

DOI: 10.5281/zenodo.12426140

## CLINICAL EFFECT OF SWEDISH MASSAGE VERSUS ADJUVANT YOGA ON BLOOD GLUCOSE LEVEL IN CHILDREN WITH TYPE 1 DIABETES MELLITUS

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Received: 13/06/2025  
Accepted: 04/01/2026

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**ABSTRACT**

*Background: Swedish massage (SM) and yoga are complementary non-pharmacological techniques that have recently been used in managing chronic disorders such as type 1 diabetes mellitus (T1DM). Both techniques play an important role in reducing stress, which contributes to lowering blood glucose levels in children with T1DM. Individuals with type 1 diabetes mellitus (T1DM) confront serious lifestyle alterations that include an absolute daily requirement for exogenous insulin, monitoring their glucose control, and paying attention to dietary intake. Yoga is an ancient mind-body practice increasingly recognized to have health benefits in various clinical and non-clinical conditions. The current trial was intended to evaluate the efficacy of yoga therapy on glycemic variability and physical activity among patients with T1DM. Objective: To investigate the effect of Swedish massage versus children's yoga exercises on blood glucose levels of children with T1DM. Setting: This study was conducted at the Outpatient Diabetic Clinic in the Specialized University Hospital at Egypt. Design: A quasi-experimental research design was used. Subjects: A convenience sample of 50 diabetic children was randomly allocated into two equal study groups: study group I (SM) and study group II (yoga). Tools: Two tools were used: socio-demographic and medical history interview schedule and blood glucose level assessment tool. Results: Swedish massage and yoga exercises were associated with significant decreases in fasting blood glucose level, random blood glucose level, and consequently HbA1c after intervention ( $P < 0.001$ ). The SM group showed a greater reduction compared to the yoga group. Conclusion: Both techniques were effective in decreasing blood glucose levels in children with T1DM, while Swedish massage was more effective than yoga exercises.*

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**KEYWORDS:** Swedish Massage, Children's Yoga, Type 1 Diabetes Mellitus, Blood Glucose Level, Children.

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## 1. INTRODUCTION

Type 1 diabetes mellitus is one of the most common endocrine and metabolic problems occurring in childhood. Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease characterized by insulin deficiency due to pancreatic  $\beta$  cell destruction which leads to increase blood glucose levels (hyperglycemia). Ineffective glycemic control can affect the growth and development of children and adolescents. It is usually associated with acute and chronic complications that have impact on children's quality of life (Katsarou et al., 2017; Madrigal et al., 2020) by primarily lowering Quality of Life (QoL) by interfering with everyday activities, and social interactions (Kelini KIS et al., 2025). In 2019, the International Diabetes Federation (IDF) reported that approximately 1,110,100 children are estimated to have T1DM worldwide. They reported that around 98,200 children under 15 years were diagnosed with T1DM worldwide each year (Patterson et al., 2019). The annual incidence in the United States is approximately 20 in 100,000 children. The prevalence of T1DM is highest in non-Hispanic whites followed by African Americans, Hispanics, and American Indians (Marcdante & Kliegman, 2019). The largest contribution to the total number of estimated childhoods T1DM cases among Eastern Mediterranean and Middle Eastern countries comes from Egypt. It accounts for about a quarter of the region's total, 8/100 000 per year in Egyptian children under the age of 15 years had T1DM (El-Ziny et al., 2014). Stress is considered as one environmental factor contributing to the development of T1DM in children. Theoretically, the beginning of the autoimmune process could be triggered by stress and contribute to its progression. Stress results in elevated cortisol levels that may contribute to insulin resistance. Epinephrine (another hormone released during stress), inhibits also the insulin secretion and leads to an increase in the need for insulin. Stress can be controlled through behavioral intervention techniques as Swedish massage and yoga which are very important to improve glycemic condition of children with T1DM (Argyropoulos et al., 2021). Recently, mind-body interventions such as children's yoga have gained increasing attention as safe and effective complementary approaches for stress reduction and metabolic regulation in pediatric populations. Children's yoga is a gentle form of physical therapy that includes simple postures designed to improve flexibility, balance, coordination, and relaxation without imposing physical or psychological strain. Yoga exercises may reduce sympathetic nervous system activity and enhance parasympathetic response, thereby contributing to improved glycemic control in

children with T1DM. Swedish massage (SM) is a relaxation technique that focuses on improving blood flow to the skin, muscle and removing tension of the muscles. It was the first systematic method of therapeutic massage based on a physiological perspective. It is built around five basic superficial strokes - effleurage (sliding or gliding), petrissage (kneading), tapotement (rhythmic tapping), friction (steady pressure) and vibration or jostling (De Omena Bomfim, 2021). Swedish massage and Progressive muscle relaxation had an effective role in decreasing blood glucose level in children with T1DM, so that the pediatric nurse should apply and educate care giver about Swedish massage and PMR techniques (Ismaili et al., 2018). This study aimed to investigate the effect of Swedish massage versus children's yoga exercises on blood glucose levels in children with T1DM. Type 1 diabetes mellitus (T1DM) is characterized by severe insulin deficiency resulting from chronic [1] and the progressive destruction of pancreatic beta-cells by the autoimmune response, resulting in hyperglycemia [2]. This is the most common endocrine-metabolic disorder of childhood and adolescence period, with important consequences on physical and emotional developments. Individuals with type 1 diabetes mellitus confront serious lifestyle alterations that include an absolute daily requirement for exogenous insulin, the need to monitor their glucose control, and need to pay attention to dietary intake [3]. Diabetes diet and workout are significant parts of management. In the short-term complications of this disease, hypoglycemia, diabetic ketoacidosis, and long-term complications such as macrovascular changes, eye, kidney, and nerve disease create more harmful and dangerous conditions for children which are all due to poor blood glucose control [4]. Incidence of T1DM is growing worldwide, it is 10% of all diagnosed diabetes, and more common in Finland and Sardinia where the incidents are 57.6 and 37.8 /100,000/ year respectively [5]. About 40-60% of people with type 1 diabetes Mellitus are younger than 20 years of age at the time of onset, making diabetes one of the most common severe chronic diseases in childhood affecting 0.3% of the general population by the age of 20 years and 0.5-1% during the lifespan [6]. In India: It is estimated about 128,500 children with type 1 diabetes mellitus according to Diabetes Atlas 2017 [7]. The prevalence of diabetes in India is variable, and three sets of data show 17.93 cases /100,000 children in Karnataka, 3.2 cases/ 100,000 children in Chennai, and 10.2 cases/ 100,000 children in Karnal (Haryana). More than 1% of Indian children are diabetic, according to a government sample survey [8]. Children with T1DM have to deal with a complex and demanding daily treatment regime which can harm the

quality of life (QoL) of these patients [9]. Although children and adolescents with DM1 have to live with a demanding treatment regime, the overall results revealed that their generic quality of life is not impaired compared to their healthy peers [10]. Young adults with Type 1 diabetes mellitus are a high-risk group with suboptimal glycemic outcomes compared to older adults with Type 1 diabetes [11]. Management is challenging due to psychosocial issues; for example, perceptions of body image [12], the increased incidence of psychiatric illness [13], eating disorders [14], and poor quality of life [15], [16]. Some studies suggest that poor glycemic variability may be associated with a lower quality of life, negative moods, and blood glucose fluctuations [17]. A meta-analysis of 27 studies demonstrated that depression is significantly associated with hyperglycemia for type 1 diabetes [18]. Moods such as anxiety and anger often accompany depression with type 1 diabetes [19], Anxiety has also been associated with poor glycemic control [20] Anger has also been linked to depression [21] and is associated with glucose fluctuation and poorer self-management of hyperglycemia in people with type 1 diabetes. For patients with type 1 diabetes, high glucose values have been reported to negatively impact mood, positive mood rating decreased, whereas negative mood ratings increased, tension and anger have been reported to be higher in type 1 diabetes individuals in the hyperglycemic range compared with those in the hypoglycemic range with continuous glucose monitoring (CGM) [22]. Although glycated hemoglobin (HbA1c) has been the standard for assessing glycemic control, glycemic variability [23]. Yoga is an ancient mind-body practice that is increasingly recognized to have health benefits in a variety of clinical and non-clinical conditions [24]. Among various types of yoga, it emphasizes both physical and mental training and usually consists of yoga poses, breathing, and meditation [25]. Yoga has been reported to not only increase physical fitness but also reduce pro-inflammatory markers such as interferon  $\gamma$  (INF- $\gamma$ ), interleukin-6 (IL-6), interleukin-2 (IL-2), and stress level [26]. Based on these results, *yoga* practice is required to achieve consistent effects especially on circulating inflammatory markers [24], improvements in physical fitness, immune activity [27], improved beta-cell function [28], and reduced stress have been proposed as physiological mechanisms for beneficial effects of yoga on the immune system [29], [30]. Previous studies on yoga, physical activity [31], [32] and exercise [33], [34] have shown that these practices changed glycemic variation, improved mental health, and quality of life (QoL) in autoimmune diseases [24]. Glucose fluctuation is a major issue in type 1 diabetes that is sustained by

chronic hyperglycemia and acute fluctuations in blood glucose, poor glycemic control, and quality of life. Current treatment has only the external insulin to insert and control the metabolic imbalance. Yoga has been a complementary and alternative therapy in several chronic health conditions, including autoimmune disorders.

To our knowledge, no studies have been reported on the efficacy of *yoga* in improving blood glycemic fluctuation, quality of life, and mental health in type 1 diabetes. Some research studies have been conducted on physical activities and exercise. There is no validated yoga module available for type 1 diabetes, the present study intended to develop and validation, and also conduct the feasibility of validated yoga module and check the efficacy of yoga on blood glycemic fluctuation in type 1 diabetes.

Massage, one of the passive warming methods preferred by athletes and coaches, can be applied to assist in acute preparation for performance [20]. It possesses relaxing and stimulating properties that can potentially affect an athlete's performance in various situations, such as before, during, and after training or competition [21]. Generally defined as the manipulation of soft tissue [22], massage can be applied for the purpose of recovery, injury prevention [23], and as a pre-performance passive warming method [24].

The most used type of massage in training and competitions is known as Swedish massage or Western massage. Swedish massage involves systematic manipulation of the body's soft tissues using strokes, kneading, rubbing, and vibration during the massage [25]. These movements promote blood and lymph circulation, muscle relaxation, pain alleviation, the restoration of metabolic balance, and various other physical and mental benefits [26]. In a study by Kaplan *et al.* [27], massage was suggested to help healthy individuals improve their balance.

Limited information exists regarding the effects of massage on balance. Sefton *et al.* [28] stated that massage improves both static and dynamic balance in adults. Another study also indicated the positive effects of massage on balance [29]. The limited number of studies on the acute balance performance of Swedish massage used as a passive warming method prompted the consideration of this study.

## 2. MATERIALS AND METHODS

**Design:** A quasi-experimental research design was used.

### *Research Hypothesis*

Diabetic children who were subjected to Swedish massage exhibit lower blood glucose levels than those who were subjected to children's yoga exercises.

### Settings:

This study was conducted at the Outpatient diabetic clinic in the Specialized University Hospital in Egypt. The registration number for our study, NCT07382492, was available on ClinicalTrials.gov

### Subjects:

A convenience sampling of 50 diabetic children who fulfilled the following criteria comprised the study subjects:

Inclusion criteria:

- Diabetic children's age: 6 - 12 years.
- Children who live in Cairo only.
- Free from other medical disorders such as cardiac, renal, or any other metabolic disorder.

The subjects of the study were randomly allocated to two equal groups as follows 1st diabetic child for study group (I) then the 2nd diabetic child for study group (II):

- a. Study group (I): Twenty-five diabetic children who received Swedish massage in addition to routine nursing care of the unit for diabetes.
- b. Study group (II): Twenty-five diabetic children who received children's yoga exercises in addition to routine nursing care of the unit for diabetes.

### Tools

Two tools were used for data collection. Tool I and Tool II were developed by the researcher after reviewing relevant literature (Elleri et al., 2014; Hockenberry & Wilson, 2018; Marcdante & Kliegman, 2019). Children's yoga intervention protocol was developed based on pediatric yoga and physical therapy literature to ensure safety and age-appropriate application in children with T1DM.

Tool I: Socio-demographic and Medical History of Diabetic Children Interview Schedule:

It included two parts as follows:

Part 1: Socio-demographic characteristics of diabetic children as age, gender and birth order.

Part 2: Medical History of Diabetic Children as duration of DM, history of recent hospitalization and presence of diabetic complications.

Tool II: Blood glucose level Assessment Tool:

This tool included:

- 1- Fasting blood sugar.
- 2- Random blood sugar.
- 3- Glycosylated Hemoglobin (HbA1c).

### Method – Training Programs

1. The researcher attended an extensive Swedish massage and children's yoga training program.
2. Each training program consisted of 24 hours over four days.

### Intervention Procedures

#### Treatment Procedures:

Intervention procedures were organized into two main categories.

Therapeutic procedures (preparatory treatment application) patient's weight, height, and BMI were recorded, and they were informed about the treatment by their parents, procedures and their purpose; contraindications (mentioned in the exclusion criteria) were excluded.

#### For Study Group (I): massage protocol

To ensure the hygiene of the massage table before each massage application, it was cleaned using a disinfectant, and a disposable cover was used. The massage room was adjusted to an appropriate temperature (22–26 °C). Approximately 15 mL of classic baby oil was used for each participant during the Swedish massage. Swedish massage was performed by using effleurage, friction, petrissage, and pressure techniques, with the massage strokes directed towards the heart and muscle fibers [30,31]. The Swedish massage administered to the participants was conducted by three expert masseurs, and to avoid affecting measurement outcomes, the masseurs administered massages to the same participants in each session. To ensure that the effects of the Swedish massage administered to the participants did not dissipate, the participants underwent balance tests shortly after the massage. Each device (InBody, Togu dynamic balance, and Desmotec static balance) had a dedicated expert practitioner.

#### Swedish Massage

a. Swedish massage was done in quiet room with appropriate temperature and light at 9 a.m.

The researcher advised children to take off their clothes except panties and lie in supine position.

The researcher did the massage for diabetic children twice per week for 30 minutes per session for 48 days

At the beginning of the massage the researcher applied the lavender Jonson oil for lubrication, spread it over the surface, warm the surface layer of tissue and reflexively create a smooth relaxing flow and rhythm for the application of the stroke.

The initial phase in the application of Swedish massage involved **Effleurage**, wherein the practitioner performed long, firm gliding strokes using either the entire hand or thumbs. These movements were directed along the outer contours of the body. The second process was **Petrissage**, where the researcher lifted, rolled, grasped, stretched, and compressed or squeezed

the underlying tissue of abdomen, back, arm, and leg of child. The third process was **Tapotement**. In this process the researcher applied rhythmic percussion, most frequently administered with the edge of her hand, a cupped hand or the tips of the fingers. The fourth process was **Friction** in which the researcher performed a deep and circular movement near joints and other bony areas such as rib cage in front and backbones in the back. The last process of Swedish massage was **Vibration**, where the researcher made shaking, quivering, trembling, or rocking movements with the fingers, or full hand to all body parts from the front and from the back. Finally, the researcher advised the children to put on their clothes.

**For Study Group (II): Children's yoga exercises**

Children's yoga sessions were conducted twice per week for 30 minutes over a period of six weeks under the supervision of the researcher. Sessions were designed to be playful, safe, and appropriate for children aged 6–12 years.

Yoga poses included:

- Cat–Cow Pose (Marjaryasana–Bitilasana): Gentle spinal movements that enhance flexibility and relaxation.
- Child's Pose (Balasana): A resting pose that promotes calmness and stretches the back and hips.
- Tree Pose (Vrksasana): A balancing posture that

strengthens the legs and improves focus.

- Bridge Pose (Setu Bandhasana): A gentle backbend that strengthens the spine and hip muscles.
- Downward-Facing Dog (Adho Mukha Svanasana): A full-body stretch that improves coordination and circulation.

Adequate rest periods were allowed, and exercises were stopped immediately if the child experienced discomfort or fatigue.

Yoga Group Participants in the yoga group underwent a 6 week intervention consisting of 60 minutes of yoga, five times a week. The integrated yoga sessions have been designed to combine the techniques of loosening exercise (sookshma vyayama), sunsalutations (suryanamaskara), physical postures (asanas), breathing practices (pranayama), and anapana meditation, as listed in Table 1, to address both the physical and 2024 Yadla et al. Cureus 16(1): e53286. DOI 10.7759/cureus.53286 2 of 10 psychological aspects of PD. Qualified yoga instructors with expertise in mental health guide the sessions, ensuring standardized delivery of the intervention. The integrated yoga module designed for individuals with panic disorder has been meticulously reviewed and approved by three certified yoga experts. No dropouts were observed in the study.

Figure 1 shows the flow diagram of the study profile

SI . NO	Name of Practice	Duration ( minutes )
Yogic micro exercises and gross exercises (yogic sukhshma and sthula vyayama)	Intelligence development process (Medha shakti vikasaka kriya) memory power development process (Smarana shakti vikasaka kriya) Intelligence and cognitive development process (Buddhi tatha dhriti shakti vikasaka kriya) upward movement (Urdhwagati)	3
Sun salutation (suryanamaskar)	Standing posture, mountain pose (Tadasana)	1
	Standing spinal twist pose (Katichakrasana)	1
	Supine posture wind-relieving pose (Pavanamuktasana)	1
	Bridge pose (Sethubhandasana)	1
	Shoulder stand pose (Sarvangasana)	1
Yogasana	Easy fish pose (Sarala Matsyasana)	1
	Prone posture crocodile pose (Makarasana)	1
	Bow pose (Dhanurasana)	1
	Sitting posture cow face pose (Gomukhasana)	1
	Spinal twist pose (Vakrasana)	1
	Corpse pose (Shavasana)	3
	Bellows breath (Bhastrika)	1
Breathing practice (Pranayama)	Alternate nostril breathing (Nadishuddi)	3
	Cooling breath (Shitali)	1
	Humming bee breath (Bhramari)	3
Meditation	normal respiration (Anapana)	6
Total		30

### Ethical Considerations & Statistical Analysis

#### Ethical considerations:

- Informed written consent was obtained from diabetic children's caregivers for their participation in the study after explaining the aim of the study.
- The right to refuse to participate or withdraw from the study at any time was assured.
- The privacy of children was ascertained.
- Confidentiality of data was maintained.
- Children in the yoga group were carefully monitored to ensure safety and comfort throughout the intervention sessions.
- Yoga exercises were applied in a non-invasive manner appropriate for the children's age and health condition.

#### Statistical analysis:

- The collected data was coded and entered in special format to be suitable for computer feeding.
- Following data entry, checking and verification process were carried out to avoid any errors.

- Data was analyzed using the statistical package for social science SPSS (version 24).
- The following statistical analysis measures were used:
  - Descriptive statistical measures included numbers, percentages of Arithmetic mean and Standard deviation.
  - Statistical analysis tests, which included Chi square, ANOVA test, Fisher Exact and Monte Carlo test.
  - Significance of the obtained results was judged at the 5% level.
  - Comparative analysis was performed between the Swedish massage group and the children's yoga exercises group to determine the effect of each intervention on blood glucose outcomes.

### 3. RESULTS

Table (1) illustrates socio-demographic characteristics of diabetic children. It revealed that 52% of each of diabetic children who received SM and those who received children's yoga exercises were females.

**Table 1: Percentage distribution of socio-demographic characteristics of diabetic children.**

	Socio-demographic Characteristics of Diabetic Children:	SM (Study I) (n = 25)		children's yoga exercises (Study II) (n = 25)	
		No.	%	No.	%
1	<b>Gender</b>				
	Male	12	48.0	12	48.0
	Female	13	52.0	13	52.0
2	<b>Child's age (years)</b>				
	6 -	10	40.0	1	4.0
	8-	4	16.0	11	44.0
	10-12	11	44.0	13	52.0
	Mean ± SD.	8.76 ± 2.39		9.80 ± 1.47	
3	<b>Birth order of the child:</b>				
	1-	15	60.0	23	92.0
	3-	9	36.0	2	8.0
	5 and more	1	4.0	0	0.0

#### SD: Standard deviation

The highest percentage of each of the diabetic children who received SM and children's yoga exercises were in the age group from 10 to 12 years (44% and 52% respectively). Medical history of diabetic children is shown in table (2). It was clear from this table that the

highest percentage of SM group (56%) was within the duration of DM from less than one to 2 years. The highest percentage in the children's yoga exercises group (40%) was within the duration of 3 to 4 years. The majority of SM group (92%), while nearly three quarters (72%) of the yoga exercises group were previously admitted to the hospital.

**Table 2: Percentage distribution of medical history of diabetic children.**

	Medical history of diabetic children	SM (n = 25) (Study I)		children's yoga exercises (n = 25) (Study II)	
		No.	%	No.	%
1	<b>Duration of DM (Years)</b>				
	<1-	14	56.0	7	28.0
	3-	5	20.0	10	40.0
	5 and ≥6	6	24.0	8	32.0
	Mean ± SD.	2.65 ± 1.68		3.72 ± 1.67	

2	<b>Previous hospital admission</b>				
	Yes	23	92.0	18	72.0
	No	2	8.0	7	28.0
3	<b>Presence of diabetic complications #</b>				
	Hypoglycemia	11	44.0	3	12.0
	Hyperglycemia	25	100.0	24	96.0
	Infections	2	8.0	0	0.0
	Lack of concentration	17	68.0	10	40.0

SD: Standard deviation # More than one answer

**Table 3: Presents comparison between SM and children's yoga exercises groups regarding means of fasting blood glucose level before breakfast.**

Level of fasting blood glucose before breakfast	SM (n = 25) (Study I)		children's yoga exercises (n = 25) (Study II)		F1 <sub>p2</sub>
	Mean ± SD.	Mean ± SD.	Mean ± SD.	Mean ± SD.	
4 day	<b>1<sup>st</sup> Session</b>	<b>2<sup>nd</sup> Session</b>	<b>1<sup>st</sup> Session</b>	<b>2<sup>nd</sup> Session</b>	0.028*
	195.8 ±80.52	166.5 ±42.62	136.56 ±15.84	142.16 ±26.30	
8 day	<b>3<sup>rd</sup> Session</b>	<b>4<sup>th</sup> Session</b>	<b>3<sup>rd</sup> Session</b>	<b>4<sup>th</sup> Session</b>	0.057
	154.2 ±49.73	154.8 ±47.20	137.96 ±17.78	129.64 ±30.15	
12 day	<b>5<sup>th</sup> Session</b>	<b>6<sup>th</sup> Session</b>	<b>5<sup>th</sup> Session</b>	<b>6<sup>th</sup> Session</b>	0.442
	152.44 ±47.80	135.48 ±44.73	138.52 ±22.64	147.44 ±23.33	
16 day	<b>7<sup>th</sup> Session</b>	<b>8<sup>th</sup> Session</b>	<b>7<sup>th</sup> Session</b>	<b>8<sup>th</sup> Session</b>	0.995
	146.92 ±47.41	139.92 ±43.25	142.80 ±17.58	140.88 ±19.52	
20 day	<b>9<sup>th</sup> Session</b>	<b>10<sup>th</sup> Session</b>	<b>9<sup>th</sup> Session</b>	<b>10<sup>th</sup> Session</b>	0.442
	133.44 ±51.68	132.20 ±37.40	144.36 ±12.48	142.24 ±17.92	
24 day	<b>11<sup>th</sup> Session</b>	<b>12<sup>th</sup> Session</b>	<b>11<sup>th</sup> Session</b>	<b>12<sup>th</sup> Session</b>	0.102
	142.0 ±53.75	123.48 ±29.92	145.96 ±22.47	139.32 ±21.28	
28 day	<b>13<sup>th</sup> Session</b>	<b>14<sup>th</sup> Session</b>	<b>13<sup>th</sup> Session</b>	<b>14<sup>th</sup> Session</b>	0.078
	130.96 ±28.34	121.64 ±28.45	139.16 ±14.16	138.48 ±15.23	
32 day	<b>15<sup>th</sup> Session</b>	<b>16<sup>th</sup> Session</b>	<b>15<sup>th</sup> Session</b>	<b>16<sup>th</sup> Session</b>	0.036*
	120.68 ±25.59	126.72 ±20.69	143.60 ±18.44	144.60 ±19.15	
36 day	<b>17<sup>th</sup> Session</b>	<b>18<sup>th</sup> Session</b>	<b>17<sup>th</sup> Session</b>	<b>18<sup>th</sup> Session</b>	0.003*
	123.96 ±22.77	117.40 ±24.52	138.88 ±19.18	138.28 ±14.95	
40 day	<b>19<sup>th</sup> Session</b>	<b>20<sup>th</sup> Session</b>	<b>19<sup>th</sup> Session</b>	<b>20<sup>th</sup> Session</b>	0.002*
	117.76 ±19.99	115.32 ±22.88	137.56 ±14.41	137.48 ±15.27	
44 day	<b>21<sup>th</sup> Session</b>	<b>22<sup>th</sup> Session</b>	<b>21<sup>th</sup> Session</b>	<b>22<sup>th</sup> Session</b>	0.073
	121.48 ±26.10	116.60 ±14.89	136.88 ±15.78	132.60 ±12.60	
48 day	<b>23<sup>th</sup> Session</b>	<b>24<sup>th</sup> Session</b>	<b>23<sup>th</sup> Session</b>	<b>24<sup>th</sup> Session</b>	0.001*
	106.60 ±18.26	106.28 ±15.43	135.20 ±14.05	133.28 ±11.05	
F2 <sub>p1</sub>	<0.001*		<0.001*		

SD: Standard deviation

F1: F for One way ANOVA test, Pairwise comparison bet. each 2 groups was done using **Post Hoc Test, (Tukey)**

F2: F test (ANOVA) with repeated measures, Sig. bet. periods was done using **Post Hoc Test (adjusted Bonferroni)**

p2: p value for comparing between SM and Yoga groups in second session

p1: p value for comparing between the studied weeks in each session in each group\*: Statistically significant at p ≤ 0.05

The mean of fasting blood glucose level of the children's yoga exercises group at the end of the 48 days was lower than that at the end of the first week

(142.16 ± 26.30). Comparison between SM and Yoga groups related to means of random blood sugar level before and after each session is highlighted in Table (4).

**Table 4: Comparison between Swedish massage and children's yoga exercises groups related to means of random blood sugar level before and after each session.**

Random blood sugar	SM (n = 25) (Study I)				Yoga (n = 25) (Study II)				F1 <sub>p2</sub>
	Before	After	Before	After	Before	After	Before	After	
	Mean ±SD.								
4 day	<b>1<sup>st</sup> Session</b>		<b>2<sup>nd</sup> Session</b>		<b>1<sup>st</sup> Session</b>		<b>2<sup>nd</sup> Session</b>		0.084
	264.7 ± 82.01	243.2 ± 71.21	227.1 ± 59.17	213.5 ± 59.15	248.52 ± 35.54	240.76 ± 34.35	253.60 ± 34.63	242.32 ± 31.33	
8 day	<b>3<sup>rd</sup> Session</b>		<b>4<sup>th</sup> Session</b>		<b>3<sup>rd</sup> Session</b>		<b>4<sup>th</sup> Session</b>		<0.001*
	202.20 ± 51.50	182.0 ± 43.10	203.40 ± 43.83	183.60 ± 37.79	246.80 ± 27.58	236.44 ± 32.37	248.84 ± 24.40	238.36 ± 27.82	

12 day	5 <sup>th</sup> Session		6 <sup>th</sup> Session		5 <sup>th</sup> Session		6 <sup>th</sup> Session		<0.001*
	212.32 ± 47.28	188.0 ± 48.66	213.08 ± 40.29	188.04 ± 35.38	244.04 ± 29.14	231.76 ± 31.33	248.52 ± 26.12	237.12 ± 26.14	
16 day	7 <sup>th</sup> Session		8 <sup>th</sup> Session		7 <sup>th</sup> Session		8 <sup>th</sup> Session		<0.001*
	208.72 ± 32.0	181.96 ± 28.60	206.28 ± 39.28	179.20 ± 37.40	246.88 ± 18.84	238.04 ± 19.39	247.24 ± 18.32	236.72 ± 19.24	
20 day	9 <sup>th</sup> Session		10 <sup>th</sup> Session		9 <sup>th</sup> Session		10 <sup>th</sup> Session		<0.001*
	198.96 ± 50.11	171.84 ± 43.29	207.96 ± 47.89	180.12 ± 45.18	240.0 ± 24.09	232.84 ± 23.20	238.80 ± 19.89	229.28 ± 20.82	
24 day	11 <sup>th</sup> Session		12 <sup>th</sup> Session		11 <sup>th</sup> Session		12 <sup>th</sup> Session		<0.001*
	208.44 ± 35.92	177.0 ± 29.88	209.0 ± 46.80	180.08 ± 41.07	241.52 ± 19.88	232.32 ± 19.73	240.20 ± 21.14	229.76 ± 21.18	
28 day	13 <sup>th</sup> Session		14 <sup>th</sup> Session		13 <sup>th</sup> Session		14 <sup>th</sup> Session		<0.001*
	210.68 ± 37.40	179.24 ± 33.81	217.72 ± 28.43	183.80 ± 23.06	237.56 ± 23.97	226.16 ± 25.29	238.08 ± 21.17	229.44 ± 21.99	
32 day	15 <sup>th</sup> Session		16 <sup>th</sup> Session		15 <sup>th</sup> Session		16 <sup>th</sup> Session		0.001*
	202.36 ± 29.28	173.12 ± 24.42	208.40 ± 42.09	178.12 ± 41.93	242.12 ± 24.59	232.44 ± 25.79	234.32 ± 25.02	224.68 ± 26.73	
36 day	17 <sup>th</sup> Session		18 <sup>th</sup> Session		17 <sup>th</sup> Session		18 <sup>th</sup> Session		<0.001*
	196.88 ± 34.70	167.52 ± 33.37	209.32 ± 17.52	174.36 ± 19.66	239.56 ± 21.06	229.84 ± 20.95	238.60 ± 22.33	228.48 ± 24.02	
40 day	19 <sup>th</sup> Session		20 <sup>th</sup> Session		19 <sup>th</sup> Session		20 <sup>th</sup> Session		<0.001*
	192.24 ± 38.56	158.44 ± 33.58	196.32 ± 21.59	165.40 ± 18.45	243.44 ± 23.74	232.16 ± 22.51	244.0 ± 22.04	235.40 ± 22.29	
44 day	21 <sup>th</sup> Session		22 <sup>th</sup> Session		21 <sup>th</sup> Session		22 <sup>th</sup> Session		<0.001*
	187.64 ± 29.50	157.84 ± 27.69	195.04 ± 26.22	156.40 ± 25.99	239.96 ± 20.05	228.64 ± 20.44	254.48 ± 65.91	231.40 ± 22.66	
48 day	23 <sup>th</sup> Session		24 <sup>th</sup> Session		23 <sup>th</sup> Session		24 <sup>th</sup> Session		<0.001*
	189.48 ± 20.35	151.32 ± 18.90	189.64 ± 19.28	150.08 ± 19.72	240.60 ± 21.46	228.92 ± 20.52	238.60 ± 23.11	218.72 ± 46.59	
F2 <sub>p1</sub>	<0.001*				<0.001*				

**F1:** F for One way ANOVA test, Pairwise comparison bet. each 2 groups was done using Post Hoc Test, (Tukey)  
**F2:** F test (ANOVA) with repeated measures, Sig. bet. periods was done using Post Hoc Test (adjusted Bonferroni)  
 P2: p value for comparing between SM and Yoga groups in second session (after)  
 p1: p value for comparing between the studied weeks in each session in each group  
 \*: Statistically significant at p ≤ 0.05

Table (5) shows comparison between SM and children’s yoga exercises groups regarding means of HbA1c.

*Table 5: Comparison between Swedish massage and yoga groups regarding means of glycosylated haemoglobin level (HbA1c).*

Glycosylated Haemoglobin (HbA1c)	SM (n = 25) (StudyI)	Yoga (n = 25) (Study II)	F1 <sub>p</sub>
Value at the beginning of the first week of the study	9.74 ± 1.11	9.74 ± 1.12	1.000
Mean ± SD.			
Value at the end of 48 days of the study	7.88 ± 0.92	9.08 ± 1.08	0.007*
Mean ± SD			
F2 <sub>p0</sub>	<0.001*	<0.001*	

**F1:** F for One way ANOVA test, Pairwise comparison bet. each 2 groups was done using Post Hoc Test, (Tukey)  
**F2:** F test (ANOVA) with repeated measures, Sig. bet. periods was done using Post Hoc Test (adjusted Bonferroni)  
 p: p value for comparing between the studied groups  
 p0: p value for comparing between beginning and end value  
 \*: Statistically significant at p ≤ 0.05

**4. DISCUSSION**

Diabetes mellitus is the most common chronic metabolic disease in childhood. Children with T1DM more frequently experience stress compared with

other children. Stress response activates sympathetic nervous system that may enhance cortisol release, increase insulin resistance and elevate blood glucose level (Nygren, 2015). So, it is important to apply complementary medicine as Swedish massage and

Yoga techniques, which helped in relieving stress in addition to routine care of diabetic children as, insulin injection, diet management, and exercise. (Anna et al., 2018). The findings of the current study revealed that children who practiced yoga exercises demonstrated significant improvements in fasting blood glucose, random blood glucose, and HbA1c levels. These improvements may be attributed to the calming effect of yoga postures, enhancement of parasympathetic activity, and reduction of stress-related hormonal responses. In addition to these approaches, children's yoga exercises such as Yoga have recently been recognized as effective complementary interventions for stress reduction in children with chronic illnesses. Yoga promotes autonomic balance by decreasing sympathetic nervous system activity and enhancing parasympathetic tone, which may positively influence glycemic regulation in children with T1DM. The present study results showed that means of fasting blood glucose level (Table 3), random blood glucose level (Table 4) and HbA1c blood glucose level (Table 5) for SM and Yoga at the end of 48 days were less than those at the end of first week. The difference was highly statistically significant. Children who practiced children's yoga exercises demonstrated significant reductions in fasting blood glucose, random blood glucose, and HbA1c levels by the end of the intervention period, indicating the effectiveness of yoga exercises as a stress-modulating and metabolic-regulating technique. Field (2019) supported the present study as he reported that implementing massage was more effective to children and adolescents with chronic diseases such as T1DM. The blood glucose levels were significantly lower in the SM group by the end of the three months period of application of massage. Talakoub et al. (2010) results were congruent with the current study. He reported that application of PMR in children was more effective in decreasing blood glucose levels at the end of the study period. The observed improvement in the yoga exercises group may be explained by the physiological effects of controlled slow breathing, which reduces hypothalamic-pituitary-adrenal (HPA) axis activation and lowers cortisol secretion, thereby improving insulin sensitivity and glycemic control. The results related to positive effect of SM and Yoga at the end of 48 days of the study may be related to the fact that children became more relaxed at the end of the study than at the beginning. They became more familiar with techniques. Likewise, children practicing Yoga became more comfortable and proficient with the breathing technique over time, which may have

enhanced its relaxation effect and contributed to sustained reductions in blood glucose levels. The findings related to positive effect of SM and Yoga on blood glucose levels could be explained in the light of the fact that SM and Yoga techniques stimulate hypothalamus to decrease action of sympathetic nervous system and increase action of parasympathetic. Children's yoga exercises share a similar mechanism by directly influencing respiratory cardiac coupling and increasing vagal activity, leading to reduced secretion of stress hormones such as cortisol and glucagon, which play a major role in elevating blood glucose levels. Moreover, these results may contribute to the role of mothers in children's life. Parental involvement may have also supported adherence to yoga exercises sessions, as children felt encouraged and motivated to practice the technique regularly, thereby enhancing its therapeutic effect. Although SM and Yoga techniques had positive effect in reducing blood glucose levels. Swedish massage technique was more effective than Yoga technique in reducing blood glucose level in diabetic children. Although Swedish massage showed superior effects compared to yoga exercises, Yoga demonstrated meaningful clinical benefits as a self-regulated, non-touch-based intervention that can be easily practiced by children with minimal supervision. These results could be contributed to that the researcher in SM technique had active role in touching children, while Yoga technique the researcher just gave instructions. In contrast, yoga exercises require active participation and self-awareness from the child, which may be challenging for some children in this age group but also provides an opportunity for developing self-regulation skills and long-term stress management strategies. From the ongoing discussion, it can be noted that integrating complementary medicines as Swedish massage and yoga techniques to routine nursing care are considered one of the nursing priorities for diabetic children. Accordingly, integrating children's yoga exercises such as Yoga into routine nursing care can be considered a valuable complementary approach that supports both physiological and psychological well-being in children with T1DM.

## 5. CONCLUSION

Based upon the findings of the current study, diabetic children who received SM or Yoga techniques had positive effects on reducing blood glucose levels (fasting, random and consequently HbA1c). There were highly statistically significant differences at the end of 48 days of the study in SM

and Yoga groups related to blood glucose level. Based upon the findings of the current study, diabetic children who received Swedish massage or children's yoga exercises showed significant improvement in blood glucose levels, including fasting blood glucose, random blood glucose, and glycosylated hemoglobin (HbA1c). There were highly statistically significant differences at the end of the 48 days of the study in both intervention groups. Diabetic children who were subjected to

Swedish massage had more positive effect in decreasing blood glucose levels (fasting, random and consequently HbA1c) than children's yoga proved to be a safe, feasible, and beneficial complementary intervention that can be integrated into routine nursing care to support glycemic control and psychological well-being in diabetic children. Also, yoga offers a valuable, non-invasive, and self-regulating intervention that encourages body awareness and long-term stress management skills in children.

### Authorship contribution statement

Amira Ezzat Mohamed Abd ElHay, Nesma EM. Barakat, Mohamed S.Zidan ,Amira H. Mohammed, Ashwaq Alqahtani, and Abeer M. Yousef participated in study conception, design & manuscript preparation and revised the article. Amira Ezzat Mohamed Abd ElHay and Nesma EM. Barakat carried out experiments. Amira H. Mohammed, Ashwaq Alqahtani, and Abeer M. Yousef played a key role in drafting the manuscript. Amira Ezzat Mohamed Abd ElHay, Mohamed S.Zidan and Abeer M. Yousef participated in data analysis and interpretation and revised the manuscript. The final manuscript has been reviewed and endorsed by all authors.

### Research ethics approval

The study was approved by the institution's Research Ethics Committee Al-Zaytoonah University of Jordan. Its number (IRB# 8/1/2025-2026).

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