Low Back Muscle Electrical Activity in Pregnant Women of the Second and Third Trimesters

K D Purnamasari¹, M N Widyawati², S Suryono³

¹Postgraduate Applied Science Midwifery program Poltekkes Kemenkes Semarang, Indonesia
²Postgraduate Applied Science Midwifery program Poltekkes Kemenkes Semarang, Indonesia
³Department of Physics, Faculty of Science and Mathematics, Diponegoro University Semarang, Indonesia

kurniatidevip@gmail.com¹,melyana_n@yahoo.com²,suryono@fisika.undip.ac.id³

Abstract. Low back pain during pregnancy causes axial or parasagittal discomfort. These problems are experienced by more than two-thirds of pregnancies. Clinically the measurement of pain was carried out using the Visual Analogue Scale (VAS) method. Unfortunately, the method has low accuracy and is subjective. This paper proposes a method of measuring pain by using electromyography tools so that pain level measurement has a high level of accuracy and is non-invasive to patients. The study was carried out by installing electromyography electrodes on L4 and L5 muscles. The signal is recorded on a digital storage oscilloscope to find out the electrical activity. The results of the recording were evaluated for the action potential and frequency values. This study was conducted on 15 respondents with lower back muscle pain in mothers monitored for 1 minute with electromyography. The monitoring results are calculated on average frequency and action potential and then presented in the form of trends. The results of the analysis of pain level measurement were compared with the results of VAS measurements. From the results of this study indicate that the trend of the action potential and signal frequency using electromyography shows different results when respondents experience the same pain scale on VAS. The value generated in the measurement using VAS is only a pain number scale that is felt by the respondent where the value is subjective.

1. Introduction

The phenomenon of lower back muscle pain in pregnant women is one of the most frequently reported complaints among pregnant women, varying from 50% to 70%[1]. Based on previous studies in various countries, even 8% of them experienced severe disability and a significant impact on quality of life that was influenced by musculoskeletal factors, a combination of mechanical, circulatory, hormonal and psychosocial factors[2]. However, there is little empirical evidence to show that this has had an impact on the care of individuals suffering from pain, that poorly managed pain increases the risk of persistent pain, reduces the quality of life and increases the use of health services for an individual [3].

Pain in the muscles of the lower back is axial or parasagittal discomfort in the lower back region. Basically, this pain is at the point of musculoskeletal which is influenced by a combination of mechanical, circulatory, hormonal, and psychosocial factors [4]. This refers to general psychosocial aspects including distress, trauma, and interpersonal factors [5]. Pain sensation experienced by a pregnant woman is a unique and complex experience [6], so understanding the concept of pain will play a role in the development of maternal pain management approaches [7]. Lower back muscle pain during pregnancy...
fluctuates rapidly during the intrapartum period, especially affected by neurophysiology which can be harmful during labor such as anxiety, underdeveloped labor, and increased risk of labor by cesarean section [8].

Pain measurement methods using Visual Analogue Scale (VAS) in Indonesia are still used by health workers. Clinically the measurement with VAS is considered to be less accurate, this is because the measurement of pain is done by focusing on the patient in choosing the scale of pain which he feels then calculated and recorded by the officer[9], the need to visualize and mark the line when there is pain causes the VAS to be impractical to use in emergency situations [10]. This is supported by research that proves that the measurement of pain intensity using Visual Analogue Scale (VAS) has low accuracy and is subjective[11], so a more accurate measurement method is needed[12].

The use of electromyography tools in pain measurement has a high degree of accuracy and is non-invasive to the mother[13]. Electromyogram is used to detect the electrical potential produced by muscle cells during contraction and relaxation[14]. When muscle activity occurs, contractions caused when the mother experiences lower back pain will be normalized and analyzed using Electromyogram [15]. This tool is easy to implement, non-invasive, and practical for recording the electrical activity of composites produced by motor units in the electrode detection area[16]. The process of pain stimulation will be converted into an electrical activity that will be received by the nerve endings. Research on the accuracy in the process of measuring the intensity of pain in the lower back muscles will be very helpful in identifying and providing care by midwives [16]. The results of this study are expected to be the basic data as a cut of point reference in determining the scale of pain in the back muscles, so using EMG midwife services can run effectively according to the pain experienced by the client.

2. Methods

This research begins by making and modifying electromyography in such a way that it can analyze brust. Before taking the data, the first thing to do is to identify the respondent in accordance with the criteria set by the researcher, then the respondent is given informed consent if the respondent agrees to the data collection by questionnaire. After the data collection is complete the respondent is fitted with an electrode, the electrode installation serves to record the electrical activity of the lower back for 1 minute. The results of recording electrical activity were analyzed to see frequency trends and action potentials with Volt units so that the results were expected to be a means of measuring lower back pain experienced by pregnant women.

The research design used was descriptive observational. This research was conducted with the sampling technique used was consecutive sampling, the number of samples was 15 respondents of pregnant women with lower back muscle pain by choosing subjects whose representation was determined based on the inclusion criteria. Data retrieval is done after the respondent agrees that the electrodes are installed with 2 electrodes installed in the bilateral L4 muscle section and 1 electrode is placed in the medial part of the L5 muscle as ground, each at a distance of 20 mm according to the operational standard shown in Figure 1.

![Figure 1](image1.png)

**Figure 1.** The reference position of electrode insertion in lower back muscles of pregnant women[17]

Data retrieval begins when respondents experience lower back muscle pain with a 5-10 VAS pain scale, then recording for 1 minute. The process of taking data and recording the electrical activity of the lower back muscles in pregnant women in the second and third trimester are shown in Figure 2.
Figure 2. The process of data retrieval and recording of lower back muscle electrical activity in pregnant women in the second and third trimesters

Recordings stored on the flash disk are then taken to be read again on the recall oscilloscope mode assisted by physicists. Furthermore, the data is presented in the form of a distribution of the average value of data retrieval results. The recording results are analyzed using a software program then the results that appear are made trending results of each measurement result. The research flowchart is shown in Figure 3.

Figure 3. Flowchart

3. Result and Discussion

3.1 Characteristics of Respondent

This study shows that the average age characteristics of respondents are (24.73 ± 2.71) years with the age range of respondents is 21-30 years. The average parity of respondents is (1.53 ± 0.52) with 1-2 pregnancy ranges. The average gestational age of respondents was (27.26 ± 7.40) weeks with a gestational age of 28-38 weeks. The average TFU of respondents is (23.93 ± 7.03) cm with a range of 12-30 cm. The average respondent's height is (156.46 ± 4.25) cm with a range of 152-167 cm. The average respondent's body weight is (62.36 ± 14.69) kg with a weight range of 40-80 kg. The average body mass index (BMI) of respondents was (25.45 ± 5.72) with the range of body mass index (BMI). The average pain scale of the Visual Analog Scale (VAS) respondent was (6.33 ± 1.63) with a range of 5-10 pain scales. Characteristics of respondents are shown in table 1.

Table 1. Characteristics of respondents

| Characteristics       | Min | Max     | Mean ± SD     |
|-----------------------|-----|---------|---------------|
| Age (y.o)             | 21  | 30      | 24.73 ± 2.71  |
| Parity                | 1   | 2       | 1.53 ± 0.52   |
| Gestation age (week)  | 28  | 38      | 27.26 ± 7.40  |
| TFU (cm)              | 12  | 30      | 23.93 ± 7.03  |
| Height (cm)           | 152 | 167     | 156.46 ± 4.25 |
| Weight (kg)           | 40  | 80      | 62.36 ± 14.69 |
| VAS scale             | 5   | 10      | 6.33 ± 1.63   |
3.2 Overview of lower back muscle pain using electromyography

Data generated from EMG on 15 respondents were then read and analyzed by looking at the recording in the Oscilloscope so that the frequency and potential action of the muscles of the mother's lower back can be known. The signal produced by the oscilloscope is shown in Figure 4.

Based on Figure 4 illustrates the time scale used in EMG is 5 seconds, which means that each box is worth 5 seconds. The action potential or contraction strength is calculated based on the depth of the valley wave and maximum hill height or peak to peak that occurs once the pain occurs for 1 minute of the signal recording process. The overall results of the data are analyzed and presented in an average form then data normalization is carried out so that it can be presented in the form of trends. The results of the calculation are through graphs and conclusions are made.

| Variable                  | Min  | Max  | Mean ± SD  |
|---------------------------|------|------|------------|
| Frequency (x/minute)      | 10.2 | 34   | 20.44 ± 6.79 |
| Potential action (V)      | 2.04 | 1.02 | 1.52 ± 0.24 |

The results of EMG recordings were analyzed using the Digital Storage Oscilloscope version 2.0 software package program so that the frequency and potential of the pain action that was occurring in the respondents could be known. Distribution of data from the monitoring of electrical activity of lower back muscle pain all respondents consisting of frequency and action potential which can be seen in table 3. Based on table 3 above it can be seen that the average frequency of lower back muscle pain in this study was (20.44 ± 6.79) times/minutes. The average action potential of lower back muscle pain in this study was (1.52 ± 0.24) Volts.

3.2.1 Frequency

The results of this study indicate the frequency of lower back muscle pain in pregnant women of the second and third trimesters has a tendency to vary between one and the other. The average maximum frequency that occurs in lower back muscle pain is 34 times/minute and the average minimum frequency is 10.2 times/minute. Trends in the frequency of lower back muscle pain in pregnant women in trimester II and III are shown in Figure 5.

3.2.2 Action potential

VAS scale low back muscles pain has a tendency to be directly proportional to the action potential of pregnant women in the second and third trimesters, moderate to heavy scale with a scale of 5 as many as 3 people (20%), scale 6 as many as 7 people (46.67%), scale 7 as much as 1 person (6.66%), scale 8 as much as 2 people (13.33%) and scale 10 as many as 2 people (13.33%) with an average signal action potential on pain scale 5 is 1.22 Volt, the average signal action potential on pain scale 6 is 1.36 Volt, the action potential of the signal is average on pain scale 7 is 2.04 Volt, the action potential of the signal is
average on pain scale 8 is 2.01 Volt and the average signal action potential on pain scale 10 is 2.04 Volt. The trend of comparison of VAS scales and action potentials on the back pain of pregnant women in the second and third trimesters is shown in Figure 6 and Figure 7.

![Figure 6. Comparison of VAS scale trends and an action potential for pain back muscles of pregnant women in trimester II](image)

![Figure 7. Comparison of VAS scale trends and an action potential for pain back muscles of pregnant women in Trimester III](image)

Increased frequency when lower back muscle pain is associated with changes in calcium ion concentration (Ca^{2+}) and lactic acid has a negative effect on coupling muscle excitation-contraction fibers. Increasing the rate of combustion of motor units in muscle cells is needed to maintain the same level of exertion. This induces variations in signal frequency depending on the time variable in the amplitude of the SEMG signal[14]. The variation in the potential action of back muscle pain experienced by patients in accordance with the theory which states that the cross-correlation of data transfer for each waveform from time to time in sequence will shift one forward and move backward to determine the maximum correlation point, so it will vary the signal action potential of one another [18].

A reduction in the generation capacity of a single muscle force or group of muscles due to pain causes the motor unit of central and peripheral muscle cells to work faster and recruit new motor units to overcome muscle fatigue. These effects cause motor unit synchronization, which causes a decrease in the median (or average) frequency of the sEMG signal and an increase in the signal potential for muscle action [19]. An open sodium channel allows a large amount of positive release of electricity to flow to the anterior part of the postsynapse cell. This will increase the membrane potential in a positive direction towards the stimulus threshold value to cause excitation. Suppression of delivery through chloride or potassium canals or both. This will reduce the diffusion of negatively charged chloride ions into the postsynaptic neurons or reduce the diffusion of positively charged potassium ions to the outside. As a result, there is inhibition/reduction of cells that are stimulated then the cell activates slowly. During the action potential, there is a significant change in the permeability of the Na^+ and K^+ membranes so that the ions move rapidly following the decreasing concentration gradient. The movement of ions must carry currents that contribute to potential changes that occur during the action potential. An action potential occurs due to the opening and closing of two specific channel types, namely the Na^+ channel with a voltage door and the K^+ channel with a voltage door [20].

4. Conclusions

Measurement of electrical activity of back muscles in trimester II and III pregnant women using electromyography shows a more quantitative value when compared to the VAS method. The results of this study indicate that the prevalence of electrical activity of the lower back muscles of pregnant women increases from 76% at 13 weeks to 90% at 38 weeks of gestation. There was an increase in lower back
pain scores in 46.6% of respondents with moderate to severe criteria at 38 weeks' gestation. Electrical activity of the back muscles of pregnant women in action potential has a tendency to be directly proportional to the scale of VAS pain experienced by patients. Action potential and signal frequency using EMG show different results when the respondent experiences the same pain scale. While in the examination using VAS the value generated is only in the form of a pain number scale felt by the respondent where the value is subjective.

5. References

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