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ANALYSIS OF STRESS AND BRAINWAVE CHARACTERISTIC OF BREASTFEEDING WOMEN

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ABSTRACT

This paper reports the investigation of the stress leveland brainwave characteristics of breastfeeding women. The stress level measured individually using the Perceived Stress Scale (PSS) questionnaire by Sheldon Cohen, and while the brainwave signals were recorded from 25 of breastfeeding women either through direct feeding or milk expressing using wireless Electroencephalogram (EEG) equipment via Bluetooth. Then, the recorded EEG signal was analysed using existing Simulink Matlab. The outcomes showed the stress level, Brainwave Balancing Index (BBI), brain hemisphere dominance and the correlation of PSS and BBI of breastfeeding women. The result presented 72 % of high in stress of breastfeeding women with 76 % of them were in balanced brainwave after breastfeeding session. Both methods either direct feeding or milk expressing showed balanced brainwave recorded by the women between 61.1 % to 77.8 %. Besides that, 44 % of breastfeeding women were in right dominance and 36 % of them had changed the dominance throughout the three sessions. Finally, there were no significant correlations between PSS and BBI of breastfeeding women for all three breastfeeding sessions.

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

INTRODUCTION

Breastfeeding activities had given much benefit to the breastfeeding women and the babies. Prior study that has noted the importance of breastfeeding activities give many benefits to early neurodevelopmental to the babies (de Jager, Broadbent, Fuller-Tyszkiewicz, and Skouteris, 2014), in terms of Intelligence Quotient (IQ) performance and positively impact brain development (Deoni *et al*., 2013). Magnetic resonance imaging (MRI) was used to measure the white matter microstructure of baby's brain and examined the relationship between breastfeeding duration and white matter microstructure. Breastfed children and extended breastfeeding duration showed a positive relationship in several brain regions and neural growth. 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 (Alina, Manan, & B, 2013). As mentioned by (Harder, Bergmann, Kallischnigg, & Plagemann, 2005), the obesity risk of women and babies being decreased depends on the duration of breastfeeding activities.

Some authors (O'Brien, Buikstra, Fallon, and Hegney, 2009; Tengku, Wan, Zaharah, Rohana, and Nik Normanieza, 2012; Yang, Song, Wang, Liu, and Zhuang, 2008; Ystrom, 2012) 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(Danso, 2014; Hassan, Kamal Halili, 2014). 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 (Kendall-Tackett, 2007).

Stress is the feeling of being too much under pressure and stress level is correlated with person's physiological features(Arnrich, Setz, La Marca, Troster, and Ehlert, 2010). No matter the health condition of the women, they have been described as providing more emotional work compared to men (Thomeer, Reczek, and Umberson, 2015). Women might have a negative physical health function like cardiovascular disease and as well as mental health outcomes like chronic posttraumatic stress dirsorder (PTSD), depression and substance abuse because of life stress. It is also effects the memory and emotion in brain areas that activate the peripheral sympathetic and hormonal systems (Orth-Gomér, Schneiderman, Vaccarino, and Deter, 2015).Hence, to accommodate the individual difference, the stress evaluation method is used (Xu, Nwe, and Guan, 2015).

Besides that, stress factors like physiological, cognitive and temperament influenced women and resulting higher negative affectivity rather than positive affectivity (Deater-Deckard, Li, and Bell, 2015). However, negative correlations were presented in (Sharma, 2013) that links between stress and cognitive functions. Higher stress level has been determined using (Sheldon Cohen, Tom Kamarck, 1983) and linked to poor sleepers due to major life events like natural disaster, emotional dysregulation, self-control lower levels and psychiatric disorder (Wu *et al*., 2015).

Preliminary work on the level of stress was identified by using EEG signals. 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 (Sulaiman, Hamid, Murat, and Taib,

2009). This also showed that when the stress is occurring, the amplitude of alpha band will decrease and the amplitude of beta band will increase (Sulaiman *et al*., 2011). (Adnan, Murat, and Abdul Kadir, 2012) measured and evaluated the level of human physical stress using the pattern of the brainwaves using Electroencephalogram (EEG). Therefore, the stress level of breastfeeding women can also be investigated in terms of Brainwave Balancing Index (BBI), developed by (Murat *et al*., 2010; Murat, Taib, Lias, *et al.*, 2011).

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 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 (Teplan, 2002).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 BBI and brain hemispheric dominance (Murat *et al*., 2010; Murat, Taib, Lias, *et al*., 2011). Besides that, the brain has two hemispheres, which is left hemisphere that involved the behavior of speech, language and analysis (Murat and Abdul Kadir, 2009; Murat *et al*., 2010; Murat, Taib, Kadir, *et al*., 2011; Sperry, 1975). Another one is right hemisphere that involved in perceiving, thinking, understanding and remembering.

The purpose of this study were 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 BBIof breastfeeding women. The outcomes showed the perceived stress scale, BBI and brain hemispheric dominance and also the correlation of PSS and BBI of breastfeeding women.

METHODOLOGY

All experiments were performed using the facilities at Biomedical Research and Human Potential, Faculty of Electrical Engineering, Universiti Teknologi MARA, Malaysia.At the first stage, all the 25 volunteers were given the questionnaire on stress level(Sheldon Cohen, Tom Kamarck, 1983). The objective of this questionnaire is to determine the level of stress of breastfeeding women. The table of stress index was computed by Table-1.

Next, the EEG of breastfeeding women was recorded for three conditions, before, during and after breastfeeding as shown in Figure-1. EEG equipment called G-Mobilab was used to carry out the EEG data acquisition as shown in Figure-2. Two channels were used connected along with the gold electrodes. 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 (Murat *et al*., 2010; Murat, Taib, Lias, *et al*., 2011) presenting the results of BBI and brainwave dominance through GUI. There are five levels of BBI index described from this experimental where Table-2 shows the element of the BBI.

Table-1. Stress index (Sheldon Cohen, Tom Kamarck, 1983).

Stress Index	Score Level	Stress category	
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	

Figure-1. Electrodes connection (Forehead and earlobe).

Figure-2. EEG Real time and wireless data acquisition.

Table-2. Brainwave balancing index (Murat *et al*., 2010; Murat, Taib, Lias, *et al*., 2011).

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

RESULTS AND DISCUSSIONS

A. Demographic data

This research was participated by the volunteered breastfeeding women in Klang Valley area. The data were collected from a questionnaire and EEG data recorded. Data were recorded from 25 participants of breastfeeding women with age 20 to 40 years old. The age of the breastfed baby was between 3 months to 15 months.

The EEG data from breastfeeding participants were recorded by using two methods, either through direct feeding or milk expressing using a breast pump. The data were collected, 7 through the direct feeding and 18 from the milk expressing method. The result of stress level, BBI

and brain dominance were presented in terms of the percentage of participants for 25 of breastfeeding women.

B. Perceived stress scale

Figure-3 shows the stress index for breastfeeding women before breastfeeding session. The total score of stress index value was determined based on Table-1. As depicted, most of breastfeeding women were high in stress, which is 72 % in total. There were only 28 % of the participants that low in stress. So, it can be concluded, the majority of the breastfeeding women were under stress condition before the breastfeeding activity.

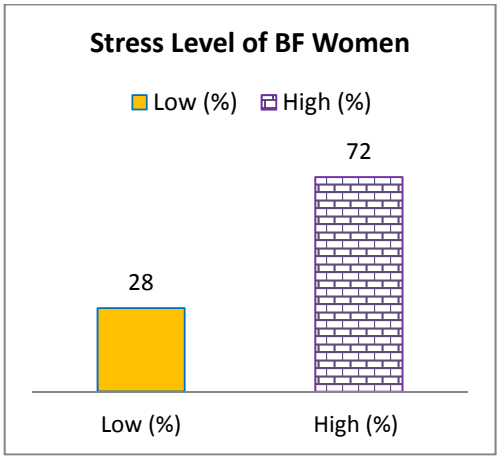

Figure-3. Stress index of breastfeeding women.

C. Result of BBI and brain dominance

Figure-4 shows the recorded BBI results of breastfeeding women for three conditions before, during and after direct feeding or milk expressing. As illustrated by Figure-4, 64 % participants 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 %.

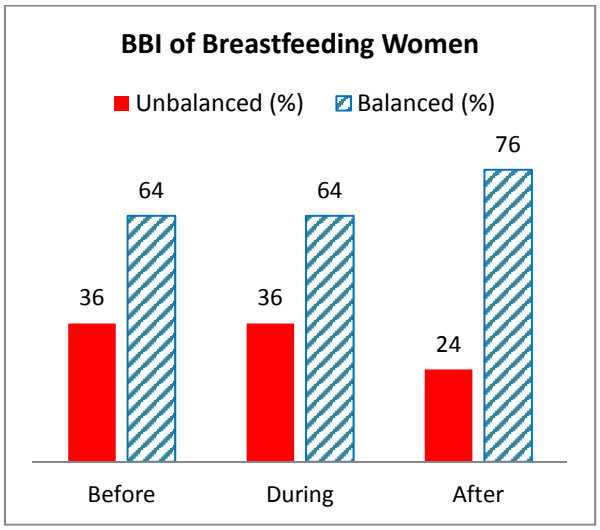

Figure-4. BBI of breastfeeding women.

The recorded BBI results in terms of two different methods that used to produce breast milk is reported in Figure-5. For direct feeding (DF) method, it can be seen that 71.4 % and 28.6 % were recorded with balanced and unbalanced BBI respectively, for all the three sessions, before, during and after. Contrary to milk expressing (ME) method, the balanced BBI had increased from 61.1 % (before and during) to 77.8 % (after). In line with that, the unbalanced BBI had decreased from 38.9 % (before and during) to 22.2 % (after).

Figure-6 shows the brain hemispheric dominance of breastfeeding women before, during and after direct feeding or milk expressing. It can be observed that there were changes of brain hemisphere dominance for some participants. As depicted, most of the breastfeeding women were in the right brain dominance for all the three sessions, with 44 % participants. Contrary with 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 demonstrated 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 (Murat and Abdul Kadir, 2009; Murat *et al.*, 2010; Murat, Taib, Kadir, *et al.*, 2011; Sperry, 1975).

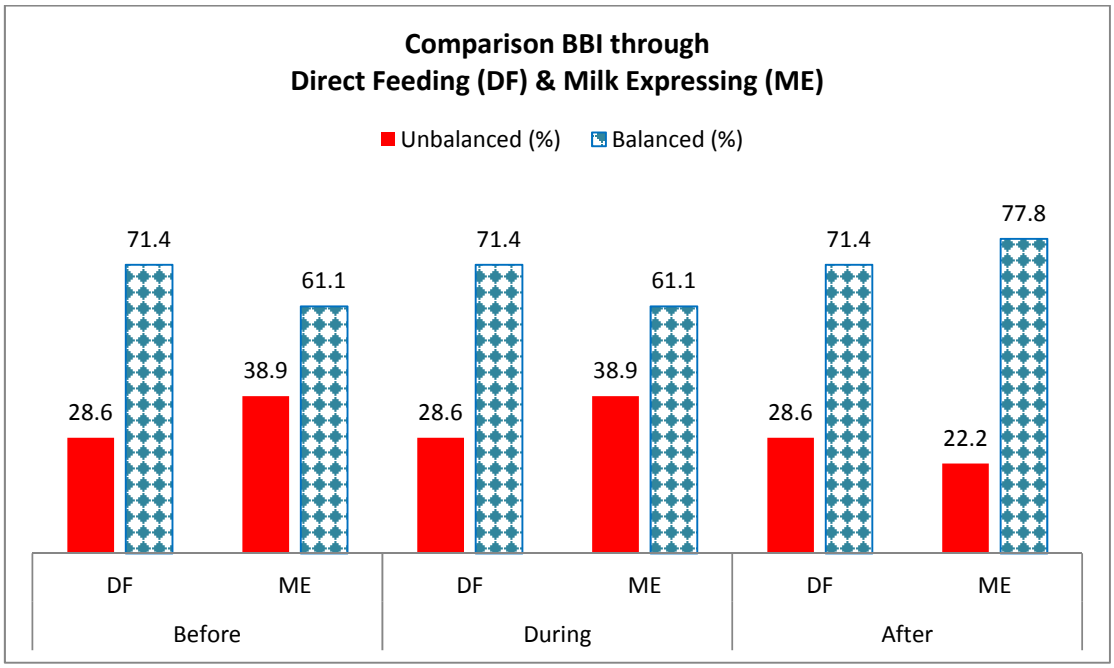

Figure-5. Comparison BBI through direct feeding & milk expressing.

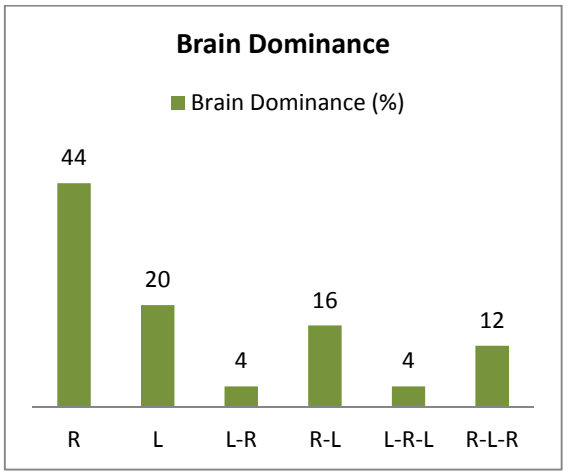

Figure-6. Brain dominance of breastfeeding women.

D. Statistical analysis

Table-3, Table-4 and Table-5 show a Spearman Rank Order Correlation that was computed to analyse the relationship between PSS and BBI before, during and after 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. A weak positive correlation was presented for PSS and BBI after breastfeeding with r_s= 0.202.

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

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

CONCLUSIONS

The analysis of PSS and brainwave characteristic of breastfeeding women was presented. The PSS of breastfeeding women was examined. In addition, by using EEG analysis, the BBI and brain hemispheric dominance were determined. After breastfeeding activity, it shows that the brainwave of breastfeeding women were more balanced compared to before and during breastfeeding session. The method used by the breastfeeding women to produce breast milk either by using direct feeding or milk expressing also presented more balanced brainwave. Both methods are good as long as the breast milk is produced by the women.

Brain dominance analysis showed a majority of breastfeeding women were in right dominance and some of them had changed the dominance throughout the three sessions. Statistical analysis resulted there were no significant correlations between PSS and BBI of breastfeeding women for all three breastfeeding sessions. 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 (Kendall-Tackett, 2007) and the brainwave became more balanced.

It is recommended to increase the number of participants to 40. Other than that, the research can be extended by comparing the brainwave characteristic between breastfeeding and non-breastfeeding women.

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