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MASSAGE EFFECT ON PSYCHOEMOTIONAL STATE AND BLOOD GLUCOSE IN TYPE 1 DIABETES ADOLESCENTS

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Abstract. *In 2021, there were approximately 1.5 million people under age 20 with type 1 diabetes mellitus (T1D) worldwide. Massage affects both physiological processes and also improves the psycho-emotional state. There have been studies on diabetes and the effects of massage on blood glucose levels, but the topic is under-researched. The purpose of the study: to find out the effect of classical massage on the psycho-emotional state and blood glucose level (BGL) in adolescents with T1D. Fifteen adolescents aged 12 to 16, diagnosed with T1D for at least six months, participated in the study. During the study, teenagers were given five classic back massages (once a week, 30 minutes). BGL was measured with glucometer before and after each massage. Participants completed the Positive and Negative Affect Schedule before each massage and the Depression Anxiety Stress Scales at the beginning and end of all massage sessions. Oscillometric method was used to determine the heart rate. The study results show that classical massage positively affects BGL and emotional states in adolescents with T1D. The overall results show a reduced BGL as well as heart rate. Although the differences are not statistically significant, and the effect is not large due to the sample size, the change direction is clinically relevant. When evaluating the results, it is necessary to consider the adolescents' specific age.*
Keywords: *adolescents, blood glucose level, classical massage, heart rate, psycho-emotional state, type 1 diabetes.*

Introduction

Nowadays, more and more children and young people are diagnosed with type 1 diabetes mellitus (T1D) - a complex of metabolic disorders characterized by chronic hyperglycemia of insulin secretion, insulin action, or a combination of these disorders (ISPAD Clinical Practice Consensus Guidelines 2022).

In 2021, there were approximately 8.4 (95% CI 8.1–8.8) million people with type 1 diabetes (T1D) worldwide: of these, 1.5 million (18%) were younger than 20 years (Gregory et al., 2022).

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These young people with an established diagnosis of T1D often feel physically and emotionally bad (Henríquez-Tejo & Cartes-Velásquez, 2018).

Tiffany Field's publication discusses research that shows the positive effects of massage on a person's psycho-emotional and physical health (Field, 2019).

The purpose of the study: To find out the effect of classical massage on the psycho-emotional state and blood glucose level in teenagers with T1D.

Research hypotheses:

1. Adolescents with T1D heart rate will have a statistically significant decrease due to massage.
2. Adolescents with T1D blood glucose levels will have a statistically significant decrease due to massage.
3. Adolescents with T1D depression, anxiety, and stress indicators will have a statistically significant decrease due to massage.
4. Adolescents with T1D indicators of negative emotions will have a statistically significant decrease, and positive ones - an increase due to massage.

T1D is a chronic condition, in which the pancreas produces little or no insulin (Mayo Clinic, 2022).

Certain factors that can contribute to the onset of T1D include family history, genetics, geography, age (Mayo Clinic, 2022). However, in the case of adolescents, this condition seems to be crucial as this stage of life is coupled with puberty which is characterized by intense hormonal changes and developing physical and social factors. Since 1989 there have been investigations showing increased insulin resistance during adolescence (Caprio et al., 1989). Also, compliance to the various control treatments can be quite tasking and this can induce stress in the patients. When stressed, insulin levels fall, epinephrine levels rise and more glucose is released from the liver. At the same time, growth hormone and cortisol levels rise, which causes body tissues to be less sensitive to insulin, thereby increasing the level of glucose available in the bloodstream (UCSF, 2022). This exposes the patient to higher risks of complications (e.g chronic hyperglycemia).

Diabetes affects life's physical, emotional, social, and financial aspects (Fatati, 2014). A link between negative emotions, especially anxiety and diabetes, and the effect of emotional state on adherence to disease control has been confirmed (Muscatello et al., 2017).

Negative emotions in adolescence are a natural phenomenon, but diabetes can noticeably intensify these emotions. A teenager has to take more responsibility for his actions than other teenagers, constantly control the sugar level in the body, follow diets, observe his feelings, and take other actions so that his health condition does not get worse. Adolescents get tired and show more

anger, shame, guilt, fear, disgust, sadness, anxiety, and other emotions, as well as tension and stress (Henríquez-Tejo & Cartes-Velásquez, 2018).

Massage helps to reduce the level of negative emotions - anger, fear, dissatisfaction, stress, and depression, as well as improve physical sensation and create joy, optimism, and a feeling of happiness (Field, 2019).

Massage affects both physiological processes and also improves the psycho-emotional state. It has been studied that massage can reduce stress and anxiety levels and improve mood in both children and adults (Hohl, Deslandes, & Mármora, 2019; Chen et al., 2019; Zadkhosh, Ariaee, Atri, Rashidlamir, & Saadatyar, 2015).

In 2011, a study in Iran investigated the effects of Swedish massage on blood glucose levels in children with T1D. It was concluded that massage significantly lowers glucose levels in children with T1D (Sajedi, Kashaninia, Hoseinzadeh, & Abedinipoor, 2011). A similar study conducted in 2008 concluded that massage and muscle relaxation techniques contribute to the reduction of glycated hemoglobin (HbA 1C) in children with T1D (Ghazavi, Talakoob, Abdeyazdan, Attari, & Joazi, 2008).

Based on repeated studies on the effectiveness of massage in reducing stress, anxiety, and depression and improving sleep quality, as well as on studies on the effectiveness of massage in normalizing glucose levels, massage could be used as a preventive method for normalizing the psycho-emotional state and blood glucose level in adolescents with T1D (Sherman et al., 2010; Field, 2016; Ghazavi et al., 2008).

Although the topic is current, more recent research in this area is lacking.

Methodology

The study was conducted within the scientific project "Effect of classical massage on psycho-emotional state, blood glucose level and other physiological processes related to the diagnosis in adolescents with type 1 diabetes mellitus," funded by Riga Stradins University Red Cross Medical College (RSU RCMC). The study took place from September 2021 to May 2022. The study has approval from the RSU RCMC Ethics Committee (session protocol nr. 20, September 6, 2021). Participants were assigned an identification code, and confidentiality of the obtained data was provided.

Forty-eight participants applied for this study, of which 15 were eligible participants. Thirty-three participants did not meet the inclusion criteria due to age, duration of diagnosis, and, most often, lack of a COVID-19 vaccination certificate.

Inclusion criteria

In order for the research to have an impact and the obtained results to be most accurately attributed directly to the effect of massage, the necessary conditions for the research participants were as follows:

- The diagnosis of T1D was established no earlier than six months ago (or the remission has ended, if there was one, so the diagnosis is conclusive, insulin release does not occur).
- Participant was in the age group of 12-16 years.
- The participant can take blood glucose readings (sensor or strips) before and after the massage.
- The participant has a COVID-19 vaccination certificate.
- Two hours before the massage, the participant did not inject short-acting insulin (because the short-acting insulin has a 2-hour effect time).
- The participant has not taken food containing carbohydrates two hours before the massage. The blood glucose level rises to 2 hours after a meal.

Exclusion criteria:

- The participant does not use an insulin pump (because its operation is not regulated, and it would be possible to introduce artificial insulin during the massage, in which case the results would not be credible).
- In cases where a participant showed up for a massage but did not meet the study criteria (hypoglycemia, hyperglycemia and administered artificial insulin, ingested carbohydrates), the results were not recorded, or the data were not selected for analysis.

Participants

Fifteen teenagers (10 females, 5 males), aged between 12 and 16 (M=14,29, SD=1,31), average body mass M=53,18 kg, SD=12,94, average height M=168,75 cm, SD=10,50, who have been diagnosed with T1D for at least six months, participated in the study. Parents signed an informed consent to participate in the study.

Instruments:

- Study participant's individual continuous glucose monitoring system for measurement of glucose level in interstitial fluid.
- Heart rate measurements using the digital sphygmomanometer device Omron M7 – IT.
- Positive and Negative Affect Schedule (PANAS) questionnaire (Watson, Clark, & Tellegen, 1988).
- Depression Anxiety Stress Scales (Lovibond & Lovibond, 1995).

Procedure

The application for participation in the study was published on social network pages of diabetes societies, where parents of children with T1D participate. Participants could apply for the study by filling out an electronic

application form. A total of 48 participant forms were submitted; 15 were recognized as appropriate for the study due to prerequisites necessary for participation. The participants and parents were introduced to the course of the study, and the parents signed the informed consent.

Massages were performed in the afternoons for each participant on the same day of the week and at the same time. The massage occurred in a medical institution at a room temperature of 22 degrees Celsius. The massage duration was 30 minutes. The classic massage was performed with stroking, rubbing, kneading, and vibration techniques in a specific order according to a uniform protocol.

Before the first and after the fifth massage treatment, the participant completed the Depression Anxiety Stress Scales. The PANAS questionnaire was filled out before each massage. Heart rate measurements were taken three times before and after each massage. In processing the results, the average of those measurements was used. Glucose level measurements were recorded before and after each massage and recorded in an electronic table using the Microsoft Excel program. Each participant received a back massage after the classical massage.

Data analysis methods

Descriptive and inferential statistical methods were used for data analysis - calculating the arithmetic mean and standard deviation, Wilcoxon Signed Ranks Test, Friedman test, and Coen d's criterion. Calculations were performed using MS Excel and IMB SPSS version 27.

Research results

To test the 1st hypothesis, "Adolescents with T1D heart rate will have a statistically significant decrease due to massage", heart rate before and after the massage was compared, using the Wilcoxon Signed Ranks Test. It demonstrated that heart rate decreased under the influence of massages (Figure 1). After the first massage session, changes in heart rate were not statistically significant. However, in subsequent times, the heart rate decreased statistically significantly (Table 1). The obtained results confirm the 1st hypothesis.

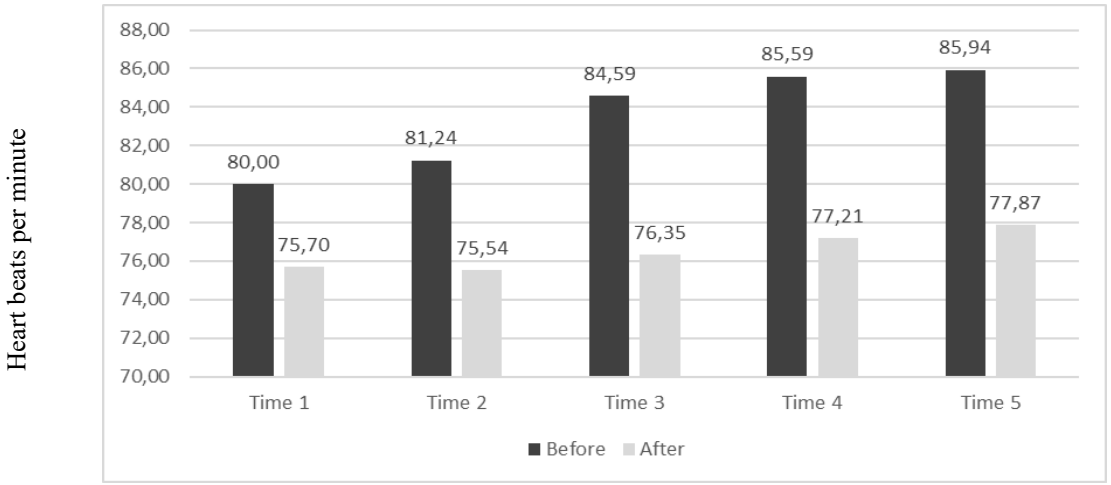

Figure 1 ***Heart rate changes during a course of five massage sessions*** *(created by the authors)*

Table 1 ***Wilcoxon Signed Ranks Test results of the effect of massage on changes in heart rate during a course of five massage sessions*** *(created by the authors)*

	Difference	*Wilcoxon Signed Ranks Test*	*p*	*Coen d*
Time 1	4,3	-1.686	.092	.27
Time 2	5,7	-2.335*	.020	.43
Time 3	8,29	-3.524***	<.001	1.04
Time 4	8,38	-3.576***	<.001	0.81
Time 5	8,08	-3.081***	<.001	0.77

*p<0,05, **p<0,01, ***p<0,001

To test 2nd hypothesis, "Adolescents with T1D blood glucose levels will have a statistically significant decrease due to massage", blood glucose levels were compared before and after massage using Wilcoxon Signed Ranks Test (Table 2). The results show that the blood glucose level also decreased due to the massage (Figure 2). It changed statistically significantly in the first three massages, but the changes were not statistically significant in the fourth and fifth massages. Therefore, the 2nd hypothesis is partially confirmed.

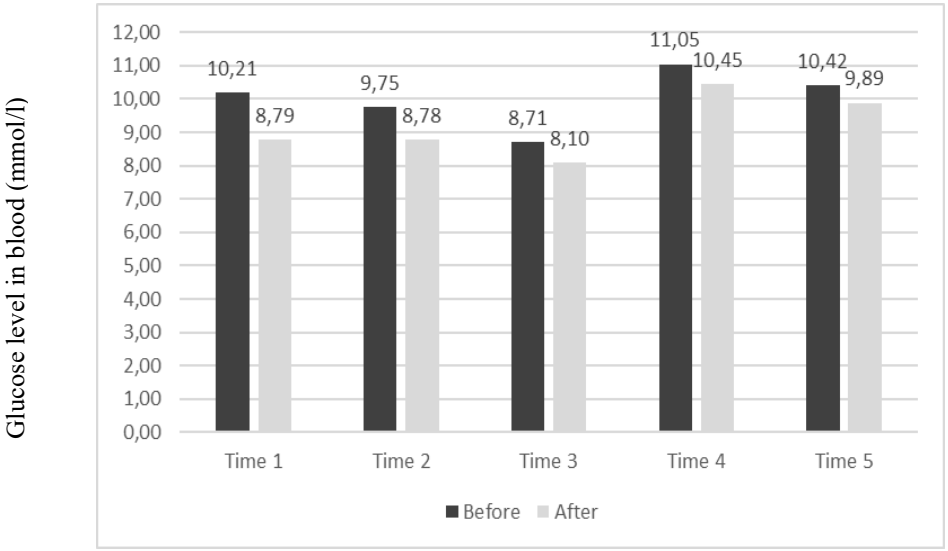

Figure 2 ***Changes in glucose levels during five massage sessions*** *(created by the authors)*

Table 2 ***Wilcoxon Signed Ranks Test results of the effect of massage on changes in glucose levels during a course of five massage sessions*** *(created by the authors)*

	Difference	*Wilcoxon Signed Ranks Test*	*p*	*Coen d*
Time 1	1,42	-3.458***	<.001	.28
Time 2	0,97	-2.273*	.023	.28
Time 3	0,61	-2.250*	.024	.22
Time 4	0,6	-1.873	.061	.11
Time 5	0,53	-.880	.379	.10

*p<0,05, **p<0,01, ***p<0,001

To test the 3rd hypothesis, "Adolescents with T1D depression, anxiety, and stress indicators will have a statistically significant decrease due to massage", depression, anxiety, and stress scores were compared at the beginning and after the massage course using the Wilcoxon Signed Ranks Test (Table 3). The results revealed no statistically significant differences in depression, anxiety, and stress scores during the massage course (Figure 3). Rates of depression, anxiety, and stress did decrease, but the change was not statistically significant. Therefore, the 3rd hypothesis is not confirmed.

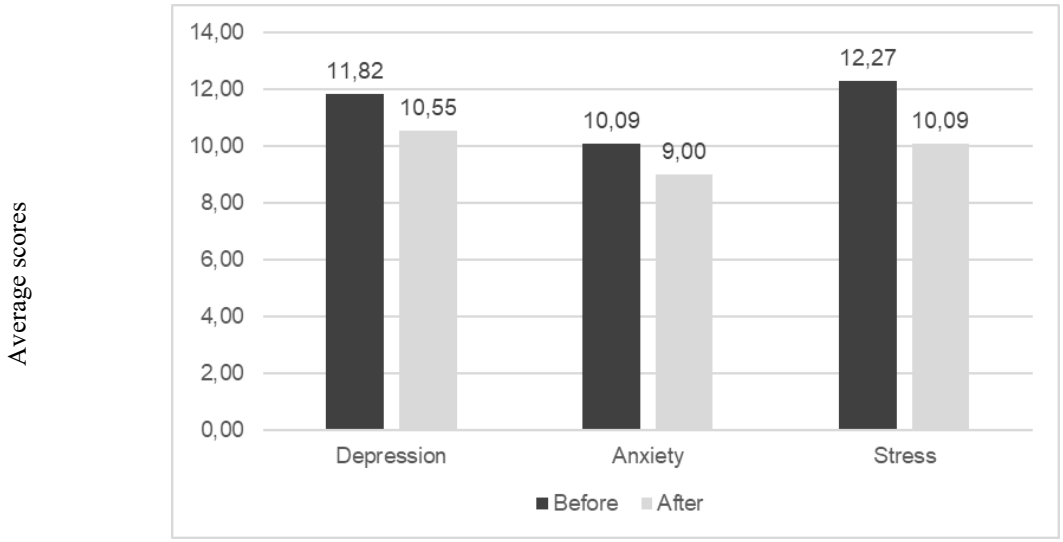

Figure 3 ***Changes in the psycho-emotional state during the massage course*** *(created by the authors)*

Table 3 ***Wilcoxon Signed Ranks Test results of changes in the psycho-emotional state during the massage course*** *(created by the authors)*

	Difference	*Wilcoxon Signed Ranks Test*	*p*	*Coen d*
Depression	1,27	-.578	.563	0.10
Anxiety	1,09	-.889	.374	0.23
Stress	2,18	-1.069	.285	0.22

To test the 4th hypothesis, the Friedman Test was used to compare positive and negative emotion scores between five massage sessions. The obtained results (Table 4) revealed that during five massage sessions, there were no statistically significant changes in either positive or negative emotions level (Figure 4). Friedman test results for positive emotions x^2 (4, 15) =2.874, p= .579, and for negative emotions x^2 (4, 15) =8.601, p= .072. The indicators of negative emotions decreased slightly at first, then returned to the previous level, while the indicators of positive emotions almost did not change (Figure 4). Thus, the 5th hypothesis is not confirmed.

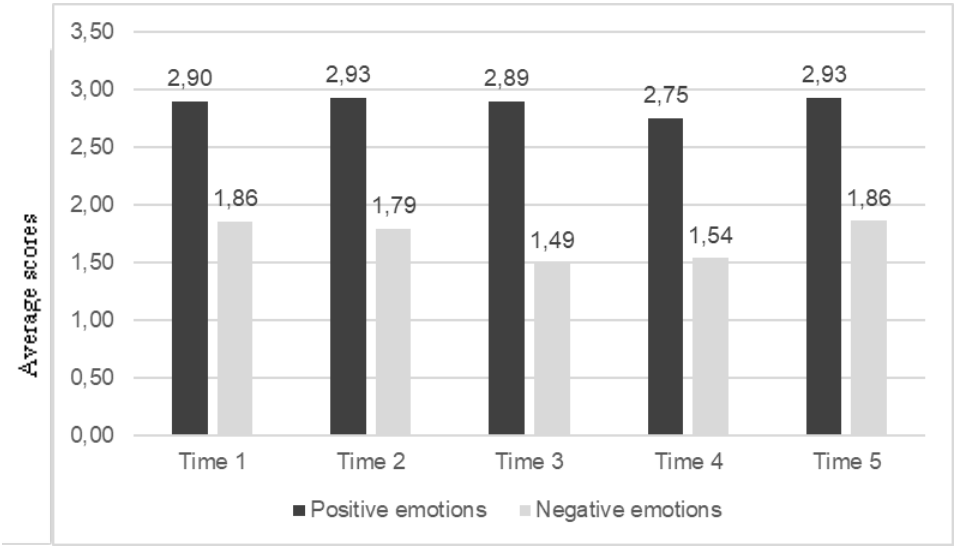

Figure 4 ***Changes in positive and negative emotions during the massage course*** *(created by the authors)*

Discussion

In Latvia, 268 adolescents aged 10 to 14 and 188 young people aged 15 to 17 are diagnosed with T1D (SPKC, Statistical data for 2020).

During this study, a classic back massage was performed once a week for 30 min. It was five massages in five weeks in total. The differences in the results of the Positive and Negative Affect Schedule questionnaire and the Depression Anxiety Stress Scales are not statistically significant, and the effect is not large. However, the direction of the changes is clinically significant. When evaluating the results, the specific age of teenagers from 12 to 16 years should be considered when their emotional state is affected by various factors. These are mood changes and physical changes in the adolescent's body.

The effect of massage has been widely studied in connection with various chronic diseases, proving its effectiveness in reducing pain of various origins and improving the quality of life. Massage affects the heart and circulatory system depending on the techniques used and their intensity. Massage treatments have been studied to normalize blood pressure and heart rate both in the short term (during and shortly after the massage) and in the long term (throughout the course of the massage) (Field, 2016; Rich, 2010; Wettlaufer, 2017; Sridani, Russeng, Nur, Fauzan, & Devi, 2020).

In this study, the heart rate of adolescents with T1D decreased because of classical massage. After the first session, the changes were not statistically significant. However, in subsequent times, the heart rate decreased statistically significantly, which can be attributed to the massage activating the body's parasympathetic nervous system through skin pressure receptors and stimulating vasodilation, resulting in a decrease in heart rate (Nelson, 2015). Vasodilation and

activation of the parasympathetic nervous system indicate a reduced stress response. Similar results have been observed in studies with healthy patients, where heart rate decreased after a massage (Lindgren et al., 2010).

A 2011 study in Iran (Sajedi, Kashaninia, Hoseinzadeh, & Abedinipoor, 2011) also observed a decrease in blood glucose levels in adolescents with T1D after massage. It changed statistically significantly in the first three massage times, but changes in the fourth and fifth massage times were not statistically significant. The GLUT4 glucose transporter activation can explain the glucose uptake in the absence of insulin during physical exercise (Richter & Hargreaves, 2013). Classical massage activates the skeletal muscles similarly to physical exercise, thus, lowering blood glucose levels. However, during this and the previously mentioned study in Iran, blood glucose level decrease was not statistically significant after successive massage sessions. As earlier described, massage activates the parasympathetic nervous system, particularly the vagal nerve, which also controls glucagon release. Glucagon is a hormone that augments blood glucose levels if they are too low. Previous studies have shown that the glucagon response due to low glucose levels in blood is absent in patients with T1D. However, it is uncertain whether the glucagon release could be triggered in these patients by other stimuli, such as exercise or massage (Bisgaard Bengtsen & Møller, 2021). It is possible that continuous massages induced the patients' glucagon response, raising the glucose level. An additional extended study with more massage sessions, where glucose and glucagon levels in blood are measured after each session, is necessary.

The conducted research is the first experimental study of this kind in Latvia. Although the small sample size and the increased psychoemotional stress due to the pandemic can be considered limitations, the results reveal that massage could help stabilize the psychoemotional state and sugar blood levels in adolescents with T1D.

Conclusion

Although the differences are not statistically significant, and the effect is not large due to the sample size, the change direction is clinically relevant. When evaluating the results, it is necessary to consider the specific age of adolescents when their emotional state is affected by various factors. These are not only mood changes but also physical changes in the adolescent's body, changes in the way of thinking, and self-awareness. Adolescents are subjected to a complex of emotions that include anger, guilt, shame, and a mixture of other emotions constantly interspersed daily with the influence of the home and surrounding environment, relationships, health issues, and resolution of those.

Reducing negative feelings with massage help for most participants is a good indicator of how to give a positive direction to teenagers with T1D, whose life

with this diagnosis is rather difficult. Massage can help reduce negative emotions and, to some extent, also increase positive emotions, which is a good indicator.

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