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A Study on the Effects of Pain Stimulus on the Blood Pressure and Heart Rate of Undergraduate Medical Students - A Randomized Control Trial

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Abstract

The objective of this study was to investigate the effect of pain stimulus on blood pressure and heart rate amongst students in Melaka Manipal Medical College, Muar campus. In this randomized-controlled trial study, 60 volunteers were randomized to Group A (intervention) and Group B (control) groups with sample size of 30 each. A questionnaire was given before the intervention to determine their androgyny and to screen for smoking and hypertension. Their systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) were assessed before any intervention. Participants were then admistered their respective intervention and their SBP, DBP, HR and Pain Score were assessed after 10 seconds and 30 seconds. Their anxiety was assessed after 30 seconds. Unpaired t-test was used to compare mean of both groups and paired t-test was used to compare the before and after of each variable. Our results showed that there were significant systolic blood pressure, pain score and anxiety results in group A compared to group B. However, there are no other significant differences in result between Group A and Group B. The results were analysed by Epi Info Version 7 and GraphPad software to calculate Unpaired t-test, Paired t-test and Chi-Square test. The conclusion is that this study shows that there was some relation between the cold pressor test causing pain and the participants systolic blood pressure after 30 seconds, pain score and anxiety. However, there was no relation between the pain stimulus and participants diastolic blood pressure and heart rate.

Keywords

Pain, Medical Students, Experiment

1. Introduction

Pain is an unpleasant sensory and emotional experience with actual or potential tissue damage, or is described in terms of such damage. [1] Acute pain is short-lasting, is a symptom, has an identifiable pathology with response to tissue damage, a biological function, is usually relieved by treatment and can be associated with anxiety. Pain in the perioperative period either from trauma or due to a sickle cell crisis falls under the acute pain category as it is a response to tissue damage. Hines and Brown described an ice water immersion test (cold pressor test, CPT or cold immersion test) in 1932, to determine individual vascular reactivity. [2, 3] After the exposure to cold stress, the reaction of the individual is measured by the change in his systolic and diastolic blood pressures. It is a well-known fact that temperature affects both heart rate and blood pressure.[4] Plunging a hand in cold water acts as a pain stimulus and causes massive stimulation of the sympathetic nervous system and the release of norepinephrine. This sympathetic stimulation triggers responses in the cardiovascular system

that includes arteriolar constriction, increased heart rate, and increased cardiac contractility. Increased cardiac contractility causes increased cardiac output. Arteriolar constriction & increased cardiac output causes increase in diastolic and systolic blood pressure respectively. This is known as the pressor response [5]. The cold pressor test is a widely used experimental technique for pain or stress induction, [5] to assess the left ventricular function,[6] and to evaluate cardiac autonomic functions.[7] The cold immersion test is non-invasive and can be used as a bedside assessment of autonomic function in patients with cardiovascular disease and evaluation of vascular reactivity in healthy subjects. For many years, the cold pressor test has been used both clinically and experimentally to evaluate nonbaroreflex-mediated sympathetic neural control in humans. [8]

Our study is performed by immersing a participant's hand into ice water (1°C to 3°C) for a short period of time (1 to 2 minutes) while measuring blood pressure (BP) and heart rate (HR). In normal participants, a vascular sympathetic response, increased peripheral resistances and a sustained increase in BP is observed.[4] The originally proposed cold immersion test of Hines and Brown required immersing the hand up to the wrist in ice cold water at 5 degree Centigrade for 5 minutes. Many studies have been done using the above basic principle, but making slight changes in the procedure. No significant variation is seen by changing the area exposed to cold water like immersing the hand up to wrist, up to the metacarpophalangeal area, feet, fingers, face, etc. Some studies showed that immersion up to the metacarpophalangeal joint was better than the method of immersing up to the wrist as the former had less pain but the results were similar in both the study [9]. The same responses were seen after changing the temperature of the cold water and the duration of exposure [10]. Studies done in cold climates (winter) and cold areas fell in alignment with the normal results except for the fact that there was better cold adaptation in the colder areas and during winter than relatively warm areas [11].

A study has been done on healthy individuals on the relationship between sex and experimental pain and the report was assesed by systolic blood pressure (SBP) at rest or during pain stimulation by using almost the same methodology [12, 13]. It has been suggested that men are socialized to limit the outward expression of pain, which might result in differential reporting of painful sensations [14]. In this studies, the researcher was more focused on the first-order biological factors such as genetic, hormonal, anatomical, and physiological differences between the sexes [13, 15]. Many studies report a continuous, inverse relationship between resting blood pressure and pain sensitivity [16-21], and women generally have lower resting blood pressure than men. Similar to previous studies, they found an inverse relationship between SBP at rest and pain sensitivity as indicated by pain tolerance. Mechanisms posited to account for this inverse relationship include central descending pathways, beta-endorphin responses, and baroreceptor sensitivity [22-24].

In normal physiology, pain acts as a protective mechanism to prevent damage to tissues and causes the individual to react by removing affected part or by escaping from the painful stimulus [25]. Hence, this study mainly focuses on the autonomic and left ventricular functions and these are measured by the blood pressure and heart rate which is altered during the cold pressor test amongst medical students in MMMC. The expected outcome of this research is that there is increase in blood pressure and heart rate after the cold pressor test.

2. Methodology

2.1. Study Design, Settings, and Population

A randomize control trial study on the effect of pain stimulus on the blood pressure and heart rate of MMMC students. This study was held in Melaka Manipal Medical College (Muar Campus). The duration of study was 4 weeks from December 2018 to January 2019.

Based on Pilot study, 60 students from MBBS course in MMMC Muar were involved in this study. Students who were involved in this study compromised of batch 37 and 38, who were in their clinical years.

2.2. Sample Size

The sample size for this research was calculated using the formula as shown below:

$$n \geq \frac{(z_{1-\alpha/2} + z_{1-\beta})^2(\sigma_1{}^2 + \sigma_2{}^2/r)}{(\mu_1 - \mu_2)^2}$$

Where,
n = size of sample
$z^2_{(1-\alpha/2)}$ = 95% confidence level (1.96)
σ^1 = Standard deviation in group 1
σ^2 = Standard deviation in group 2
β = Probability of a type II error
r (ratio) = Group2/Group1
μ_1 = Mean in group 1
μ_2 = Mean in group 2

The formula used for adjustment for attrition 10% was as follows:

$$n_{final} = \frac{n_{calculated}}{1 - nonresponse\%}$$

As there were no previous studies similar to our research, we are doing a Pilot study with 30 participants in the intervention group and 30 participants in the control group. Hence, we had a total sample of 60 participants taking part in our research.

2.3. Sampling

Our study used purposive sampling, as the participants of this study were volunteers. Questionnaires were distributed to students of MBBS Batch 37 and 38 of MMMC in hard copy. A written informed consent was attached as the front page of

the printed questionnaires for participants to sign as proof that they were willing to participate in this study voluntarily. Our inclusion criteria were students of batch 37 and 38 who fit in the criteria of normotensive. Our exclusion criteria were students who are known to have systemic diseases, those who are current smokers and on those on medications. In addition, those who failed to finish answering the questionnaire (incomplete questionnaire), and left the printed questionnaires blank despite signing the informed consent were also excluded from the study.

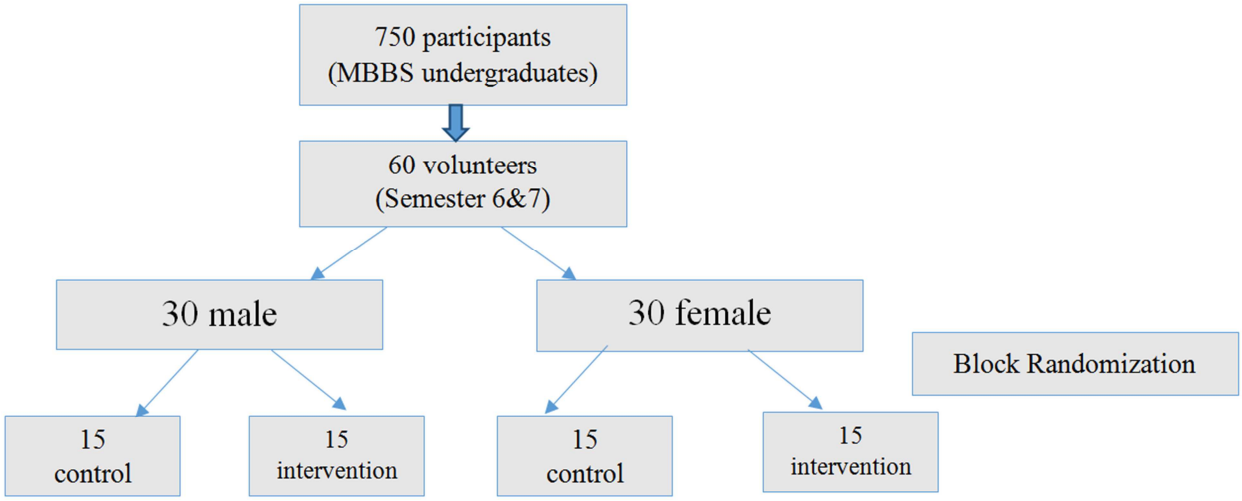

Figure 1. *Flow chart of sampling and randomisation method.*

Once we had attained a sample population of 60 participants of 30 males and 30 females, we then utilized stratified randomization to obtain a sample group for each of the two groups; one group receiving pain stimulus (intervention group) consisting of 15 males and 15 females, and another group as a control group consisting of 15 males and 15 females. We achieved this with block randomization with the block size 2. We used the website *randomizer.org* to allocate each sample member to a group. The intervention group was denoted as group 1, and the control group was denoted as group 2. We then created 30 sets (blocks) whereby the numbers 1 and 2 were evenly allocated amongst the sample members. Those allocated with the number 1 were assigned to the intervention group, and those allocated with the number 2 were assigned to the control group. This then resulted in an equal and randomized distribution of 30 sample members for each of the two groups.

2.4. Procedures and Intervention

60 volunteers were given a questionnaire for screening for known systemic diseases, smoking, and medications and to assess their Bem Sex Role Inventory (BSRI) score. Those eligible students who are normotensive will be picked and further randomly distributed into 2 groups by block randomisation. The two randomly assigned groups are administered their respective intervention which are pain stimulus (Group A) and the control group (Group 2). Details of intervention are as follow:

1. Group 1 participants received pain stimulus by immersion of their right hand up to the mid-forearm into cold water at a temperature of 3°C.
2. Group 2 participants received pain stimulus by immersion of their right hand up to the mid-forearm into cold water at a temperature of 20°C.

To ensure non-biased results, participants were separated into two separate rooms and were given a questionnaire on masculinity and femininity (BSRI) [26] before starting the trial and their systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) were recorded twice and the average was calculated. The researcher taking the blood pressures are AK and JS for the control group and VIG and YKB for the intervention group.

This BSRI questionnaire has 2 subscales (each with 20 items) and 20 neutral items:

1. Masculinity (how masculine is your psychological profile)
2. Femininity (how feminine is your psychological profile)

The scores are given on the 1-7 scales, thus if you have a score of 4, you are exactly in the middle.

If people score above median on both scales, they are considered to be "androgynous".

The method of collecting data is by recording systolic blood pressure, diastolic blood pressure and heart rate at three different intervals. The first recording would be done before the experiment is conducted after the participants have completed the questionnaire. The second recording would be done at the ten second mark after immersing their hands in the cold water. The third recording would be done at thirty seconds after immersing their hands in the cold water.

The pain threshold and pain tolerance levels will be recorded as the participants notify the examiners. If the participant reaches their pain threshold level before thirty seconds, the participant is allowed to withdraw their hand and participant readings are taken and the time at which participant withdrew their hand is recorded as pain tolerance. The pain score will also be measured at the ten and thirty second mark.

Questions on anxiety, pain score and adverse effects of

hypertension were taken after the experiment by means of a numeric analogue scale.

2.5. Data Collection and Processing

After the participants were exposed to their respective intervention, participants were required to answer the numeric analogue scale. Based on the results of the readings the outcomes of the participants were assessed. The outcomes were none other than increase blood pressure, heart rate, pain and anxiety. In addition, common side effects of pain such as cramps, headache, nausea, vomiting, blisters, itching, redness and palpitations were recorded if they were present. The BSRI was assessed according to the sex role inventory and the scores are given on a scale of 1 to 7, with more than 4 being significant. If a person was both feminine and masculine, they are known as androgynous.

2.6. Data Analysis

Based on the data collected from the questionnaires given, the data were summarized and exported to Microsoft Excel. The data was recorded and analysed by using GraphPad. The frequency and percentage of categorical variables (gender, ethnicity, caffeine intake, family history of hypertension, exercise habits, meditation and sleep in the Intervention group (pain stimulus) and the control group were calculated. The mean and standard deviation were also calculated for quantitative variables. Unpaired t-test was used to compare the outcome variables (SBP, DBP, heart rate) between intervention and control groups. Paired T test was chosen for the comparison of SBP, DBP and HR in each group before versus after the intervention (at 10 seconds and at 30 seconds). Chi-squared test was used to compare the adverse effects between intervention and control groups. The level of significance was 0.05.

2.7. Ethical Consideration

Ethical consideration is critical in a research study. To ensure this study is conducted ethically, research participants are briefed about the study and a written informed consent is obtained from the participants prior to the study. The protection of privacy of the research participants and confidentiality of research data are ensured as well. Lastly, the study is approved by the Research Ethics Committee, Faculty of Medicine of Melaka Manipal Medical College, Malaysia Campus.

3. Results

Table 1. *Baseline Characteristics between Intervention (n=30) and Control (n=30).*

Variables		Pain Intervention (n=30)	Control (n=30)	Total
		n (%)	n (%)	n (%)
Age (years)		22.9 (0.98)	22.7 (0.94)	22.8
Gender	Male	15 (25)	15 (25)	30
	Female	15 (25)	15 (25)	30
Ethnicity	Malay	0 (0)	5 (16.67)	5 (8.33)
	Chinese	10 (33.33)	7 (23.33)	17 (28.33)
	Indian	17 (56.67)	11 (36.67)	28 (46.67)
	Other	3 (10)	7 (23.33)	10 (16.67)
Family History of Hypertension	Yes	13 (43.33)	10 (33.33)	37 (61.67)
	No	17 (56.67)	20 (66.67)	23 (38.33)
Caffeine	Yes	20 (66.67)	14 (46.67)	34 (56.67)
	No	10 (33.33)	16 (53.33)	26 (43.33)
Exercise	Yes	16 (53.33)	15 (50.00)	31 (51.67)
	No	14 (46.67)	15 (50.00)	29 (48.33)
Meditation	Yes	2 (6.67)	3 (10.00)	5 (8.33)
	No	28 (93.33)	27 (90.00)	55 (91.67)
Sleep	<5 hours	9 (30.00)	7 (23.33)	16 (26.67)
	5-7 hours	19 (63.33)	22 (73.33)	41 (68.33)
	>7 hours	2 (6.67)	1 (3.33)	3 (5.00)
Bem Sex Role Inventory	Feminine	2 (6.67)	8 (26.67)	10 (16.67)
	Masculine	3 (10.00)	2 (6.67)	5 (8.33)
	Androgynous	25 (83.33)	20 (66.67)	45 (75.00)

Table 1 displays certain aspects of patient demographics that have been recorded during our research. There are exactly 30 male and 30 females who volunteered. In terms of ethnicity, 8.33% are of Malay origin, 28.33% are of Chinese origin, 46.67% are of Indian origin and 16.67% are of other races. In terms of family history of hypertension, 61.67% of volunteers have positive history while 38.33% of volunteers do not. In terms of caffeine consumption, 56.67% of volunteers consume caffeinated products, while 43.33% do not. In terms of exercise, 51.67% of volunteers exercise regularly, while the remaining 48.33% do not exercise. In terms of meditation, 8.33% of volunteers perform

meditations while 91.67% do not. In terms of sleep, 26.67% of volunteers sleep less than 5 hours per day, 68.33% sleep for 5-7 hours per day and 5% sleep for more than 7 hours per day. In terms of BSRI Rank, 16.67% of volunteers are purely feminine, 8.33% are masculine and 75% are androgynous.

Table 2. *Pain Score, SBP, DBP, Heart Rate and Anxiety between intervention and control groups.*

Variable	Mean (SD)		Mean Difference (95% CI)	t-statistics (df)	P-value
	Intervention	Control			
Pain Score (10s)	5.23 (2.24)	0.13 (0.43)	5.10 (4.27 to 5.93)	12.25 (58)	<0.001
Pain Score (30s)	8.17 (1.39)	0.9 (1.16)	7.27 (6.61 to 7.93)	22.01 (58)	<0.001
SBP (mmHg) before	116.12 (15.5)	118.52 (10.98)	-2.40 (-9.34 to 4.54)	0.69 (58)	0.492
SBP (mmHg) 10s	119.90 (17.38)	120.33 (16.10)	-0.43 (-9.09 to 8.23)	0.10 (58)	0.921
SBP (mmHg) 30s	123.40 (25.47)	120.67 (13.61)	2.73 (-7.82 to 13.29)	0.52 (58)	0.607
DBP (mmHg) before	75.52 (9.89)	76.95 (8.68)	-1.43 (-1.43 to -6.24)	-0.60 (58)	0.553
DBP (mmHg) 10s	77.27 (12.69)	78.71 (11.57)	-0.90 (-7.18 to 5.38)	-0.29 (58)	0.775
DBP (mmHg) 30s	78.97 (17.25)	76.63 (11.13)	2.33 (-5.17 to 9.84)	0.62 (58)	0.536
Heart Rate before	80.9 (10.57)	78.58 (12.43)	2.317 (-3.647 to 8.280)	0.78 (58)	0.440
Heart Rate 10s	81.97 (14.46)	79.20 (14.63)	2.77 (-4.75 to 10.28)	0.74 (58)	0.464
Heart Rate 30s	79.10 (13.71)	79.27 (10.48)	0.96 (-6.47 to 6.14)	0.05 (58)	0.958
Anxiety	6.10 (2.76)	1.70 (1.37)	4.40 (3.27 to 5.53)	7.83 (58)	< 0.001

Table 2 displays the comparison between the pain intervention and control group on the pain score after 10 seconds and after 30 seconds of exposure to pain stimulus. The mean of the pain score in the pain intervention group is more when compared to the control group both in 10 seconds and 30 seconds after exposure to pain stimulus. There is a significant association between pain stimulus and pain score. (mean difference of pain score at 10 seconds: 5.10, the 95% CI: 4.27, 5.93 and the P-value of pain score at 10 seconds: <0.001) (mean difference of pain score at 30 seconds: 7.27, 95% CI: 6.61, 7.93 and the P-value: <0.001). The table also shows the systolic blood pressure reading before the exposure to the stimulus, after 10 seconds of exposure to the stimulus and after 30 seconds of exposure to the stimulus. The systolic blood pressure reading before the exposure to the pain stimulus is not significantly associated with the pain stimulus. (mean difference: -2.40, 95%CI: -9.34, 4.541, and P-value: 0.9205). The systolic blood pressure reading is seen to be lower in the pain intervention group compared to the control group after 10 seconds of exposure to the pain stimulus. There is no significant association between the exposure to the pain stimulus for 10 seconds and systolic blood pressure. (mean difference:-.43, 95%CI:-9.09.8.23 and the P-value is 0.9205). The systolic blood pressure reading after 30 seconds exposure to pain stimulus is higher in the pain intervention group compared to the control group. There is no significant association between the exposure to pain stimulus for 30 seconds and systolic blood pressure reading. (mean difference: 2.73, 95%CI:-7.82, 13.29 and P-value: 0.6061). Table 2 also displays the diastolic blood pressure readings before the exposure to the pain stimulus, after 10 seconds exposure to the pain stimulus and after 30 seconds exposure to the pain stimulus. The diastolic blood pressure before the exposure to the pain stimulus between the intervention group and control group is not significant. (mean difference: -1.43, 95%CI:-1.43,-6.24 and P-value: 0.553). The diastolic blood pressure after 10 seconds of exposure to pain stimulus is seen to be lower in the pain intervention group compared to the control group. There is no significant association between the pain stimulus after 10 seconds and diastolic blood pressure. (mean difference:-0.90, 95%CI: -7.18, 5.38 and P-value: 0.775). The diastolic blood pressure after 30 seconds of exposure to pain stimulus shows that the pain intervention group has higher reading compared to the control group. There is no significant association between the pain stimulus after 30 seconds and diastolic blood pressure. (man difference: 2.33, 95%CI: -5.17, 9.84 and P-value: 0.536). The heart rates of the participants before the exposure to pain stimulus, after 10 seconds of exposure to pain stimulus and after 30 seconds exposure to pain stimulus are also showed in table 2. The heart rate before the pain stimulus in both groups is not significant. (mean difference: 2.317, 95%CI: -3.647, 8.280 and P-value: 0.4400). The heart rate after 10 seconds of exposure to pain stimulus is higher in the pain intervention group compared to the control group. There is no significant association between the pain stimulus for 10 seonds and heart rate. (mean difference: 2.77, 95%CI:-4.75, 10.28 and P-value: 0.4643). The heart rate after 30 seconds of exposure to pain stimulus is seen to be lower in the pain intervention group compared to the control group. There is no significant association between the pain stimulus for 30 seconds and heart rate.(mean difference: 0.96, 95%CI:-6.47, 6.14 and P-value: 0.9580). Lastly table 2 shows the anxiety levels of the participants after the exposure to pain stimulus. The participants in the pain intervention group have higher anxiety levels compared to participants in the control group. There is a significant association between the pain stimulus and anxiety levels. (mean difference: 4.40, 95%CI: 3.27, 5.53 and P-value is <0.001).

Table 3. *Adverse Effects.*

Adverse Effects	Intervention	Control	X^2-statistic (df)	P-value
Redness	4 (13.33)	0 (0%)	4.29 (1)	0.038
Numbness	5 (16.67)	0 (0%)	5.45 (1)	0.020
Cramp	0 (0%)	0 (0%)		
Headache	0 (0%)	0 (0%)		
Nausea	0 (0%)	0 (0%)		
Vomiting	0 (0%)	0 (0%)		
Blisters	0 (0%)	0 (0%)		
Itching	0 (0%)	0 (0%)		
Palpitations	0 (0%)	0 (0%)		

Table 3 shows the list of adverse effects that had been asked to all the participants of this study. The participants of the pain intervention group only experienced redness and numbness after the exposure to pain stimulus while the control group did not experienced any adverse effcets that are listed above. The pain intervention group had redness after exposure to stimulus and it is significantly associated to the pain stimulus. (chi-square value: 4.29 and the P-value is 0.038). Participants of the pain intervention group also felt numbness after the exposure to the stimulus and numbness is also significantly association to the pain stimulus. (chi-square: 5.45 and P-value is 0.020)

Table 4. *Pain Score, SBP, DBP and Heart Rate between before, 10 seconds and 30 seconds among pain intervention group.*

Variable	Mean (SD)			Mean Difference (95% CI)	t-statistics (df)	P-value
	Before	10s	30s			
SBP (mmHg)	116.1 (15.50)	119.9 (17.37)		-3.783 (-8.18 to 0.611)	1.760 (29)	0.089
SBP (mmHg)	116.1 (15.50)		123.4 (25.47)	-7.283 (-14.50 to -0.06)	2.060 (29)	0.048
SBP (mmHg)		119.9 (17.38)	123.4 (25.47)	-3.50 (-10.13 to 3.13)	1.080 (29)	0.289
DBP (mmHg)	75.52 (9.89)	77.27 (12.69)		-1.750 (-5.55 to 2.05)	0.941 (29)	0.354
DBP (mmHg)	75.52 (9.89)		78.97 (17.25)	-3.450 (-9.64 to 2.74)	1.140 (29)	0.264
DBP (mmHg)		77.27 (12.69)	78.97 (17.25)	-1.70 (-6.94 to 3.54)	0.663 (29)	0.512
Heart Rate	80.9 (10.57)	82.0 (14.46)		-1.0 (-5.4 to 3.3)	0.490 (29)	0.666
Heart Rate	80.9 (10.57)		79.1 (13.71)	1.8 (-2.5 to 6.1)	0.840 (29)	0.406
Heart Rate		82.0 (14.46)	79.1 (13.71)	2.9 (-1.4 to 7.1)	1.370 (29)	0.180
Pain Score		5.23 (2.24)	8.17 (1.39)	-2.93 (-3.76 to -2.11)	7.264 (29)	<0.001

Table 4 shows the results obtained in the pain intervention group before the exposure to the pain stimulus, after 10 seconds of exposure and after 30 seconds of exposure to the pain stimulus. It shows the dependent variables such as systolic blood pressure, diastolic blood presure, heart rate and also pain score that had been measured before and after the exposure to the pain stimulus. The systolic blood pressure is higher after 10 seconds of exposure to pain stimulus compared to before the exposure. There is no significant association between the systolic blood pressure before the exposure and 10 seconds after the exposure to the pain stimulus. (mean difference: -3.78, 95%CI: -8.18, 0.61 and P-value: 0.089). When comparing the systolic blood pressure before and after 30 seconds of exposure to the pain stimulus, the systolic blood pressure is higher after 30 seconds of exposure to the pain stimulus compared to before the exposure. There is a significant association between the systolic blood pressure before and after 30 seconds of exposure to pain stimulus. (mean difference: -7.28, 95%CI: 14.50, 0.07 and P-value is 0.048). The systolic blood pressure is higher after 30 seconds of exposure to pain stimulus compared to after 10 seconds of exposure to pain stimulus. There is no significant association between the systolic blood pressure after 10 and 30 seonds of exposure to pain stimulus. (mean difference: -3.50, 95%CI: -10.13, 3.13 and P-value: 0.289). The diastolic blood pressure is higher after 10 seconds of exposure to pain stimulus compared to before the exposure. There is no significant association between the diastolic blood pressure before the exposure and 10 seconds after the exposure to the pain stimulus. (mean difference: -1.75, 95%CI: -5.55, 2.05 and P-value: 0.354). The diastolic blood pressure before and after 30 seconds of exposure to the pain stimulus is compared and it is found that the diastolic blood pressure is higher after 30 seconds of exposure to pain stimulus compared to before the exposure. There is no significant association between the diastolic blood pressure before and after 30 seconds of exposure to the pain stimulus. (mean difference: -3.45, 95%CI: -9.64, 2.74 and P-value is 0.264). The diastolic blood pressure is higher after 30 seconds of exposure to pain stimulus compared to after 10 seconds of exposure to pain stimulus. There is no significant association between the diastolic blood pressure after 10 seconds and 30 seonds of exposure to pain stimulus. (mean difference: -1.70, 95%CI: -6.94, 3.54 and P-value: 0.512). The heart rate is higher after 10 seconds of exposure to pain stimulus compared to before the exposure. There is no significant association between the heart rate before the exposure and 10 seconds after the exposure to the pain stimulus. (mean difference: -1.00, 95%CI: -5.40.3.30 and P-value: 0.666). When comparing the heart rate before and

after 30 seconds of exposure to the pain stimulus, the heart rate is higher after the 30 seconds of exposure to pain stimulus compared to before the exposure. There is no significant association between the heart rate before and after 30 seconds of exposure to the pain stimulus. (mean difference: 1.80, 95%CI: -2.50, .10 and P-value is 0.406). The heart rate is lower after 30 seconds of exposure to pain stimulus compared to after 10 seconds of exposure to pain stimulus. There is no significant association between the heart rate after 10 seconds and 30 seconds of exposure to the pain stimulus. (mean difference: 2.90, 95%CI: -1.40, 7.10 and P-value: 0.180). Finally, the table also shows the comparison between the pain score after 10 seconds and 30 seconds of exposure to pain stimulus. The pain score is higher after 30 seconds of exposure compared to 10 seconds of exposure to the pain stimulus. Thus, there is a significant association between the pain score after 10 seconds and 30 seconds after exposure to the pain stimulus. (mean difference: -2.93, 95%CI: -3.76,-2.11 and P-value: <0.001)

Table 5. *Pain Score, SBP, DBP and Heart Rate between before, 10 seconds and 30 seconds among control group.*

Variable	Mean (SD)			Mean Difference (95% CI)	t-statistics (df)	P-value
	Before	10s	30s			
SBP (mmHg)	118.52 (10.98)	120.33 (16.10)		-1.817 (-5.87 to 2.24)	0.917 (29)	0.367
SBP (mmHg)	118.52 (10.98)		120.67 (13.61)	-2.150 (-5.64 to 1.34)	1.260 (29)	0.218
SBP (mmHg)		120.33 (16.10)	120.67 (13.61)	-0.33 (-4.25 to 3.58)	0.174 (29)	0.863
DBP (mmHg)	76.95 (8.68)	78.167 (11.57)		-1.217 (-4.50 to 2.07)	0.758 (29)	0.454
DBP (mmHg)	76.95 (8.68)		76.63 (11.13)	0.317 (-2.18 to 2.81)	0.260 (29)	0.797
DBP (mmHg)		78.17 (11.57)	76.63 (11.13)	1.53 (-0.79 to 3.85)	1.352 (29)	0.187
Heart Rate	78.58 (12.42)	79.20 (14.62)		-0.617 (-5.01 to 3.81)	0.290 (29)	0.778
Heart Rate	78.58 (12.42)		79.27 (10.48)	-0.683 (-2.90 to 1.53)	0.630 (29)	0.534
Heart Rate		79.20 (14.63)	79.27 (10.48)	-0.07 (-5.09 to 4.96)	0.027 (29)	0.979
Pain Score		0.13 (0.43)	0.90 (1.16)	-0.77 (-1.18 to -0.35)	3.803 (29)	0.001

Table 5 shows the tabulation of the results of the control group. It displays the variables that are measured before and after the exposure to the stimulus. The variables that were measured are systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate and pain score. The systolic blood pressure is higher after 10 seconds of exposure to stimulus compared to before the exposure. There is no significant association between the systolic blood pressure before the exposure and 10 seconds after the exposure to the stimulus. (mean difference: -1.82, 95%CI:-5.87, 2.24 and P-value: 0.367). When comparing the systolic blood pressure before and after 30 seconds exposure to the stimulus, the systolic blood pressure is higher after 30 seconds exposure to the stimulus compared to before the exposure. There is no significant association between the systolic blood pressure before and after 30 seconds of exposure to the pain stimulus. (mean difference: -2.15, 95%CI: -5.64, 1.34 and P-value is 0.218). The systolic blood pressure is higher after 30 seconds of exposure to stimulus compared to after 10 seconds of exposure to stimulus. There is no significant association between the systolic blood pressure after 10 seconds and 30 seconds of exposure to the pain stimulus. (mean difference: -0.33, 95%CI: -4.25, 3.58 and P-value: 0.863). The diastolic blood pressure is higher after 10 seconds of exposure to stimulus compared to before the exposure. There is no significant association between the diastolic blood pressure before the exposure and 10 seconds after the exposure to the pain stimulus. (mean difference: -1.75, 95%CI: -5.55, 2.05 and P-value: 0.354). The diastolic blood pressure before and after 30 seconds exposure to the stimulus is compared and it is found that the diastolic blood pressure is higher after the 30 seconds exposure to pain stimulus compared to before the exposure. There is no significant association between the diastolic blood presure before and after 30 seconds of exposure to the pain stimulus. (mean difference: -3.45, 95%CI: -9.64, 2.74 and P-value is 0.264). The diastolic blood pressure is higher after 30 seconds of exposure to stimulus compared to after 10 seconds of exposure to stimulus. There is no significant association between the diastolic blood pressure after 10 seconds and 30 seconds of exposure to the pain stimulus. (mean difference: -1.70, 95%CI: -6.94, 3.54 and P-value: 0.512). The heart rate is higher after 10 seconds of exposure to stimulus compared to before the exposure. There is no significant association between the heart rate before the exposure and 10 seconds after the exposure to the pain stimulus. (mean difference: -0.62, 95%CI: -5.01, 3.81 and P-value: 0.778). When comparing the heart rate before and after 30 seconds exposure to the stimulus, the heart rate is higher after the 30 seconds exposure to stimulus compared to before the exposure. There is no significant association between the heart rate before and after 30 seconds of exposure to the stimulus. (mean difference: -0.68, 95%CI: -2.90, 1.54 and P-value is 0.534). The heart rate is higher after 30 seconds of exposure to stimulus compared to after 10 seconds of exposure to stimulus. There is no significant association between the heart rate after 10 seconds and 30 seconds of exposure to the stimulus. (mean difference: -0.07, 95%CI: -5.09, 4.96 and P-value: 0.979). Lastly, the table also shows the comparison between the pain score after 10 seconds and 30 seconds of exposure to stimulus. The pain score is higher after 30 seconds of exposure compared to 10 seconds of exposure. Thus, there is significant association between the pain score at 10 seconds and at 30 seconds after exposure to the stimulus. (mean difference: -0.77, 95%CI: -1.18,-0.35 and P-value: <0.001)

4. Discussion

This is a reflection on our study on the effects of painful stimuli on the systolic blood pressure, diastolic blood pressure, heart rate, pain score and anxiety. Our study showed that the systolic blood pressure, diastolic blood pressure and heart rate of the participants between the intervention group and the control group had no significant differences between them. This results does not support our hypothesis that is, there is significant difference between the blood pressure and heart rate between the intervention and control group though our study was based on previous study done by Hines and Brown on the effects of cold pressor test on heart rate and blood pressure which showed that there is a rise in both heart rate and blood pressure after the cold pressor test. This proves that pain stimulus has only a limited effect on human cardiovascular system.

As for the anxiety, pain score and side effects between the intervention and control groups, the mean between these two groups shows that there is a significant difference. This result supports our hypothesis that the anxiety, pain score and side effects in intervention group is higher compared to the control group. A study that was done by Obrist on the effects of cold pressor test on the anxiety, pain score and side effects shows that there is a significant difference of the anxiety, pain score and side effects of the intervention group after the cold pressor test compared to the control group. There is also a significant difference in the means of the pain scores at 10 seconds and 30 seconds after stimulus regardless of the stimuli.

Meanwhile, for the mean difference of diastolic blood pressure and heart rate of the participants before and after intervention with pain stimulus showed that there is no significant effect of the cold pressor test towards the blood pressure and heart rate. This differs from our initial hypothesis that there was an increase in the diastolic blood pressure and heart rate of the participants 30 seconds after the intervention. However, there is a significant difference in the mean of the systolic blood pressure before and after intervention with pain in the intervention group. This concurs with our initial hypothesis that there was an increase in the systolic blood pressure of the participants 30 seconds after the intervention.

This study has a few limitations, such as the temperature of the water used in the cold pressor test. Even though the temperature of the water was standardized, there are chances that there may be slight variation in the temperature of the water prepared. Also, due to time limitations, we could only recruit 60 participants. Hence, the generalizability of the results to other population was limited. Therefore, future studies should explore the effect of pain with larger sample size. Further research is required to clarify the effects of cold pressor test on blood pressure, heart rate, anxiety levels, pain score and adverse effects.

For future studies, it is recommended that the research be held for a longer period of time to monitor the side effects and also to follow-up the participants with the proper settings. Besides, it is also recommended to include more participants in this study. This may contribute to the effectiveness of the study conducted along with the variables tested. It is also advised to take the average reading of the blood pressure and heart rate instead of taking a single reading. It is also advised to occupy the participants during waiting period by giving them a questionnaire regarding BSRI rank. Other variables can also be included and tested in the future such as the effect of cold pressor test on reaction time, blood glucose level and the effect on other blood parameters. Different tests for concentration and attention can also be used which is more relevant for the study purpose.

5. Conclusion

Based on the study done, we can conclude that exposure of pain stimulus does have some effect on heart rate, systolic blood pressure, diastolic blood pressure, anxiety, pain score even though these effects cannot be portrayed through this study. This is because, there is no significant difference between the diastolic blood pressure and heart rate between the intervention and control group. As for the systolic blood pressure, anxiety, pain score and side effect between the intervention and control group, the mean between these two groups shows that there is significant difference. We believe that our results may have been influenced by other factors like confounding factors and systematic errors. Even some other studies that were conducted on the same topics were concluded that pain stimulus has an effect on blood pressure, heart rate, anxiety and pain score. However, its best advised to conduct further studies to asses other domains and also for a more accurate results.

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