indicated an improvement of brain function. Meanwhile, Beta waves showed slower power ratings. This showed improvement of the ability to focus and pay attention because there are less chaotic thoughts. Therefore, it can be concluded that the children participating in the Mindfulness Therapy program for children with ADHD, have improved behavior or symptoms of ADHD, and improved Executive Functions, specifically for inhibitory control, and forebrain development.

The study found positive changes of ADHD symptoms evaluated by the parents. There were also statistically significant changes in the components involved in the Executive Functions, specifically in Inhibitory Control assessed by the Stroop Test, which is a classic test for assessment of Inhibitory Control. The results of this study showed that Inhibitory Control of the children participating in the program was significantly improved, both before and after training. Comparing the two groups, findings state that mindfulness therapy is associated with Executive Functions, Self-regulation and Brain functions (Bishop, 2004; Tang et al., 2009; Black et al., 2011). The study of Mindfulness and Inhibitory Control in Early Adolescence show positive results of Inhibitory Control in 99 pre-adolescence. The study found that there was a significant increase in Inhibitory Control according to an assessment scale called Mindful Attention Awareness Scale (MAAS) and by an application for assessment of Inhibitory Control called Dots Task (tested by having the children press a keyboard on the same side as a flower image appears on-screen and pressing the keyboard opposite to the flower image.) (Davidson, Amso, Anderson, & Diamond, 2006)

EEG results in the study indicate improvement of forebrain functions (Left-Right Anterior) and Midline, both before and after the Mindfulness Therapy Programs for children with ADHD, based on the power scores of Delta waves, which are significantly lower in eyes-closed and tend to decrease in eyes-open state. Studies of brain functions in ADHD often found that those who are diagnosed with ADHD have an increase of slower brain waves than the same age group. Delta waves are slow waves with .05 – 4 Hertz . Similarly, Theta waves are 4 – 8 Hertz. The neurodevelopment hypothesis (Neurodevelopmental Models) suggests that behavior of children and adolescents with ADHD are caused by slower development of the brain (Maturational Lag and Deviation Model). Brain maturity of children with ADHD is slower than the same age for about 3 years, especially in the frontal area, which may be delayed by 5 years (Burke & Edge, 2013). There is low arousal of brain waves in relation to poorly responsive brain conditions or in a drowsiness state, while high frequency brainwaves are associated with alertness

and the ability to concentrate (Ogrim, Kropotov, & Hestad, 2012). It was found that in a calm state (Resting State), both eyes-opened and eyes-closed, participants' delta waves decreased after joining the program, and that the results of the two groups tended to be in the same direction. Therefore, it can be concluded that the functions of the subjects' forebrains have improved.

Another interesting finding from EEG is that there are changes in power scores in the high frequency Beta brainwave (13 - 20 Hertz), which is likely to decrease before and after the program. In eyes-open state, the Beta wave power scores were higher at pre-test, than at post-test. In eyes-closed state and Breathing Mindfulness, it was found that post-test power scores were lower than pre-test. This phenomenon shows that participants in the program improved their ability to control their thoughts. While in the eyes-open state in a calm room, many beta waves were detected. This indicates that much thinking is occurring in the brain. However, in the eyes-closed state, participants were able to control their thoughts better, especially when doing Breathing Mindfulness. Left / Right posterior brain waves tended to decrease significantly. Beta waves are related to many activities during the waking state, such as anxiety, stress and depression. Thus, it shows relaxation of participants in the Mindfulness Therapy Program. When comparing the average power scores of Beta waves of the two groups, it suggests that the ADHD participants in the program showed better management of thoughts than the untrained group, due to the fact that during the eyes-open state, detected Beta waves in the experimental group were higher than in the control group, and decreased during eyes-closed state and Breathing Mindfulness. This phenomenon shows that during eyes-open, the experimental group had more thoughts than the control group, thus, more brain functions and more beta waves, but during eyes-closed state and Breathing Mindfulness, the experimental group could control their thoughts better. The Mindfulness Therapy Program for children with ADHD, practiced once per week for 1 - 1.30 hours in the therapy room, helped to reduce the symptoms of ADHD, enhanced Executive Functions, especially concentration and developed low-frequency waves (Delta waves).

Recommendations

Research recommendation: The Mindfulness Therapy Program for children with ADHD is a relatively new study in Thailand that should be developed continuously for adjustment and improvement of the Program. Studies should be done in larger Sample groups with application to the public health system and regular education. Various activities may be employed, however, the same study objective needs to be kept in mind. Additional research topics such as 'The Effectiveness of Mindfulness Therapy Programs on the Reduction of Behavioral and Emotional Problems in Vulnerable Groups', 'Mindfulness Therapy Programs for Children in Observation and Protection Centers or Children's Training Centers' could be taken into consideration. This study still has limitations, particularly regarding brain wave results, as the participants attend RICD, a special care hospital, where clients normally come with complex and severe conditions. Thus, it is barely selected for only ADHD disorder. So, I would add as a limitation of the study, that the result of brain waveท may indicate ADHD with comorbidity rather than solely ADHD.

Recommendation for therapists: During treatment for children with ADHD, there should also be a training program or session which provides general knowledge for parents. It would be especially helpful if teachers could use this program in schools. For development of a Mindfulness Therapy Program for Children with ADHD, the issue of experienced therapists in mindfulness or concentration training is very

important. It involves understanding and problem solving which might occur during the therapy. Therefore, training should be provided on the main skills required for the program.

Policy Recommendation: The program should be expanded for treatment of Children with ADHD who are unwilling to take medication or are not responding to medication, as well as groups with behavioral and emotional problems, because the study results show that the problem of persistent disobedience and individualized behaviors of the children were significantly reduced. Mindfulness Therapy Programs for children with ADHD could be considered helpful for improving behaviors and emotions, even in normal children.

Ethic approval

This project was appored by the Human Research ethic commitees Rajanagarindra Institute of Child Development. The number was 4/2016.

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