

Increased Performance of the Hypothalamus in Producing Neurotransmitters in Insomnia through a Combination of Cognitive Therapy and Muscle Relaxation

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Abstract: Insomnia is problem on sleep that disorder of hyperarousal. Insomnia is sleep problem that often occurs followed by headache, spasm around the head to the neck. These problems cause by delivery of excitatory neurons that reach muscle is not conveyed properly because transportation of neurotransmitter is not produced well in the hypothalamus. Hypothalamus is in suprachiasmatic nuclei has long relation, some of the relation are the limbic system, pineal gland and brain stem which control the afferent and stage of sleep. Physiotherapy intervention which can give for insomnia is combination of cognitive therapy and muscle relaxation. That methods effective to improve hypothalamus performance in producing neurotransmitter for the best impulse conduction for insomnia. This research is use experimental design with one group pre and post test design. Intervention Cognitive therapy and Muscle Relaxation for 2 weeks with a daily frequency and monitored sleep disorder before and after intervention. It can be seen the p-value = 0,002 that means less than 0,05 ($p < 0,05$) so zero hypothesis (H_0) is rejected and alternative hypothesis is accepted. So that Combination of Cognitive Therapy and Muscle Relaxation effective to improve the performance of hypothalamus in producing neurotransmitters for insomnia after intervention.

1 INTRODUCTION

Insomnia is one of clinical condition between many problems such as psychology and physics, the problems are difficulties for go to sleep and maintain it. It can be from nonorganic and nonrestorative that show like sleep disorders for one month and siesta time. Sleep disorders nonorganic is primary insomnia, nonrestorative is secondary insomnia and increase impaired emotion regulation resulting from sleep loss may increase the risk of developing emotional disorders by increasing the use of maladaptive emotion regulation strategies (Ranum, 2019).

Sleep processing by reticular system just take a few responses from cerebral cortex and from external body. Wake up condition occur when reticular system stimulated with impulses from cerebral cortex, organs and cells of sense in skin formation. Sleep is caused by process active inhibition. There is any old theory about excitatory area in upper brainstem called activation reticular system that can be exhaustion

cause many activities a day. The condition is passive theory of sleep. Sleep is similar to other health behaviours, in that many aspects of sleep are under direct behavioural control (Mead and Irish, 2019).

A research by National Sleep Foundation in America found there are 36% young adult in 18-29 years old got difficulties for wake up compared with 20% in 30-64 years old and 9% in over 65 years old. (Magoun, 2014). Poor sleep is a significant public health issue in the United States, with nearly 33% of adults reporting inadequate sleep duration (CDC, 2016) and > 40% feeling fatigued most days (Mead and Irish, 2019).

Every years, there are 20%-40% adult got sleep disorder and 17% among it got serious problems. Prevalence of sleep disorder can increase every years, this relevance with increase age and another causes (Judarwanto, 2015).

Young adult usually get drowsiness, academic ability, productive creativity and communication were not decrease. Some job or another logic work,

pleasure and seize attention could remove drowsiness till give confusion about mentality. The research showed, there are drowsiness can easier to remember but too hard in future to get information with creativity and constructive. Someone can express the logic thinking but less than for brilliant (Silber, 2015).

Sufferers of Insomnia in long term cause somatic symptoms and development illness. The patient can induce all dimency mentality. Insomnia like an inability to sleep, sleep or comfortable. Acute and stress period insomnia can be chronic, fatigue, extreme anxiety and mental disorders (Culebras, 2016).

Insomnia is generally more frequent and prolongs at the end of the night when sleep is more prevalent. Movement are often associated with vocalisation and tend to be defensive, brief and undirected, typically involving previous acquaintances or occupations.

Hypothalamic function for sleep is relationship with neurotransmitter. Awake or wake up are very influence with ARAS system (Ascending Reticular Activity System. When activity of ARAS increase in sleep and decrease when go to sleep. ARAS activity influence by neurotransmitter activity as serotonergic, noradrenergic, kholonergic and histaminergic systems (Roth, 2016).

All humans body have a life rhythm who matches time in a 24-hour cycle. The rhythm along rotation globe is referred to circadian rhythm. The circadian rhythm control center lies in the ventral anterior part of hypothalamus. Experiencing insomnia caused by influence of hormonal systems. Hormones that affect sleep system like adrenocorticotropic hormone (ACTH), Growth hormone (GH), thyroid stimulating hormone (TSH), and luteinizing hormone (LH) (Judarwanto, 2015).

These hormone were secreted regularly by anterior pituitary gland through the hypothalamus pathway. System regularly affects the production of neurotransmitter norepinephrine, dopamine, serotonin which are tasked with regulating sleep and wake mechanisms. The sleep and wake problems are sleep disorder that interfere with cognitive problems in individuals (O'Connor, 2013).

This research used intervention cognitive therapy and muscle relaxation to improve sleep patterns of individuals experiencing insomnia. Because cognitive therapy can improve the cognitive distortion in insomnia, environment, future and to increase confidence so the feels empowered that still identify wrong person's attitudes and beliefs about sleep (Brust, 2014).

Muscle relaxation expected to be able for relaxing muscles that are experiencing tension thereby inhibiting course of neurotransmitter to hypothalamus as hormone producer. Such as interventions of sleep mechanism to affect the hypothalamus in generating a sleep cycle regulating hormone (Mehta *et al.* 2014).

Energy produced by hypothalamus in hormones that secreted into the central nervous system, muscles and organs. Many hormones are produced to regulate performance of body's system, among it hormones can regulate human sleep patterns such as ACTH, GH, TSH, and LH. These hormones are secreted regularly by anterior pituitary gland through the hypothalamus pathway. This system regularly affects production of neurotransmitter norepinephrine, dopamine, serotonin which are tasked with regulating sleep and wake mechanisms (Overeem, 2016).

When someone falls asleep, alpha activity begins to disappear. Beta waves arise frequency more than 14 rounds per second and can be as high as 80 rounds per second. Stage I is characterized by regular activities, low voltages and frequency of 3-7 per second cycles. Stage II is characterized by a pattern showing the taped-in (spindle-shaped) recording with frequency of 12-14 per second (sleep spindle) cycle, slow and trifastic known complex K. Stage III complex marked with Delta waves Which shows high voltage activity with a frequency of 0.5-2.5 per second cycle. Delta waves occur during deep sleep, infants and severe brain organic diseases. Teta waves have frequencies between 4 and 7 rounds per second. This wave occurs in emotional stress on adults, especially when experiencing disappointment and frustration as well as brain disorders especially state of brain that is degeneracy (Zaini, 2015).

Insomnia and severely disturbed sleep are also increasingly recognized accompanying features of limbic encephalitis, a rare disorder in wich fluctuating confusion, seizure and autonomic symptomology usually predominate. Delayed sleep phase syndrome sometimes presents as insomnia unlike the typical case of primary insomnia by definition, there are also major problems in waking at several times or hours.

2 METHODOLOGY

This research explain in Figure 1 that used quasi experimental with one group pre and post test design in one group consist of 9 young adults in Medan, this research is measure variables conducted before and after the intervention of cognitive therapy and muscle relaxation.

Measurement of hypothalamus performance is used remonitoring for 2 weeks with sleep disorder form (MSDF) monitoring in Table 2. MSDF is form of performance monitoring hypothalamus for sleep disorders. Calculation of MSDF value after the intervention is result by calculation duration headache, impaired activity and stress levels by insomnia sufferers every day for 2 weeks.

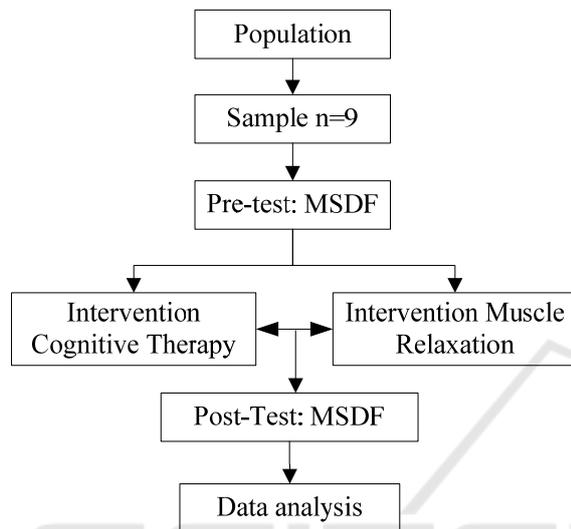


Figure 1: Research plot.

Procedure of screening with MSDF is performed four times per day within 2 weeks. Respondents asked to pay attention for activity by giving cross sign (x) when activities want to sleep, eat and temperature body. Female respondents the menstrual period should be considered.

2.1 Cognitive Therapy

Cognitive therapy is part of several techniques used to reduce chronic insomnia. Stimulus control therapy states that insomnia is a maladaptive response such as sleep time factors and sleep environments e.g. in-reading books in bed from sleep. By giving the patient instructions on sleep limits, insomnia patients can learn to increase their sleep time by inducing less sleep by reducing their time in bed. To avoid it can be monitoring system or supervision patients using the standardization of questionnaire (Rains, 2012).

Endorphins have been shown to serve as modulators of pain in experimental, it has been suggested they are responsible for decrease pain perception that some experience during running. Endorphin system apparently does not function tonically but influences physiological processes in a

rather selective manner only under

specific environmental conditions of extreme change in circumstances such as stress (Francis, 2014).

Some of that need to be cared for in insomnia regarding cognitive therapy can be seen in Table 1.

2.2 Muscle Relaxation

Manual therapy targeting the cervical and head have been suggested to be the most accepted therapeutic intervention for management of this population. Physical therapy management of patients with insomnia suggest a treatment approach consisting of both manual therapy management.

Muscle relaxation can be used to enter sleep condition by controlling the muscles intentionally will form a calm and relaxing atmosphere. This atmosphere is necessary to achieve the Alpha wave condition that is a condition that needs to enter the initial sleep phase (Purwanto, 2013).

Table 1: Sleep Hygiene for insomnia.

NO	Essential sleep hygiene
1	Sleep and awake according to the time
2	Avoid to lay down in the afternoon
3	Remove stimulation (cafein, nicotine)
4	Bedroom should be dark
5	Not consumption alcohol
6	Exercise regularly (avoid exercise 5 hours before go to sleep)
7	Used bed for sleep not for other

Relaxation massage is always used to respond to skeletal muscles that have an increase in muscle tone by responding through the relaxation of the the nerve that conducts the sleep-regulating neurons. Tonus can be increased in stressful and cold conditions. Massage can stimulate externally through sensory organs and increase muscle tone with stimulation. The sympathal nervous system supplies the delivery of neurons to muscle spindles that respond to the nervous system. Massage techniques used are relaxation with local massage (Holey, 2008).

Table 2: Instrument Monitoring Sleep Disorder Form.

D A Y	Date:	1 a	2 a	1 a	2 a	3 a	4 a	5 a	6 a	7 a	8 a	9 a	0 a	1 p	1 p	1 p	2 p	2 p	3 p	4 p	5 p	6 p	7 p	8 p	9 p	0 p	1 p	Temper ature :			
	Head ache																														
	Distrupt ed activity																													Menstr uation :	
	Stress																														
	Sleep																													Sleep time:	
	Meal																														Sleep quality:
	Medicine (total) :													Comment :																	

Massage technique for insomnia (Holey, 2008) :

- Effleurage
According to Figure 2, movement along the parotid gland, until it crosses to the head then down to side of neck under the chin to submandibular node
- Finger kneading
Starting from the head, forehead, chin and under the nose or over the lips followed by other facial muscles. Avoid overstretching of muscles and skin.
- Plucking
Apply tissue picking technique in the same area followed by finger kneading.
- Wringing
According to Figure 3, perform wringing techniques on an ongoing basis according to the groove of the head, forehead and chin.
- Tapping
The technique is flowing or stimulating muscles.
- Vibrations
Used the middle finger, give vibrations around the ophthalmic foramen (supraorbital foramen), maxilla (infraorbital foramen) and mandible (mental foramen) by stimulating the nerve.

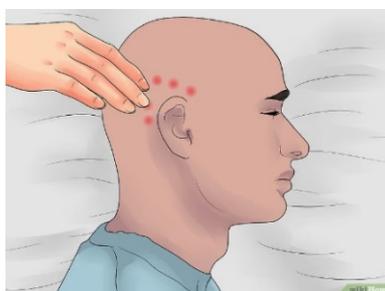


Figure 2: Massage relaxation on head.



Figure 3: Massage relaxation on cervical.

2.3 Hypothalamic Performance

The hypothalamus is part of brain that contains a number of small nuclei. The hypothalamus is located below the thalamus, just above the brain stem. In neuroanatomy terminology, it forms the ventral diencephalon part. The hypothalamus is responsible for certain metabolic processes and other activities of the autonomic nervous system that synthesize and releases neurohormonal, often called the hypothalamus, releasing hormones that stimulate or inhibit the secretion of the pituitary hormone (Pugliese, 2011).

The hypothalamus is a system that regulates accentuation of individual. Increased activation systems can deliver stress to the brain and peripheral centers, which regulate cognitive and bring back energy to the central nervous system, muscles and body organs (O'Connor, 2013).

The energy produced by the hypothalamus is hormones secreted to the central nervous system, muscles and organs of the body. Many hormones are produced to regulate the performance of body systems, including hormones that regulate human sleep patterns. Like ACTH, GH, TSH, and LH. These hormones are each secreted regularly by the anterior

pituitary gland through the hypothalamus pathway. This system regularly influences the release of the neurotransmitter norepinephrine, dopamine, serotonin which are responsible for regulating sleep and wake mechanism (Overeem, 2016)

The hypothalamus responds to the coordination of behavior and emotional responses in the forebrain. The information is processed and sent via pathway to brain control centers that mediate metabolic activities to produce coordination of autonomy and behavior control. The pathway is the medial part of the forebrain and the medial periventricular part in midbrain. While the hypothalamus output that delivered through network to the forebrain then down to the brain stem fibers and spinal cord to fibers and blood vessels to the pituitary (Lynch, 2016).

The hypothalamus has control centers for several types of unconscious activities of the body, one of that involves sleeping and wake up. Damage to the hypothalamus can cause a person to sleep in an unusually long or long period and sufferers also have difficulty starting to sleep (Roth, 2016).

Reticular formation regulates to delivery impulses to the brain. The formation rises up through the medulla, pons, midbrain, then to hypothalamus. The formation is composed of many nerve cells and nerve fibers that communicate through synapses. The fibers have connections that transmit impulses to the brain and the spinal cord. The reticular formation allows for reflex and deliberate movements to occur easily, as well as cortical activities related to the alert state. Insomnia who experience neuronal delivery disorders will always in a state of alert so it is difficult to start sleep (O'Connor, 2013).

At bedtime, the reticular system gets only a little stimulation from the cerebral cortex (skin of the brain) and the outer surface of the body. A state of wakefulness occurs when the reticular system is stimulated by stimuli from the cerebral cortex and from the organs and sensing cells in the skin. It is suspected that the cause of sleep is the active inhibition process. There is an old theory that states that the excitatory area in the upper brain stem, called the "reticular activation system", experiences fatigue after a day of being awake and, therefore, becomes inactive. This situation is called the passive theory of sleep (Choi, 2013).

All living things have a rhythm of life according the circulation of time in a 24 hour cycle. The rhythm that goes along with rotation of the globe is called the circadian rhythm. The circadian rhythm control center is located in ventral anterior part of the hypothalamus. The part of central nervous system that carries out synchronization is located in the ventriculo reticularis

medula oblongata substance called the sleep center. The part of the central nervous system that eliminates synchronization / desynchronization is found in the rostral medula oblongata called the aurosal state (Magoun, 2014).

Activities of disturbed sleep patterns can also be determined by questionnaire method. Namely by asking patients directly about their daily sleep diary in terms of disability, stress levels, amount of sleep and quality of sleep. Some of these can be calculated through filling out a questionnaire to find the categorized as insomnia or not (Mehta et al, 2014).

3 RESULT AND DISCUSSION

3.1 Respondent Characteristics

Respondents in this study were 9 young adults with insomnia with maximum age of 22-25 years with 5 people (55.6%) and the most gender are women (89.1%) listed in Table 3. Findings the data is in accordance with research conducted in 2011 in America by the National Sleep Foundation found that, more than third (36%) of young adults aged 18-29 years reported having difficulty getting up early compared with 20% at ages 30-64 years and 9% over the age of 65 years (Sulistiyani, 2011).

Young adults begin at the age of 18-40 years, when physical and psychological changes accompanying reduced reproductive abilities. In general, classified as young adults will experience a transition period, both physical transition (physically transition) intellectual transition (cognitive transition) and the transition to social roles (social role transition) (Psychologymania, 2011).

Table 3: Respondent characteristic.

Characteristic	n	%
Sex		
Man	1	11,1
Women	8	89,1
Age		
< 22 years	2	22,2
22 – 25 years	5	55,6
>25 years	2	22,2

3.2 Measuring of Monitoring Sleep Disorder Form Value in Patients with Insomnia

A description of the characteristics of Sleep Diary monitoring values before and after the intervention of a combination of cognitive therapy and muscle relaxation, can be seen in Table 4.

Table 4: Characteristic of monitoring sleep disorder form.

Monitoring Sleep Disorder Form			
MSDF	Min	Max	Mean±SD
Pre Test	11,12	48,30	25,26 ± 12,94
Post Test	4,5	7,50	5,96 ± 6,35

The value of Monitoring Sleep Disorder Form (pre test) the maximum value is 48.30 while the minimum value is 11.12 with mean of 25.26 and standard deviation of 12.94. After the intervention, it is known that the value of monitoring sleep diary is a maximum value of 7.50 while the lowest value is 4.5 with a mean of 5.96 and a standard deviation of 6.35.

3.3 Combination of Cognitive Therapy and Muscle Relaxation to Improve Performance of Hypothalamus to Producing Neurotransmitters in Insomnia

Hypothesis testing used paired samples t test. Paired samples t test aims to see changes in treatment by comparing conditions before and after intervention. Hypothesis test can be seen in Table 5. Hypothesis test results show that a combination of cognitive therapy and effective muscle relaxation to improve the performance of the hypothalamus pathway in producing neurotransmitters in people with insomnia after intervention.

Table 5: Hypothesis test with Paired Samples t-test.

Characteristic of MSDF	Hypothesis test			
	n	t	p	Mean ± SD
Pre Test – Post Test	9	4,68	0,002	19,30 ± 12,35

Hypothesis testing used paired samples t test. Paired samples t test aims to see changes in treatment by comparing conditions before and after intervention.

Hypothesis test can be seen in Table 5. Hypothesis test results show that a combination of cognitive therapy and effective muscle relaxation to improve the performance of the hypothalamus pathway in producing neurotransmitters in people with insomnia after intervention.

The t value is 4.68 which means that the MSDF value in insomnia has low sleep quality with a lower hypothalamic performance before intervention than after intervention.

3.4 Combination Cognitive Therapy and Muscle Relaxation

This study aims to look at the effectiveness of a combination of Cognitive Therapy and Muscle Relaxation to improve the performance of the hypothalamus pathway in producing neurotransmitters in young adults with insomnia.

In insomniacs, assessment was carried out which included history taking in form of sex, age and examination of the value of sleep disorder using the monitoring sleep disorder form which was conducted for 2 weeks. For patients who meet the inclusion criteria, intervention can be done every day for 2 weeks.

Based on statistical tests paired samples t test on the MSDF value before and after the intervention on 9 respondents. From the results of data analysis, it was found that there was an effect of intervention so that the combination of both cognitive therapy and muscle relaxation interventions was effective in increasing the performance of the hypothalamus in producing neurotransmitters with insomnia in young adults, which is indicated by the value of $p = 0.002$, which means that a p value of less than 0.05 ($p < 0.05$) so the null hypothesis (H_0) is rejected and alternative hypothesis (H_a) is accepted.

This is consistent with the theory and purpose of both methods, Cognitive Therapy is part of several techniques used to reduce the factors of chronic insomnia. Stimulus-control therapy states that insomnia is an maladaptive response such as factors of sleep time and sleep environment such as the frequency of reading a book in bed rather than sleeping. By giving patients guidance on sleep restrictions, insomniacs can learn to increase their sleep time by inducing insufficient sleep by reducing their time in bed. To avoid this, monitoring or surveillance system for patients can be done by using a standardized questionnaire (Rains, 2012).

Muscle Relaxation can be used to enter sleep conditions because by deliberately relaxing the muscles it will form a calm and relaxed atmosphere.

This atmosphere is needed to reach alpha wave condition which is a state that is needed by someone to enter the early sleep phase (Purwanto, 2013). So that the combination of both can be effective for increasing the performance of hypothalamus which decreases in producing neurotransmitters as regulators of the production of sleep regulating hormones.

According to several studies of these interventions. Several studies have suggested that the touch of a hand can increase hormone production and reduce the production of cortisol (stress levels) which keeps a person in a state of guard making it difficult to start sleeping in young adults. Studies conducted, massage given is 15 minutes to 10 days with relaxation massage to increase serotonin and dopamine levels (Dixon, 2004). Combined with cognitive therapy several Cognitive Therapy studies provided an average of 6 sessions with a total time of 5.8 hours per patient. Based on Meta analysis shows that individual therapy is more effective than group therapy therapists can provide therapy for 4-6 sessions of 20-50 minutes each. The result have been reported when therapy has reached 3-10 sessions (Ralston, 2015).

4 CONCLUSION

Based on the results and discussion that has been done, the conclusion can be drawn is that there is an average increase in the value of MSDF (Monitoring Sleep Disorder Form) on 9 respondents, for 1 month with a value of $p = 0.002$ ($p < 0.05$). So that the combination of Cognitive Therapy and Muscle Relaxation is effective to increased the performance of the hypothalamus patway in producing neurotransmitters in young adults with insomnia, where both interventions simultaneously affect cognitive and muscle stimulation, thereby delivering stimulation to the brain and producing neurotransmitters as regulators of the production of sleep regulating hormones.

5 SUGGESTION

From the conclusions above, the authors suggest several things related to this study, including:

- Further research needs to be done by using more samples and longer time to further support and

strengthen the conclusions of this study and to obtain maximum and satisfying research results.

- For physiotherapist, It is expected to be able for apply intervention method of combining cognitive therapy and muscle relaxation to patients with insomnia with the aim of providing stimulus control therapy and helping patients to reduce insomnia.

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REFERENCES

- Brust, John C.M. 2014. *Current diagnosis and treatment neurology*. United States of America: Medical Publishing division.
- Choi, Jenifer H.K and Ted Abel. 2013. *Sleep and long term memory storage*. United states of America. Cambridge University of Press.
- Culebras, Antonio. 2nd edition. 2007. *Sleep disorder and neurologic disease*. United States of America: Informa healthcare.
- Holey, Elizabeth and Eileen cook. 2008. *Therapeutic massage a practical guide for therapists*. USA: Elsevier
- Judarwanto, Widodo. 2015. *Children sleep clinic information education network*. Jakarta: Yudhasmara foundation.
- Lynch, Gary ang Richard granger. 2016. *Big brain and future of human intelligence*. United States of America: Palgrave Macmillan.
- Magoun, Horace Winchell. 2014. *American Neuroscience in the twentieth century confluence of the neural behavioral and communicative streams*. Netherlands: Balkema publishers.
- Mehta, Noshir R, et al. 2014. *Head, face and neck pain science evaluation and management*. Canada: Blackwell publishing.
- O'connor, et al. 2013. The stress response and the hypothalamic pituitary – adrenal axis : from molecule to melancholia. *Q.J Med.* 93, 323-333.
- Overeem, Sebastian and Paul Reading. 2016. *Sleep disorder in Neurology*. United Kingdom: Blackwell Publishing ltd.
- Phycologymania. 2011, Jul 12. *Psikologi (perkembangan dewasa awal)*. Retrieved from http://www.aktivasiotak.com/fungsi_otak.htm
- Pugliese, luca,et al. 2011. *The anatomy of extended limbic pathway in asperger syndrome: a preliminary diffusion tensor imaging tractography study*. Retrieved from <http://www.elsevier.com/locate/ynim>
- Purwanto, Setiyo. 2013. Mengatasi insomnia dengan terapi relaksasi. *Jurnal kesehatan ISSN 1979 – 7261*. 1 (2), 141 – 148.

- Rains, Jeanetta C and David M.Biondi. 2012. *Sleep disorders and headache*. Canada: Blackwell publishing.
- Ranum, Bror M. CandPsych, Lars Wichstrom, Stale Pallesen, Jonas Faich-Madsen, Marte Halse, Sije Steinsbekk. 2019. Association between objectively measured sleep duration and symptoms of psychiatric disorders in middle childhood. *JAMA Network Open*.
- Ralston, George E. 2015. *Cognitive-behavioural therapy for anxiety*. USA: Elsevier
- Roth, Thomas. 2016, Aug 15. Insomnia: Definition, prevalence, etiology and consequences. *Clinical sleep medicine*. 3, S7 - S10.
- Silber, Michael H. 2005, Aug 25. Chronic Insomnia. *English journal med*. 353, 803-810.
- Zaini, Nurzakiah Binti. 2014. Apa itu insomnia. *Insomnia sleeping disorders*.

