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Cognitive behavior therapy intervention on adolescents to decrease anxiety problem study: the role of serotonin

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ABSTRACT

The existence of demands that occur simultaneously causes some adolescents to be unable to adapt properly, especially the condition of adolescents who experience changeable emotions, are unstable, easily stressed, feel anxious, depressed, and feel helpless. Cognitive behavior therapy (CBT) is a form of psychotherapy that can be used for adolescent emotional problems. The purpose of this study is to prove that CBT interventions can increase serotonin levels and reduce adolescent anxiety levels. The research population is adolescents with anxiety problems in the city of Surabaya. The research sample is 32 respondents with techniques systematic sampling. Inclusion criteria include: i) adolescents aged 12–18 years, ii) experiencing mental emotional anxiety problems as measured by a score with self-reporting questionnaire (SRQ-29), and iii) being willing to participate in the research and get permission from parents. Data collection using an instrument in the form of a Taylor Manifest Anxiety Scale (TMAS). The data have been analyzed by the Wilcoxon test. The results show that there were significant differences in serotonin levels and anxiety levels before and after the intervention given CBT. The average value of serotonin levels in the posttest was higher than the pretest (p=0.001) and the average value of anxiety levels in the posttest was lower than the pretest (p=0.043) indicating that giving CBT interventions was able to significantly reduce anxiety levels. CBT interventions are proven to increase serotonin levels and reduce adolescent anxiety levels. By changing the form of thought and the resulting consequences, the intensity of the subject's anxiety decreases.

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1. INTRODUCTION

Adolescence is a critical period because many events will not only determine the life of adulthood but also the quality of life for the next generation. The adolescents undergo biological, psychological and social changes that require them to make adaptations [1]. They encounter many challenges and conflicts, look for self-identity, and tend to fantasize about excessive power.

The various demands of the adolescents may result in poor adaptation. i.e. unstable emotion, stress, depression, and feeling of helplessness [1]. According to data from the Indonesian Statistics Center, there are 22,176,543 people aged 15-19 years old and in the city of Surabaya itself it is estimated that the number of teenagers is 225,871 people [2]. Reports from epidemiological studies according to Kessler, in Marrison show

that anxiety is the most common problem during childhood and adolescence between the ages of 10-19 years, which if not taken seriously will make a person experience difficulties in his daily life [3], [4]. Data from World Health Organization (WHO) states that the increasing incidence of mental health disorders around the world has become a severe problem in various countries.

It is estimated that 10% of the world's population is at risk of mental disorders and 25% are at risk of mental disorders at particular times in their life. estimation prevalence of mental disorders (depression, anxiety, post-traumatic stress disorder, bipolar disorder, and schizophrenia) was 22.1%. 13.0% for mild forms of depression, anxiety, and post-traumatic stress disorder and 4.0% for moderate forms. The mean comorbidity-adjusted, age-standardised point prevalence for severe disorders (schizophrenia, bipolar disorder, severe depression, severe anxiety, and severe post-traumatic stress disorder) was 5.1% [5]. The American Psychiatric Association (APA) reported that 100,000 adolescents and young adults the United States experience first-episode psychosis (FEP) every year [6]. It can be implied that the risk of developing mental disorders is very high. Thus, early diagnosis and treatment are necessary to manage the symptoms before they become aggravated Based on the results of another study conducted on the determinants of emotional and mental symptoms in junior high school students in China, show that a total of 63,205 participants were involved, in which the weighted prevalence of depression in all subjects was 23.0%, and the weighted prevalence of anxiety was 13.9%, logistic regression results showed girls, being single-child, non-nuclear family, peer bullying, sleep disturbance, and internet gaming disorder symptoms were positively associated with depressive and anxiety symptoms [7].

Essau explains that first incidence of anxiety disorders to be significantly higher in childhood and adulthood than in adolescence and emerging adulthood. Female gender was associated with first incidence, but not with recurrence. Significant comorbidity was found between anxiety disorders and major depressive disorder (MDD) across the four developmental periods. The comorbidity between anxiety and substance use disorders (SUD) was significant in childhood, emerging adulthood and adulthood, but not in adolescence.

The presence of anxiety disorders during childhood and adolescence significantly increased the probability of having an anxiety disorder during emerging adulthood [8]. Reports from Cohen the trajectory of anxiety symptoms was best described by a discontinuous homotypic pattern in which childhood anxiety predicted adolescent anxiety [9]. Adolescents with anxiety usually go undetected in primary health care. The best predictors of adolescent anxiety are angry states, aggressive behavior, empathic attention a lack of coping mechanisms that focus on problem-solving and the perception that stress is a threat [3]. According to the Diagnostic and statistical manual of mental disorders-DSM-5, signs and symptoms of anxiety can be described as feelings of fear & worry about several events/things or activities the patient finds difficult to control this worry, restlessness, irritability, fatigue, muscle tension, difficulty concentrating, disturbed sleep (difficult, frequent awakenings, sleepless nights) [10].

According to Stuart [11], adolescence experiences biological, psychological, and social changes that require adolescents to be able to adapt because they experience many challenges and conflicts, are looking for self-identity, have high ideals, and like to fantasize/exaggerate fantasies [12]. Mental health is fundamental to overall health and well-being during this sensitive period. But poor mental health during adolescence can also carry impacts that extend into adulthood [1] and to the next generation [13]. The existence of demands that occur simultaneously causes some adolescents to be unable to adapt properly, especially the condition of adolescents who experience changeable emotions, are unstable, easily stressed, and feel anxious, depressed, and feel helpless.

Risk factors for mental and emotional disorders in adolescents can be viewed from changes in various aspects including biological, psychological, and socio-cultural aspects. Changes in the biological aspects of adolescents, namely brain development where changes occur in the neuron system which causes a faster physical response to stress, hormones, and neurotransmitters that affect adolescent behavior which results in extreme emotional responses such as mood swings, anxiety, and outbursts [11].

Many actions in the treatment of mental disorders are ways of influencing the body's serotonin system. Several studies have found a decrease in the neurotransmitter's serotonin, norepinephrine, dopamine, acetylcholine, and an increase in the concentration of monoamine oxidase in the brain in someone who is experiencing anxiety.

Other studies have shown that the neurotransmitters associated with anxiety pathology are serotonin and epinephrine. Serotonin (5HT) disorders have implications for several types of mental disorders including anxiety, depression, psychosis, migraine, sexual dysfunction, sleep, cognitive, and eating disorders [14]. So besides influencing mood, the Serotonin hormone also plays a role in various other body functions, such as digestion [14], which can affect the development of children and adolescents.

Preventive and curative efforts need to be made to prevent or reduce the number of incidents, especially for adolescents who experience anxiety or depression where it is difficult for people to get medicines to overcome these problems [15]. Psychotherapy, especially cognitive therapy, showed statistically significant

decreases in attenuated psychotic symptoms, negative symptoms, depression, cognitive biases and improvements in functioning. Familial factors are strongly implicated in the onset and maintenance of anxiety, but available evidence-based treatments are usually individual-focused. The aim of this review was to evaluate the current evidence base of family-based interventions addressing youth and adult anxiety and highlight findings comparing family based and individual-focused treatments resulting in 22 included youth studies.

Overall, family-based treatments performed better than no-treatment controls and as well as individual-based interventions, with some evidence that family-based interventions. Family based interventions may represent a good alternative for anxiety treatment in youth [16]. Cognitive therapy can help reduce the anxiety severity of the symptoms in adolescents who are at risk of psychosis [17].

Cognitive behavior therapy (CBT) is a form of psychotherapy that can be used for adolescent emotional problems which aim to eliminate signs, symptoms, or emotional problems by changing and rebuilding positive and rational cognitive status so that they have healthy behavior and somatic reactions [18]. The main procedure principles of CBT are to provide prolonged and continuous exposure to feared or anxiogenic stimuli (sometimes obsessions) and prevention of responses that normally reduce anxiety (such as compulsions).

Standard psychotherapy for anxiety can use relaxation therapy, self-knowledge-oriented psychotherapy, cognitive therapy, behavioral therapy, group therapy, or short-term anxiety provocation therapy. The results of the study indicate that CBT therapy is recommended to be continued in its application to manage anxiety because CBT can reduce the patient's anxiety [19]. Based on the results of Shean's research on the effects of CBT and psychotherapy with psychopharmaceuticals, it was found that the two had very significant differences [15].

2. METHOD

This research uses a pre-experimental design with a pre-post-test group model. The research population was teenagers with anxiety problems in three Junior High Schools (SMP) in the city of Surabaya. The research sample consisted of 32 respondents using a systematic sampling technique. Determination of a large sample size using a formula to test the hypothesis of two proportions on one side. Number of research samples in each school that meets the research sample criteria.

The recruitment and selection process are carried out by collecting a list of students from each school. The third school was randomized to control confounding variables. Inclusion criteria include: i) teenagers aged 12–18 years, ii) junior high school students living in the city of Surabaya, iii) experiencing mental and emotional anxiety problems as measured by a score with the SRQ-29, iv) ready to take part in a CBT intervention activity, v) ready to take part in the research and obtain parental permission (father/mother). To obtain data about students who experience emotional and mental disorders and anxiety, all students from the third school were asked to fill out the SRQ 29 questionnaire. This research has limitations in sample size, which has an impact on subjectivity.

The research procedure carried out activities in stages i) identifying phenomena and feasibility studies on subjects and research sites as well as conducting preliminary studies on research-related materials, ii) the process of obtaining research ethical clearance from the Ethics Commission of the Faculty of Medicine, Diponegoro University, iii) secondary data collection, preparation of intervention modules, preparation of research instruments and trials of research instruments, and identification of research samples, iv) to equalize perceptions with research enumerators and conduct Cohen's Kappa Consistency Test researchers and research enumerators, v) carried out the first (pretest) and second (posttest) measurements including anxiety levels and serotonin levels by laboratory assistants according to the data collection protocol before and after the CBT intervention, vi) CBT interventions in give. CBT techniques are given five sessions of 45 minutes each in three meetings.

The study was approved by the ethical committee with number No.75/EC/KEPK/FK-UNDIP/III/2022 obtained from Health Research Ethics Commission (KPEK) Faculty of Medicine, Diponegoro University before data collection. At the time of data collection, the researcher explained the reasons for the research, outlined the rights of the respondents and only involved respondents who were willing to complete informed consent. All information about respondents is kept confidential and only used for research purposes.

The data from this research were analyzed using the Paired t-test and the Wilcoxon test. with the help of SPSS version 21. The demographic profile of the respondents will be analyzed using descriptive statistics and frequencies to determine characteristics. The description of the research variables is carried out by looking at the frequency distribution, mean value, standard deviation, and minimum and maximum values. Meanwhile, for categorical data, proportion or presentation values are used. A homogeneity test was carried out using the variance test or F test. The bivariate analysis carried out in this study was the paired difference t-test analysis. Testing the effect of CBT intervention on increasing serotonin levels and reducing anxiety was carried out using paired t-test or Wilcoxon test analysis. The test criteria state that the significance value is <level of significance (alpha=0.05).

3. RESULT

Based on the data presented in Table 1, it is known that the majority of respondents are female (59.4), aged 16 years seven months to 18 years six months (50.0), Grade 8 (46.9), parents work as private employees (46.9), parents earn 3-5 million (71.9), 2nd child order (50.0), has knowledge in the tofu category (65.6), has an authoritarian and democratic parenting style (28.1), and has parental support (62.5).

Table 1. Distribution of frequency based of demography data (n=32)

Variable	Category	Frequency	Percentage (%)	*p* value
Sex	Male	13	40.6	
	Female	19	59.4	0.096
Age	12-14.6 y.o	6	18.8	
	14.7-16.6 y.o	10	31.3	
	16.7-18.6 y.o	16	50.0	0.001
Class	7 th grade	4	12.5	
	8 th grade	15	46.9	
	9 th grade	13	40.6	0.434
Weight	<40 kg	2	6.3	
	40-50 kg	13	40.6	
	51-60 kg	10	31.3	0.367
	61-70 kg	5	15.6	
	71-80 kg	2	6.3	
	>80 kg	0	0.0	
Parental profession	Unemployed	4	12.5	
	Civil service	4	12.5	0.287
	Private employee	15	46.9	
	Indonesian national army/Police/TNI	5	15.6	
	Self-employed	4	12.5	
Parental income	3-5 million	23	71.9	
	>5-8 million	5	15.6	0.360
	>8 million	4	12.5	
Birth sequentialy	1 st child	10	31.3	
	2 nd child	16	50.0	0.665
	3 rd child	5	15.6	
	more than 3	1	3.1	
Subject knowledge	No	11	34.4	
	Yes	21	65.6	0.171
Parenting style	Authoritarian	9	28.1	
	Democratic	9	28.1	0.366
	Permissive	8	25.0	
	Neglectful	6	18.8	
Parental support	No	12	37.5	
	Yes	20	62.5	0.200

Based on the descriptive analysis in Table 2, it can be seen that in the intervention group, on average, there was an increase in serotonin levels (71.4) after being given the intervention CBT. The average value of serotonin post-intervention was higher than pre-intervention indicating that the intervention CBT was able to improve significantly rate Serotonin. Serotonin plays an active role in conveying emotional messages, controlling behavior and psychological responses to environmental stressors, and is involved in the pathophysiology of depression.

Based on Table 3, descriptive analysis it can be seen that on average there is a decrease in level anxiety (42.5) after being given the intervention CBT. This is supported by the statement put forward by Meriçtan and Sevi [20], which states that CBT can be given to children to adolescents with behavioral disorders, such as angry behavior, opposing behavior, and destructive behavior and anxiety. CBT does not only focus on changes in the nerves that exist in the body or on changes in behavior but rather on the existence of cognitive distortions in the subject and by following therapy it is hoped that it can help solve the subject's psychological problems.

Table 2. Serotonin levels description (n=32)

Descriptive	Serotonin levels	
	Pretest	Posttest
Minimum	54321.00	67247.00
Maximum	112573.00	109959.00
Means	75580.2188	82720.2500
Standard deviation	13310.67343	9769.84454

Table 3. Anxiety levels description (n=32)

Descriptive	Anxiety level	
	Pretest	Posttest
Minimum	13.00	7.00
Maximum	41.00	44.00
Means	30.6250	26.3750
Standard deviation	8.16661	8.81256

Based on the data presented in Table 4, it is known that before being given the intervention most of the respondents had anxiety in the severe category (68.8), after being given the intervention there was a decrease in the level of anxiety from severe to mild (25.0) and moderate (31.2). CBT is seen as a more suitable intervention to be applied to the subject. It is hoped that with CBT, the subject's cognitive distortions can change so that the intensity of the subject's anxiety decreases, the subject is more adaptive and can carry out his adaptive function properly.

Table 4. Anxiety level categoric (n=32)

Category	Anxiety level			
	Pretest		Posttest	
	Frequency	Percentages	Frequency	Percentages
Mild anxiety	4	12.4%	8	25.0%
Moderate anxiety	6	18.8%	10	31.2%
Severe anxiety	22	68.8%	14	43.8%
Total	32	100%	32	100%

Based on Table 5 above, it can be seen that the results of the statistical test analysis with the paired t-test or the Wilcoxon test, or the intervention group on both variables yielded a significance value of p<alpha (0.05). Therefore, it can be stated that there are significant differences in serotonin levels and anxiety levels before and after the intervention is given CBT. Or in other words, there is a significant effect of CBT intervention on serotonin levels and anxiety levels. The mean value of serotonin levels in the posttest was higher than the pretest (p=0.001) indicating that the CBT intervention was able to significantly increase serotonin levels. Then the average value of anxiety in the posttest was lower than the pretest (p=0.043) indicating that the provision of CBT interventions was able to significantly increases serotonin levels and reduce anxiety levels. Serotonin is a neurotransmitter from one part of the brain to another and is expected to play an active role in regulating behavior in response to stress exposure and is associated with depression which can affect quality of life. Cognitive restructuring techniques help subjects change their negative thoughts into more rational and positive alternative thoughts.

Tabel 5. Analysis of the intervensi cognitive behaviour therapy serotonin levels and anxiety level

Variabel	Test	Statistics	*Sig.*
Serotonin levels	Pretest Posttest	-3.188[b]	0.001
Anxiety level	Pretest Posttest	2.114[a]	0.043

Note: [a]Paired t-test, [b]Wilcoxon test

4. DISCUSSION

Cognitive behavioral therapy (CBT) is an appropriate and effective first-line intervention for anxiety disorders in children and adolescents [21]. The cognitive behavioral approach is based on the concept that psychological problems such as depression, anxiety, and stress are often exacerbated by overthinking. CBT practitioners, then help patients identify their mindsets and change their behavior using evidence and logic, CBT appears to be effective for improving a person's psychological health. This is supported by research results Fennell [22] with a study meta-analysis of 115 studies has shown that CBT is an effective treatment strategy for depression and that combined treatment with pharmacotherapy is significantly more effective than pharmacotherapy alone.

Evidence also suggests that the relapse rate of patients treated with CBT is lower compared with patients treated with pharmacotherapy alone [6]. Examined the impact of cognitive-behavioral interventions on anxiety and depression among Nigerian undergraduate students enrolled in social science education majors [23]. They found that cognitive-behavioral therapy had a significantly positive impact on reducing levels of anxiety and depressive. To avoid the negative impact of anxiety, it is necessary to carry out certain interventions. In this study, researchers used the CBT intervention to overcome anxiety. This is supported by the statement put forward by Meriçtan and Sevi [20], which states that CBT can be given to children to adolescents with behavioral disorders, such as angry behavior, opposing behavior, and destructive behavior and anxiety. CBT does not only focus on changes in the nerves that exist in the body or on changes in behavior but rather on the existence of cognitive distortions in the subject and by following therapy it is hoped that it can help solve the subject's psychological problems [24].

The basic assumption of the CBT approach is that overt behavior is influenced by cognitive processes, and these processes can influence a person's behavior. The CBT therapy provided is related to social skills, problem-solving, and anxiety management [20]. The emergence of problems that become factors causing anxiety related to the existence of beliefs and cognitive distortions that are wrong in dealing with a problem. Kaczkurkin and Foa [24] said that emotional and behavioral problems in children arise as a result of cognitive dysfunction or irrational thoughts.

On the subject, the cognitive dysfunction that occurs is that the subject has the perception that all the wishes of the subject must be fulfilled, and the perception that other people will insult the subject because of their poor economic situation [24]. Intervention with CBT, intervention without only focuses on changing behavior but also on cognitive influences that affect children's behavior, so they can manage their anxiety. CBT interventions do not only focus on changes in the nerves that exist in the body or on changes in behavior, but rather on the existence of cognitive distortions in the subject, and by participating in therapy it is hoped that it can help solve the subject's psychological problems.

On this basis, CBT is seen as a more suitable intervention to be applied to the subject. It is hoped that with CBT, the subject's cognitive distortions can change so that the intensity of the subject's anxiety decreases, the subject is more adaptive and can carry out his adaptive function properly. After receiving CBT intervention in several sessions, slowly the subject's negative thoughts began to decrease or even completely disappear. Subjects can even think positively and rationally.

Cognitive restructuring techniques help subjects change their negative thoughts into more rational and positive alternative thoughts. In practice, to overcome tense situations, relaxation is applied to achieve a relaxed state. Finally, the whole series of CBT processes can overcome the cognitive side of the subject by modifying cognitive distortions into realistic-positive thoughts based on self-report analysis, observation, and interviews, overcoming the affective side with a relaxation process that can bring calm when anxiety arises. Relaxation is applied to achieve a relaxed state.

Cognitive behavioral therapy is a nursing therapy that can help patients not experience anxiety [25], [26]. According to Stuart [11], the goal of cognitive behavioral therapy is to increase activity, reduce unwanted behavior, increase desired behavior, increase satisfaction, and achieve social skills. Cognitive behavioral therapy is an intervention that is considered effective for treating psychotic symptoms and reducing the risk of relapse and dealing with anxiety [11]. CBT is very good for teenagers because it is a therapy that teaches types of coping strategies to deal with environmental pressures and this is one of the solutions that can be given to teenagers who experience anxiety.

Intervention CBT given as many as 5 sessions with interviews guided by the module package, where each session is 45 minutes, in each meeting 2 sessions are carried outheld for five days and lasted±1 hours for each meeting. Interventions in this study were provided in the form of psychoeducation, discussion, relaxation, role-playing, exposure, and giving tasks to be carried out so that the subject gained a deeper understanding of the anxiety experienced. Each material given at each meeting has its own goals and objectives for the symptoms of anxiety disorders experienced by the subject. The next stage is follow-up measurement after the intervention is given by giving back the TMAS questionnaire to find out whether the effectiveness of the intervention CBT nature lowers the level of anxiety in adolescents. Subjects were invited to share their experiences after the intervention was carried out. It was said to be effective because it met the criteria required in this study, namely decreased levels of anxiety, reduced even loss of negative thoughts and behaviors, and subjects were more able to think positively and rationally, until the follow-up period.

Based on the data presented in Table 3, it is known that in the anxiety in the mild category increased by 12.5% from pre-intervention to post-intervention. This shows that the increase in anxiety in the group. Furthermore, it was found that in group the level of anxiety in the severe category decreased by 25.0% from pre-intervention to post-intervention. This shows that the reduction in anxiety in the weight category of the group. After receiving the CBT intervention in several sessions, slowly the subject's negative thoughts began to decrease or even completely disappear. Subjects can even think positively and rationally. Cognitive restructuring techniques help subjects change their negative thoughts into more rational and positive alternative thoughts. In practice, to overcome tense situations, relaxation is applied to achieve a relaxed state.

The CBT process carried out on adolescents consists of how adolescents are taught to Self-assessment, identifying negative automatic thoughts, Behavioral therapy, Evaluation of therapy, practicing the ability to change thoughts and adaptive behavior to reduce the risk of respondents returning to an anxious state. Adolescents are given added abilities and opportunities for consultation and exploration of expectations, reinforcement, and support systems. In adolescents who have had the CBT intervention, it was found that therapy can significantly reduce the level of anxiety in adolescents. The effectiveness of the CBT intervention is because adolescents gain the ability and opportunity to consult and explore hope, reinforcement, and support systems that teach types of coping strategies and protection against environmental pressures that may occur to accelerate change where this is not available from other psychotherapy [21]. Coping strategies and ways of

protecting against environmental pressures are things that are needed by adolescents with anxiety because external stressors are one of the stressors that play a very important role in causing anxiety in adolescents.

Implementation success CBT influenced by internal and external factors. Internal factors include motivation within the subject to change, personality traits that are mature enough, and limited (not widespread) problem complexity. Motivation in the subject to change can be seen from their initiative and willingness to become research participants and their sincerity in following the given intervention step by step and several tasks, so that evaluation can be carried out effectively. Counseling and assistance are very important factors in changing individual behavior. Personality maturity is shown from his attitude during meetings, communication with friends and teachers individually makes intervention easier and faster to handle. Other things that support reducing subject anxiety are personality, self-acceptance, ability to understand oneself, openness to input, discipline to practice skills, and applying the results of training during mentoring. As a result, receiving counseling service seems significantly decreasing anxiety level for this sample [27]

Several external factors influence success CBT also, among other things, the use of effective modules, and the use of objective measuring instruments to see how far the level of anxiety has decreased. Draft CBT it is based on an effective cognitive-behavioral approach to addressing psychological problems, including social anxiety and individual anxiety. A structured counseling and mentoring process makes it easier for the subject to describe his anxiety problems and to internalize the interventions that have been taught. This condition creates a feeling of being able to the subject so that the subject is more confident and lowers his level of anxiety. Thus, even though the subject's anxiety has decreased, they still need support from the family, especially parents.

Based on Table 5, it can be seen that the results of the statistical test analysis with the Wilcoxon or paired t-test on all variables yield a significance value of <alpha (5% or 0.05). Therefore, it can be stated that there is a significant difference in serotonin levels before and after the intervention is given, or in other words, there is a significant effect of treatment CBT on serotonin levels. The average value of serotonin post-intervention was higher than pre-intervention indicating that the intervention CBT was able to improve significantly rate Serotonin.

Urits *et al*. research results demonstrated that CBT interventions in advanced Cognitive behavioral therapy for the treatment of chronic pelvic pain, CBT may be another option when treating chronic pelvic pain syndrome and should be considered [28]. Serotonin is a neurotransmitter from one part of the brain to another and is expected to play an active role in regulating behavior in response to stress exposure and is associated with depression which can affect quality of life. Serotonin is derived from the dorsal and median raphe nuclei in the midbrain. When there is exposure to stress, serotonin activity increases, as evidenced by increased gene expression in the dorsal raphe nucleus. Histone serotonylation in dorsal raphe nucleus contributes to stress- and antidepressant-mediated gene expression and behavior [29]. CBT is a therapy for depressed patients, this therapy helps a person identify negative thoughts as wrong and deviant thoughts, then tries to replace them with more positive thoughts that can make a person feel better. Treatment and psychotherapy for anxiety can include CBT, which teaches ways to change thoughts and behaviors that contribute to depression, can help increase brain serotonin levels and improve symptoms of depression [30]

This study examined changes in brain serotonin activity using single-photoemission tomography (SPECT) imaging in people with depression before and after they received CBT. Serotonin plays an active role in conveying emotional messages, controlling behavior and psychological responses to environmental stressors, and is involved in the pathophysiology of depression. Several studies have implied disturbances of the serotonin (5-HT) system and the hypothalamus-pituitary-adrenal (HPA) axis as the most consistent neurobiological changes associated with depressive tendencies [31]. Previous research measured serum cortisol levels in advanced cervical cancer patients after CBT intervention compared to standard therapy, showing a very significant difference (p=0.000) [32]. Another study by Sutanto CBT affects the improvement of anxiety, depression, and quality of life for pre-diagnosed lung cancer patients [32]. Advanced-stage cervical cancer patients experience tremendous emotional pressure which causes a decrease in their quality of life (QOL).

Due to long-term therapy, cervical cancer patients undergoing chemotherapy are in a state of great biological and emotional stress which can cause a decrease in serotonin levels. Acute stress will acutely reduce serotonin levels and inhibit the immune system, while psychological stressors will lower serotonin levels gradually and inhibit the immune system. Among biological factors, a possible cause that has been studied recently is changes in the activity of special areas of the brain's nerve cells called serotonin receptors, which are at reduced levels in people with depression [30].Serotonin is known to naturally affect mood, making depression treatments aimed at increasing serotonin levels important.

Based on the results of Soetrisno's research found that serotonin levels and quality of life scores were higher after the intervention compared to controls [30]. In addition, the Foundation and the European Cystic Fibrosis Society recently partnered to produce consensus guidelines on the application of developmentally appropriate psychoeducation and screening for anxiety and depression in patients. This is consistent with Curth *et al.* [32] research, in his research stated that Antidepressants are the most frequently prescribed drugs

after psychiatric consultations. Selective serotonin reuptake inhibitors (SSRIs) were prescribed in 17.4% of patients [33].

Based on the analysis results show that CBT interventions are effective in increasing serotonin levels in adolescents. Therapy for anxious and depressed patients consists of pharmacotherapy and non-pharmacotherapy. Pharmacotherapy for patients with anxiety and depression consists of selective serotonin reuptake inhibitors (SSRIs), serotonin-norepinephrine reuptake inhibitors (SNRIs), tricyclics, benzodiazepines, and pregabalin. In contrast, non-pharmacotherapy consists of CBT, supportive psychotherapy, and insight-oriented therapy.

The results of the statistical test analysis with the paired t-test in Table 4 show that the intervention on all variables resulted in a significance value of p<alpha (p=0.043). Therefore, it can be stated that there is a significant difference level of anxiety before and after being given CBT intervention, or in other words, there is a significant effect of giving CBT intervention to reduce anxiety levels. The average value of the anxiety level in the post-intervention was lower than the pre-intervention, indicating that the administration of CBT intervention was able to significantly reduce anxiety levels.

5. CONCLUSION

Based on the research that has been done, it can be concluded that CBT interventions are proven to increase serotonin levels and reduce adolescent anxiety levels. The results of the subject's evaluation at each therapy session also showed a change for the better in terms of thoughts, feelings, behavior, and physiological conditions. By changing the form of thought and the resulting consequences, so that the intensity of the subject's anxiety decreases, the subject is more adaptive and can carry out his adaptive function well. It is suggested that schools can apply the results of this study to ease the burden on their students by identifying student anxiety using simple tools and providing interventions such as CBT.

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