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A COMPARATIVE STUDY OF STRESS AND BRAINWAVE CHARACTERISTIC BETWEEN BREASTFEEDING AND NON-BREASTFEEDING WOMEN

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ABSTRACT

Exclusive breastfeeding is important not only for the women's health but also to children's brain development since breast milk can give positive impact for their brain development. The approach that has been used in this study aims to compare the stress level and brainwave characteristic between breastfeeding (BF) and non-breastfeeding (NBF) women. The stress level measured using the Perceived Stress Scale (PSS) questionnaire by Sheldon Cohen. In addition, the brainwave signals were recorded for 25 of breastfeeding women and 25 of non-breastfeeding women using wireless Electroencephalogram (EEG). Then, the recorded EEG signals were analyzed using readily available Brainwave Balancing Index (BBI) system. The outcomes presented the Brainwave Balancing Index (BBI), brain hemisphere dominance and the correlation of PSS and BBI between BF and NBF women. The outcomes presented BBI of BF women were more balanced, compared to before and during breastfeeding session. While the majority of NBF women were recorded with balanced BBI although all of them were high in stress. Majority of BF women were recorded with right brain dominance and some of them had changed the dominance throughout the three sessions. In contrast for NBF women, most of them presented with left brain dominace. Statistical analysis resulted there were no significant correlations between PSS and BBI of BF women for all three breastfeeding sessions and also for NBF women.

Keywords: breastfeeding, brainwave balancing index, brain hemisphere dominance, EEG, stress level.

INTRODUCTION

Exclusive breastfeeding is recommended by World Health Organization (WHO) and Ministry of Health, Malaysia up to six months of age, with continued breastfeeding along with appropriate complementary foods up to two years of age or beyond, also has been encouraged among Muslims. Breastfeeding activities had given much benefit to the breastfeeding women and the babies. The hormone prolactin is released during breastfeeding which gives mom a feeling of tranquility, pride, happiness, satisfaction, relief, relaxation, enjoyable and comfortable [1]. Prior study that has noted the importance of breastfeeding activities give many benefits to early neurodevelopmental to the babies [2], in terms of Intelligence Quotient (IQ) performance and positively impact brain development [3].

A research on relationship of early brain development and breastfeeding has been examined among 133 children. Breastfed children and extended breastfeeding duration showed a positive relationship in several brain regions and neural growth [3]. Another important finding was that, it gives benefit to the babies and the mother such as good health, including lowest risk of pneumonia and protecting women from breast cancer [4]. As mentioned by [5], the obesity risk of women and babies being decreased depends on the duration of breastfeeding activities.

However, researchers reported that stress has been identified as the influence factor to a problem in breastfeeding; breastfeeding cessation, low breastfeeding rates and low breast milk production among the women in Kelantan, Norway, Jining City and Australia [1], [6]–[8]. They have speculated that, the anxiety, stress and depression affected breast milk production, where women will not produce sufficient breast milk for their child and made the decision to stopped breastfeeding early. It seems possible that these results are due to working breastfeeding women that had a difficult time and lack of facilities to express breast milk in order to continue their breastfeeding activities [9], [10]. Another possible explanation for this is that the first time breastfeeding activities can make the women in depression mode. In contrast to earlier findings, however, it was reported that breastfeeding activities can reduce stress [11].

Stress is the sensation of being too much under pressure and stress level is linked with person's physiological features [12]. Stress level has been determined using questionnaires from Sheldon Cohen technique and higher stress level that caused by poor sleepers due to major life events like natural disaster, emotional dysregulation, self-control lower levels and psychiatric disorder has been reported [13], [14]. No matter the health circumstance of the women, they have been defined as providing additional emotional work compared to men [15].

Women might have an undesirable physical health function like cardiovascular disease and as well as mental health outcomes like chronic posttraumatic stress disorder (PTSD), depression and substance exploitation because of life stress. It is also effects the memory and emotion in brain areas that trigger the peripheral sympathetic and hormonal systems [16]. Hence, to accommodate the individual variance, the stress evaluation method is used [17]. Besides that, stress factors like

physiological, cognitive and temperament influenced women and resulting greater destructive affectivity rather than constructive affectivity [18]. However, negative correlations were presented in [19] that links between stress and cognitive functions.

The Electroencephalogram (EEG) has been found to be a powerful tool in the field of neurology and clinical neurophysiology because of the capability to reflect both the normal and abnormal electrical activity of the brain [20]. Many researchers in the field of human brainwaves implicitly discovered that it is possible to measure the symmetrical characteristics of brain waves by analyzing EEG signals [21]–[23]. Preliminary work on the level of stress was identified by using EEG signals [24]. Stress level is difficult to detect at delta and theta band because this band produced when our brain is in deep sleep or light sleep. The stress level can be presented at alpha and beta band where the alpha band represent the relaxation state of the brain activity meanwhile the beta band represents alertness state of brain activity [25]. This also showed that when the stress is occurring, the amplitude of alpha band will decrease and the amplitude of beta band will increase [24]. All the brain spontaneous activity is recorded by EEG in term of electrical potential along the scalp that produced by the interconnection of neurons.

The intelligent signal processing technology combined with specific algorithm and presented via Graphical Users Interface (GUI) was used to analyze the EEG data for the Brainwave Balancing Index (BBI) and brain hemispheric dominance [26], [27]. [28] measured and evaluated the level of human physical stress using the pattern of the brainwaves using Electroencephalogram (EEG). Studies have shown that breastfeeding women have reduced levels of stress hormones in their bodies and enhanced levels of hormones that foster feelings of well-being [7]. Therefore, the comparison between breastfeeding (BF) and non-breastfeeding (NBF) women's stress scale in terms of brainwave and brain dominance can be done.

The purpose of this study are to examine the perceived stress scale, to analyze the brainwave characteristic in term of BBI and brain hemispheric dominance and to investigate the interrelationship of perceived stress to BBI of BF and NBF women. The results and discussion section presents the stress level, BBI and brain hemispheric dominance and also the correlation of stress and BBI of BF and NBF women.

METHODOLOGY

All experiments were performed using the facilities at Biomedical Research and Human Potential, Faculty of Electrical Engineering, Universiti Teknologi MARA, Malaysia. This research was participated by the volunteered BF and NBF women in Klang Valley area. The data were collected from a questionnaire and EEG. Data were recorded from 25 participants of BF women and 25 of NBF women with age 20 to 40 years old. The age of the breastfed baby was between 3 months to 15 months.

At the first stage, all the 25 BF and 25 NBF women were given the questionnaire on stress level [14]. The objective of this questionnaire is to determine the level of stress of breastfeeding women. The table of stress level was computed in Table-1.

Table -1. Stress level [14].

Stress Index	Score Level	Stress Level	
1	0 – 7	Very low in stress	Low
2	8 – 11	Low in stress	
3	12 -15	Average in stress	
4	16 - 20	High in stress	High
5	21 and over	Very high in stress	

The EEG data from BF participants were collected, 7 through the direct feeding and 18 from the milk expressing method. While for NBF women, the EEG data was collected once. The result of stress level, BBI and brain dominance were presented in terms of the percentage of participants for both 25 of BF and 25 of NBF women. The EEG of breastfeeding women was recorded by using two methods, either through direct feeding or milk expressing using a breast pump for three conditions, before, during and after and once only for NBF women.

The EEG equipment called G-Mobilab was used to carry out the EEG data acquisition. Two channels bipolar connection were employed using five pieces of gold electrodes. The points chosen were Fp1 for the left side of the forehead and Fp2 for the right side of the forehead, connected to Channel 1 and Channel 2 respectively. Fpz was used for the reference at the center of forehead and also both A1 and A2 for the earlobes reference points. The electrodes connection follows the International Standard 10 – 20 electrode placement system as shown in Figure-1.

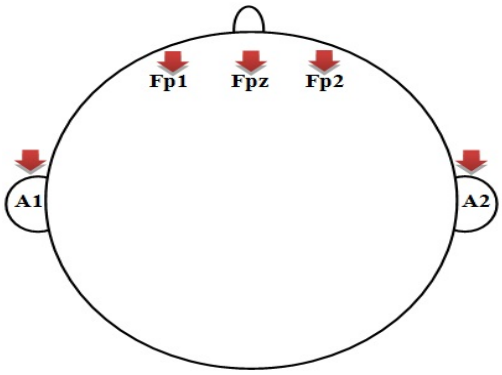

Figure-1. Electrodes connection.

Simultaneously, bluetooth is used to send EEG raw data to the processing device. Then, the recorded EEG signal was analyzed using readily available Brainwave Balancing Index System [26], [27] presenting the results of BBI and brainwave dominance through GUI. The

system concentrates on the frontal region of the brain. The BBI was calculated based on [27] as Eqn. (1);

$$\text{Percentage Difference} = 2 \times \left|\frac{\sum \text{left} - \sum \text{right}}{\sum \text{left} + \sum \text{right}}\right| 100\% \quad (1)$$

There are five levels of BBI index described from [27] based on the percentage difference between left and right brainwaves as in the mentioned equation, where Table-2 shows the element of the BBI. The lowest score of percentage difference is categorized for highly balanced while the highest score of percentage difference is categorized for unbalanced BBI.

Table-2. Brainwave balancing index [26], [27].

INDEX	CATEGORY	
5	Highly Balanced	Balanced
4	Balanced	
3	Moderately balanced	
2	Less Balanced	Unbalanced
1	Unbalanced	

RESULTS AND DISCUSSION

Stress level

Figure-2 shows the stress level for BF women before breastfeeding session and also for NBF women. The stress level value was determined based on Table-1. As depicted, all of NBF women were high in stress compared to 72 % of BF women before the BF session. Besides that, there was only 28 % of BF women were low in stress. So, it can be concluded, majority of the BF women and all of NBF women were under stress condition.

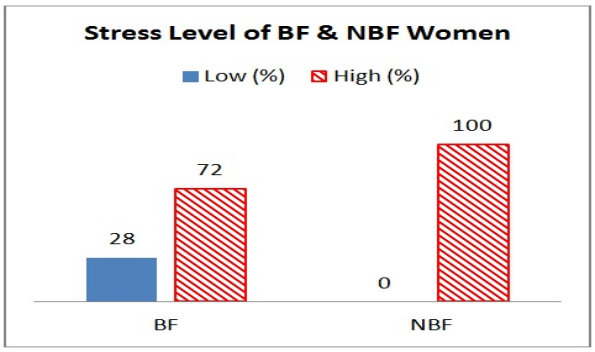

Figure-2. Stress level of BF and NBF women.

BBI and brain dominance

Figure-3 shows the comparison recorded BBI results of BF women for three conditions before, during and after direct feeding or milk expressing and also NBF women. As illustrated by Figure-4, 64 % of BF women were recorded for balanced BBI before and during breastfeeding while 36 % for unbalanced BBI. After breastfeeding, the number of participants had increased to 76 % for balanced BBI. It appears that for unbalanced BBI, the number of participants had decreased to 24 %. It also can be clearly seen that 80 % of NBF women had balanced BBI compared to another 20 % with unbalanced BBI.

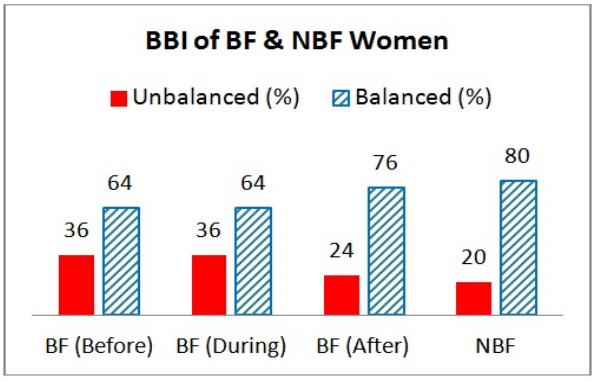

Figure-3. BBI of BF and NBF women.

Figure-4 shows the brain hemispheric dominance comparison of BF women for direct feeding or milk expressing and also NBF women. It can be observed that there were changes of brain hemisphere dominance for some BF women but not for NBW women. As depicted, 68 % of NBF women were recorded with left dominance, another 32 % with right dominance and there was none for brain dominance change. Contrary with BF women, most of them were in right brain dominance for all the three sessions, with 44 % participants and for left dominance, there were 20 % participants.

Besides that, 20 % participants of breastfeeding women were recorded with changed of the brain dominance once, either from left to right (L-R) or right to left (R-L) throughout the data collection before, during and after breastfeed. It is also demonstrates in Figure-6 that 16 % participants who had changed the brain dominance for each session, either left-right-left (L-R-L) or right-left-right (R-L-R). In general, 60 % of the breastfeeding women were identified with right brain dominance after the breastfeeding session while another 40 % were recorded with left brain dominance. This right brain dominance indicates that breastfeeding women were more in emotion [26], [29]–[31].

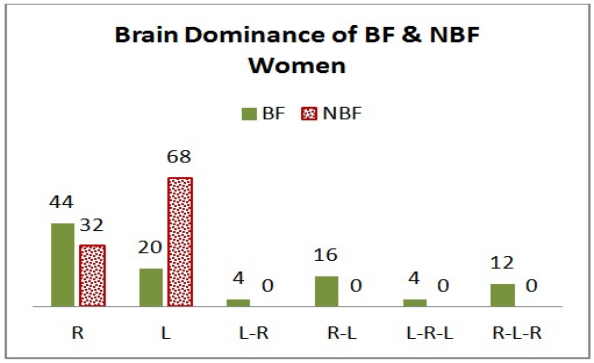

Figure-4. Brain dominance of BF and NBF women.

Statistical analysis

Table-3 and Table-4 present a Spearman Rank Order Correlation that was computed to analyse the relationship between PSS and BBI before and during breastfeeding respectively. The result showed weak negative correlations for PSS and BBI before and during breastfeeding with r_s= -0.005 and r_s= -0.028 respectively. While Table-5 and Table-6 records weak positive correlations for PSS and BBI after breastfeeding and for NBF women with r_s= 0.202 and r_s= 0.216 respectively.

The result of PSS index did not significantly correlated to BBI of the BF (before, during, after) and NBF women with *p*= 0.397, 0.448, 0.167 and 0.150 respectively. Overall, there were no significant correlations between these two variables for all the three sessions for BF women and also for NBF women since the *p* value was greater than 0.05.

Table-3. Spearman rank order correlation between stress index in PSS and BBI before breastfeeding.

			Stress Index	BBI Before
Spearman's rho	Stress Index	Correlation Coefficient	1.000	-.055
		Sig. (1-tailed)	.	.397
		N	25	25
	BBI Before	Correlation Coefficient	-.055	1.000
		Sig. (1-tailed)	.397	.
		N	25	25

Table-4. Spearman rank order correlation between stress index in PSS and BBI during breastfeeding.

			Stress Index	BBI During
Spearman's rho	Stress Index	Correlation Coefficient	1.000	-.028
		Sig. (1-tailed)	.	.448
		N	25	25
	BBI During	Correlation Coefficient	-.028	1.000
		Sig. (1-tailed)	.448	.
		N	25	25

Table-5. Spearman rank order correlation between stress index in PSS and BBI after breastfeeding.

			Stress Index	BBI After
Spearman's rho	Stress Index	Correlation Coefficient	1.000	.202
		Sig. (1-tailed)	.	.167
		N	25	25
	BBI After	Correlation Coefficient	.202	1.000
		Sig. (1-tailed)	.167	.
		N	25	25

Table-6. Spearman rank order correlation between stress index in PSS and BBI for NBF women.

			Stress Index	BBI NBF
Spearman's rho	Stress Index	Correlation Coefficient	1.000	.216
		Sig. (1-tailed)	.	.150
		N	25	25
	BBI NBF	Correlation Coefficient	.216	1.000
		Sig. (1-tailed)	.157	.
		N	25	25

CONCLUSIONS

The comparative study of PSS and brainwave characteristic of BF and NBF women was presented. The PSS of both BF and NBF women has been examined with 72 % to 100 % of them were high in stress. In addition, by using EEG analysis, the BBI and brain hemispheric dominance were determined. After breastfeeding activity, it shows that the brainwave of BF women were more balanced, compared to before and during breastfeeding session by 12 % increment. While majority of NBF women were recorded with balanced BBI although all of them were high in stress.

Brain dominance analysis showed a majority of BF women were in right dominance and some of them had changed the dominance throughout the three sessions. In contrast for NBF women, most of them presented with left brain dominance and the rest with right brain dominance.

Statistical analysis resulted there were no significant correlations between PSS and BBI of BF women for all three breastfeeding sessions and also for NBF women. Hence, the stress level did not influence breastfeeding women to breastfeed their children. Most of them were in balanced brainwave condition after the breastfeeding session, although there were high in stress before the breastfeeding session.

As a conclusion, breastfeeding activity produced balanced brainwave condition among the breastfeeding women either by direct feeding or milk expressing. Consequently, breastfeeding activity help women to release their stress [11] and the brainwave became more balanced. As for NBF women, balanced brainwave was presented for majority participants even all of them were evaluated with higher in stress

It is recommended to increase the number of participants. Other than that, the research can be extended by comparing the brainwave characteristic between working breastfeeding women and stay at home breastfeeding women.

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