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Evaluate of vest massage therapy with rotating pressure based on pre-experimental methods

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ABSTRACT

Many postpartum mothers complain that their milk production is too low to supply the baby's needs. There are two essential substances in the milk: the prolactin hormone and the oxytocin hormone. Consequently, there are two ways to stimulate these hormones: massage techniques such as breast care and oxytocin massage. This study aims to design vest therapy devices to expedite breast milk production. With the use of vest therapeutic devices, it can be observed that the amount of breast milk production increases. This research uses a pre-experimental method in postpartum mothers, which uses the vest massage therapy and does not use the vest massage therapy. Accidental sampling was used as the sampling method for this study, and the data were analyzed using the independent t-test. It is hoped that making Vest therapy devices can facilitate breastfeeding for postpartum mothers with the aim that they can increase the amount of breast milk and supply the milk for the babies in the early stage of their life. The test result discovered an increase in breast milk volume in breastfeeding mothers by an average of 7.3 ml in postpartum mothers who used vest therapy equipment compared to the previous amount of milk produced.

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1. INTRODUCTION

Breastfeeding is a process of feeding a baby with a fluid that comes out of the mammae gland, and that is the best way to nourish a baby as it is the best start in a baby's life [1], [2]. It is estimated that more than one million children die every year from diarrhea, respiratory diseases, and other infections due to inadequate breastfeeding [3], [4]. Hence, breastfeeding mothers hope to be able to breastfeed exclusively and smoothly. However, not all postpartum mothers immediately give out their milk since the typical experiences of postpartum mothers are nipples, swollen breasts, breast canal clotting, swelling of the breasts, as well as mechanical nerve stimuli and hormones that influence milk production.

Two things can be performed to smooth up milk: milk production and milk consumption. This milk production problem is influenced by a decrease in the stimulation of the hormone prolactin and the oxytocin hormone, while physical and psychological changes can affect the process of lactation [5]. The hormone oxytocin is released through stimulation into the nipple through the infusion of the baby's mouth or through the massage. Other than that, a spine on the mother's spine will enhance the feeling of calm and relaxation and increase the threshold of pain and love for the baby [6]. This causes the hormone oxytocin and the milk to go out. The attempt can be performed through a massage or stimulation of the postpartum mother's spine.

The neurotransmitter will stimulate the medulla oblongata directly by mastication or spine stimulation, sending a message to the hypothalamus in the posterior pituitary gland to release oxytocin, which causes the breast to release milk [7]-[9]. During this massage, the hormone oxytocin is released, which aids in the circulation of the mother's milk, facilitated by the baby's suckling on the nipple. Notably, prolactin and oxytocin are crucial for milk production and the release of puerperium blood [10]. According to the manual book entitled "Breastfeeding-Counseling-Participants-Manual-English," it has been suggested that applying a massage to the oxytocin point might induce a sense of relaxation in lactating mothers [11]. Some studies investigated the effectiveness of oxytocin massage and breast care massage, and the results suggested that oxytocin massage had a more significant effect on the breast milk production of postpartum mothers [12]-[14]. Other research makes a new lactation aid designed to address common breastfeeding problems reactively and proactively. It is a small soft sphere filled with thermochromic hot/cold gel and hollow surface protrusions, allowing users to decide their level of compression pressure [15]. However, based on the previously mentioned research, there is not an automated system available for anywhere, at any time, to perform oxytocin massages.

The research aims to analyze and design a therapeutic device to assist postpartum mothers in milk production and lactation. Subsequently, it will be incorporated into a prototype, and the effect of oxytocin massage on milk volume post-therapy will be compared. The prototype looks like a vest using a direct curent (DC) motor as a massager positioned on the breast and the back of the postpartum mother, and it has two-time settings, 15 minutes and 20 minutes [8]. By utilizing the DC motor as a driver to perform oxytocin massages, the prototype can potentially simplify the process of delivering a message to postpartum mothers that is both effective and safe, and it can be utilized at any time and anywhere.

2. METHOD

To answer the problem, researchers use pre-experimental methods that involve researchers lacking the ability to manipulate subjects, leading to using random groups as treatment and control groups [16]. The research design utilized in this investigation is the one groups pretest-posttest design, which involves conducting a pretest before administering treatment and a posttest after treatment [17], [18]. Therefore, the treatment can be assessed more accurately by comparing it to the condition prior to treatment. This activity aims to obtain comparative values of the volume of breast milk in postpartum mothers before and after using the prototype. The design of the research method can be illustrated in (1) [19]:

$$O_1 \times O_2 \tag{1}$$

Description: O_1 is pretest value (before treatment); $\times$ is treatment; and O_2 is posttest value (after treatment).

The hardware design of the vest massage with rotating pressure utilizes a 3.7 V lithium polymer battery, which is then boosted to 5 V using a step-up circuit. This voltage powers three main components: the minimum system, IC L298 motor driver, and DC motor. Ensure that the supply voltage for the minimum system circuit does not exceed 5 V. If the voltage supplied to the minimum system exceeds 5 V, it will cause damage to the system. The timing is directly adjusted using the Arduino program according to the oxytocin massages as a benchmark. The tool workflow is displayed in Figure 1 as a diagram block of the prototype.

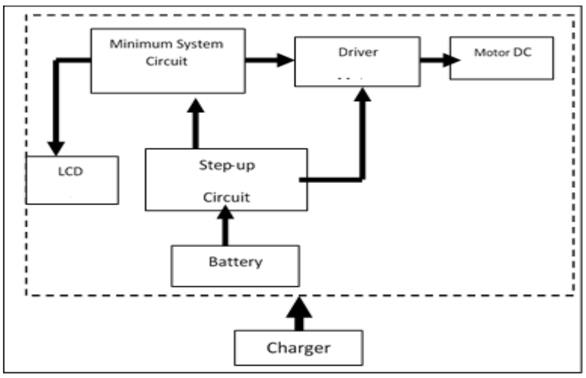

Figure 1. Diagram block prototype

Figure 1 explained the DC motor was used as a massage motor driver, as its name suggests, a DC motor with a DC voltage. Changing the voltage polarity will reverse the rotation of the DC motor. When an external voltage (V) is applied to the motor, an electric current (I) will flow through the brush connected to the armature via the switch. Consequently, the anchor will experience a significant torque due to the large electric current flowing through it. The commuter ensures that the current flows consistently in one direction, causing the rotor to rotate smoothly in a fixed direction. The rotation of this anchor in the magnetic field causes an electrical force. This electrical motion is characterized by moving opposite to the current that caused it. Hence, it is referred to as the opponent's style of motion [20], [21]. A mechanical diagram is a diagram that describes the physical shape of the prototype. The vest massage with a rotating pressure mechanical diagram including the front and back of the vest, the design of DC motor, and design of control box and its side are illustrated in Figures 2(a) to (f).

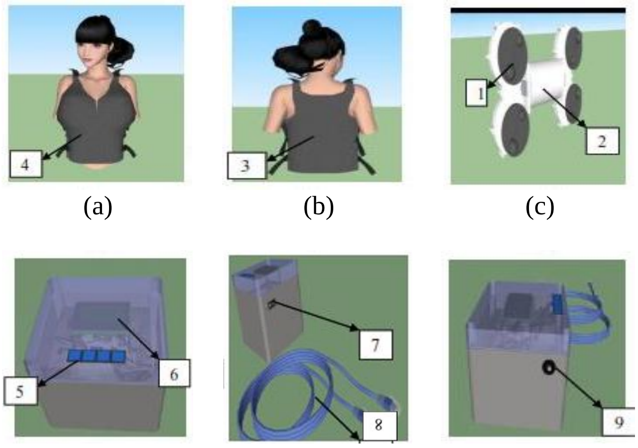

Figure 2. Mechanical diagram: (a) front, (b) back, (c) DC motor, (d) control box, (e) the side of control box, and (f) the side of control box

Figure 2 explains how to use the tool and a picture of its overall shape:
1) Massages: a customizable massage component designed for the waist area, made from 3D-printed polylactic acid (PLA).
2) DC motor: the primary driver of the massager part.
3) The back of the vest: place of the massage component on the back.
4) The front of the vest: place of the massage component on the breast.
5) Push button: there are four buttons consisting of start, 15-minute timer, 20-minute timer, and reset.
6) Display: acts as a time viewer when the motor works as a massager.
7) LAN socket: connects the control box to the therapeutic vest.
8) Cable LAN: the connection between the control box and the therapeutic vest.
9) On/off switch: switch to turn on and off the vest.

3. RESULTS AND DISCUSSION

The testing and measurement of massage vests with rotating pressure include several tests: timer testing, motor speed testing, and instrument function testing.

3.1. Timer testing

The measurement test involved timing with a stopwatch for 15 minutes or 900 seconds using a vest massage with a rotating pressure therapeutic device. Figure 3 displays the time measurements conducted in 20 experiments. Figure 3 portrays the calculation of the time on the therapeutic device using some formulas in (2) to (4):

$$\bar{X} = \frac{\sum x_n}{n} \tag{2}$$

$$Deviation = X_n - \bar{X} \tag{3}$$

$$Error\ (\%) = \frac{deviation}{X_n} \times 100\% \tag{4}$$

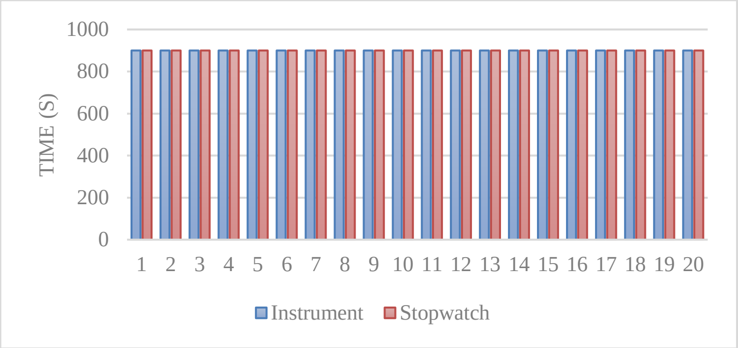

Figure 3. Timer testing graph in 15 minutes

Based on (2), the average of 900 seconds is obtained, with a 0% error presentation using (3) and (4), where the figures indicate the accuracy of the device's time. Note that the measurements are performed as many as 20 times for each measure. The measurement test involved timing with a stopwatch for 20 minutes or 1,200 seconds using a vest massage with a rotating pressure therapeutic device. Figure 4 displays the time measurements conducted in 20 experiments.

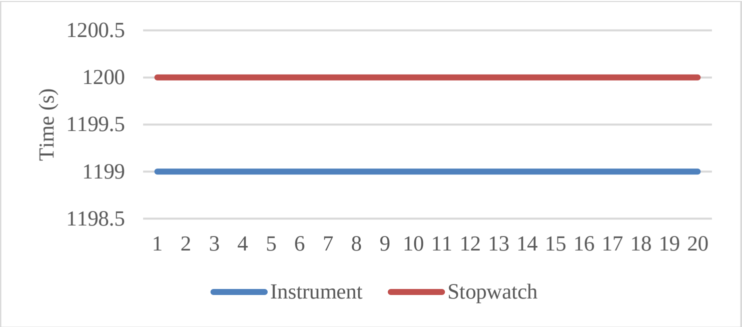

Figure 4. Timer testing graph in 20 minutes

Based on Figure 4 and using (2), it demonstrates that the average measurement is 1,199 seconds. In addition, using (3) and (4), the error presented by the device is 0.05%. Consequently, it can be inferred that there is a 1-second tolerance of error on the device in comparison to the stopwatch.

3.2. Motor speed test

Speed measurements were conducted on the vest massage with a rotating pressure therapeutic device at time intervals ranging from 1 to 15 minutes using a comparative tachometer DT-2234L. Table 1 displays the motor speed measurements obtained in the shortest therapy time (15 minutes). Based on Table 1 and (2) suggest that by measuring the motor speed with a time interval of 1 minute, it was discovered that at the minimum therapy time of 15 minutes, the average motor speed was 29.12 revolutions per minute (RPM). The graph exhibited a rise in the 13th and 14th data points, specifically reaching values of 32.5 RPM and 32.7 RPM, followed by a subsequent decrease in the 15th data point to 31.5 RPM. The occurrence of measurement instability arises when the author's data capture is inconsistent while maintaining control over the tachometer. Subsequently, the authors conducted a speed measurement assessment of the vest massage with a rotating pressure therapeutic device at regular 2-minute intervals, employing the DT-2234L tachometer. The data presented in Table 2 displays the measurements of the motor speed during the maximum therapy duration (20 minutes).

Table 1. The performance of the DC motor in 15 minutes

Number	Minimum time interval (15 minutes)	Motor speed (RPM)
1	0 minutes	0
2	1 minutes	28.9
3	2 minutes	29.2
4	3 minutes	30.4
5	4 minutes	30.3
6	5 minutes	31.1
7	6 minutes	30.7
8	7 minutes	31.2
9	8 minutes	32.1
10	9 minutes	31.4
11	10 minutes	30.7
12	11 minutes	31.4
13	12 minutes	32.5
14	13 minutes	32.7
15	14 minutes	31.5
16	15 minutes	31.8
Total		45.9
Average		29.12

Table 2. The performance of the DC motor in 20 minutes

Number	Maximum time interval (20 minutes)	Motor speed (RPM)
1	0	0
2	2 minutes	30.1
3	4 minutes	30.4
4	6 minutes	30.3
5	8 minutes	31.9
6	10 minutes	31.2
7	12 minutes	30.8
8	14 minutes	31.4
9	16 minutes	30.5
10	18 minutes	30.5
11	20 minutes	31.0
Total		308.1
Average		28.1

Table 2 and (2) suggest that during the assessment and quantification of motor speed using a 2-minute time interval, an average motor speed of 28.1 RPM was recorded at the maximum therapeutic duration of 20 minutes. The motor speed is measured using a DEKKO DT-2234L tachometer. The measurements are recorded 11 times for each 2-minute interval over a total period of 20 minutes. Correspondingly, the chart displayed a 31.9 RPM increase in speed on the 5th data point during the 8th minute. On the 6th, there was a decrease in the data speed by 31.4 RPM, followed by an increase in speed on the 10th data by the same amount. The accuracy of the data is compromised due to the author's error in utilizing an unreliable tachometer.

3.3. Function test

The study conducted a trial by comparing the results of milk consumption before and after therapy using vest massage with rotating pressure. The study employs the t-test for random samples, which is a statistical procedure used to compare the means of two groups of cases [22]-[24]. Following the production and testing of the vest massage with rotating pressure, the average is determined by comparing samples taken prior to therapy with those taken after therapy. From the comparison measurements, sampling results obtained the following data presented in Table 3 as the comparison data before and after therapy. In order to enhance the reader's ability to observe the outcomes of comparisons before and after the implementation of therapeutic instruments, a comparative graph can be generated both before and after therapies, as depicted in Figure 5.

Furthermore, it is used in statistical analysis to assess the impact of a treatment on a sample using the t-test. If the significant value of the t-test is greater than 0.05, it means there is no significant effect on treatment. However, if the significant value of the t-test is lower than 0.05, it means there is a significant effect on treatment [25], [26]. Table 3 provides the result of the t-test using statistical program for social science (SPSS) applications.

Table 3. Comparison of before and after therapy

No	Sample	Age (th) Mother	Age (th) Baby	Result (ml) Before	Result (ml) After
1	Ms. S	33	14	30	42
2	Ms. W	22	5	2	10
3	Ms. P	33	8	20	28
4	Ms. T	22	15	5	10
5	Ms. A	21	3	45	70
6	Ms. As	25	14	10	8
7	Ms. R	22	5	20	28
8	Ms. D	21	9	18	18
9	Ms. I	28	11	35	39
10	Ms. Iu	30	5	15	20
Total				200	273
Average				20	27.3

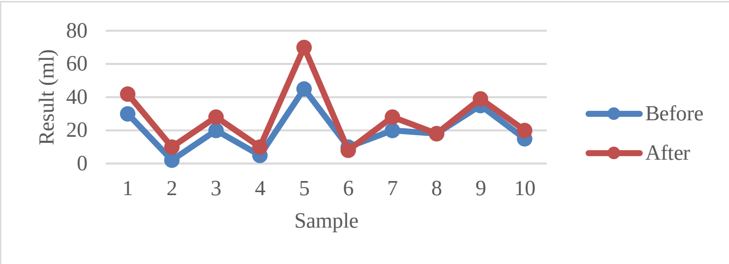

Figure 5. Comparison before and after therapy graph

Based on Table 4, Figure 5, and (2) suggest that the data analysis of breast milk volume measurement yielded an average of 20 ml prior to the utilization of the therapeutic device and 27.3 ml following the implementation of the therapy device. The milk volumes in the 4.5 and 6 data exhibited a rise, which was influenced by several factors, specifically the mother's postpartum and baby's ages. Within the dataset, the quantity of breast milk was measured at 5 ml prior to the intervention and 10 ml after the intervention. In the 5th data point, a milk volume of 45 ml was produced before the treatment, and a milk volume of 70 ml was produced after the treatment. Furthermore, the data in Table 4 suggests that the significant value of before and after therapy is 0.013, which means that the therapy has a significant effect on the patient in increasing milk production.

Table 4. T-test

		Paired samples test Paired differences							
		Mean	Std. deviation	Std. error mean	95% confidence interval of the difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Before treatment-after treatment	-7.30000	7.43938	2.35254	-12.62182	-1.97818	-3.103	9	.013

4. CONCLUSION

From the data, it can be concluded that the prototype operates effectively. During the timer measurement using the comparator, the stopwatch recorded an error value of 0.05%. Furthermore, there was an increase in postpartum mothers after therapy. There are data with fixed results, and this is due to many factors that affect both the physical and psychological aspects of the postpartum mother. An average of 20 ml before and after therapy of 27.3 ml were obtained, with an average increase of 7.3 ml. The t-test also demonstrates that the therapy has a significant effect on postpartum mothers to increase the production of milk.

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