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RESEARCH ARTICLE

PHYSICAL FITNESS RESPONSE OF WII TRAINING IN EGYPTIAN CHILDREN WITH T1DM

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Abstract

Background:- Type 1 (insulin-dependent) diabetes mellitus (T1DM) is a form of diabetes caused by autoimmune damage of insulin-producing beta cells of the pancreas which leads to hyperglycemia. It often occurs in childhood.

Methods:- Thirty Egyptian children suffering from T1DM participated in this study. Their age ranged from 11 to 15 years. Glycosylated hemoglobin, blood glucose (fasting and postprandial), insulin intake and Physical Fitness Index were measured before and after Wii aerobic training. The Wii aerobic training was conducted for 30 minutes, 3 times per week for 12 weeks.

Results:- Comparing the pre and post treatment mean values of the measured variables revealed significant improvement in the blood glucose levels and Physical Fitness Index after the Wii training.

Conclusion:- It may be concluded that the Wii game training was effective in the treatment of T1DM.

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Introduction:-

Type 1 (insulin-dependent) diabetes mellitus (T1DM) is a form of diabetes caused by autoimmune damage of insulin-producing beta cells of the pancreas which leads to hyperglycemia (random blood glucose concentration more than 200mg/dL)^{1, 2}. It often occurs in childhood¹. It usually starts in children aged 4 years or older, with the highest prevalence of beginning at age 11-13 years, matching with early adolescence and puberty³. The incidence of T1DM in the Egyptian children is one per 1000⁴.

The most common symptoms of T1DM are polyuria, polydipsia, and polyphagia, along with lassitude, nausea, and blurred vision which are resulting from the hyperglycemia⁵. The most cases of T1DM caused by environmental factors the interacted with a genetically susceptible person⁶. These environmental factors includes viral infection (e.g. mumps and rubella), exposure to toxic chemicals, Dietary factors (e.g. cow's milk in infancy) and cytotoxins^{6,7}. Type 1DM is associated with microvascular and macrovascular complications³. It is managed by insulin injection, diet control and physical activity which reduce the prevalence of these complications^{1,3}.

A basal insulin concentration is needed corrections for hyperglycemia throughout the day. Parameters such as physical activity, illness and stress levels are necessary to monitored to detect the appropriate insulin dosage⁹. Diet control aids to avoid unbalanced and irregular carbohydrate intake. Physical activities e.g. sports, aerobic and strength exercises has beneficial effects on quality of life, endurance capacity, body composition, bone mineral

density, lipid profile – fraction of ‘good’ (HDL-C) and ‘bad’ cholesterol (LDL-C), tissue insulin sensitivity – insulin receptor efficiency and glycemic control¹.

Virtual reality (VR) is a technology that provides a sense of presence in a real environment with the help of 3D pictures and animations formed in a computer environment and enable the person to interact with the objects in that environment.

Its use in physiotherapy and rehabilitation has increased significantly in the last 6-7 years¹⁰. Wii training is a feasible and enjoyable intervention for children as VR technology¹¹. It is significantly useful for children with developmental delay¹¹, cerebral palsy¹², down syndrome^{13,14}. But its effects on the diabetic children not investigated yet. So our study aims to determine the effect of Wii training on blood glucose level, insulin dose reduction, glycosylated hemoglobin and physical fitness in children with type 1 diabetes mellitus.

Children, instrumentations and procedures:-

Children:-

Thirty Egyptian children from both sexes (11 males, 19 females) suffering from T1DM participated in this study. Their age ranged from 11 to 15 years old with mean age 12.87 ± 1.28 years. This study was conducted in the period from November 2014 to September 2015. They were recruited from the endocrine unit in Abo-Elrish Pediatric Hospital according to the following criteria: Inclusive criteria for children selection: 1) their body mass index (BMI) ranged from 18.5 to 24.9 kg/ m²¹⁵, 2) the chronicity of the disease ranged between 3 to 5 years, 3) they were controlled by the same insulin therapy, 4) they were following diet control as regimen directed by dietitian. Exclusive criteria for children selection: 1) children with other hormonal diseases, 2) hereditary sensory and autonomic neuropathy, 3) cardiac, neurological, orthopedics problems and any other diseases may affect the research e.g. chest diseases, 4) dropped out through the study more than three sessions were excluded.

The study was approved by an Ethics Committee of the Cairo University. Child's parents were provided with a Volunteer Information Sheet and written consent informing them about the purpose of the study, its benefits and inherent risks and their committee with regard to time and money.

Instrumentations:-

For evaluation:

- ❖ Laboratory kits were used for blood glucose and glycosylated hemoglobin.
- ❖ ADVIA 120 (By Bayer): it is a computerized device used for detection of blood glucose.
- ❖ RA-50 (By Bayer): it is a computerized device used for detection of Glycosylated hemoglobin.
- ❖ Weight and height scale.
- ❖ Recording sheet for insulin dosage.
- ❖ A 51 cm high bench and stop watch to detect Physical Fitness Index (PFI)^{17, 18}.

For Treatment:-

- ❖ Ninten do Wii FitTM was conducted to all children who participated in this study. It provided games focused on the aerobics training.

Procedure:-

Before evaluation, the purposes and procedures were fully explained to the children's parents. All the children were tested before and after Wii training program. The Wii training programme was conducted for 30 minutes, 3 times per week for 12 weeks. Each child was evaluated and tested individually following the standard protocol.

General guidelines that may regulate the glycemic response to exercise should be considered during Wii training¹⁹. It can be summarized in table (1).

For evaluation:-

Consent form was taken from parents. Evaluation sheet for children personal, past, present history and recording measurements was taken.

The tape measurement was installed on the wall by using pins. The height of the child was determined as the vertical distance between the floor and the top of the head and measured with the child standing erect against the wall and looking straight ahead¹⁶. Then the child was asked to stand on a weight scale to determine his weight in kilograms.

The BMI was calculated as the ratio of the subject's height (in meter) and weight (in kilogram) i.e. weight/ height². The normal child's BMI value should range from 18.5 to 24.9 kg/ m²¹⁵.

Table 1:- General guidelines that may regulate the glycemic response to exercise.

Metabolic control before physical activity.
Avoid exercise if fasting glucose levels are >250 mg/dl and ketosis is present, and use caution if glucose levels are >300 mg/dl and no ketosis is present.
Ingest added carbohydrate if glucose levels are <100 mg/dl.
Blood glucose monitoring before and after physical activity.
Identify when changes in insulin or food intake are necessary.
Learn the glycemic response to different exercise conditions.
Food intake.
Consume added carbohydrate as needed to avoid hypoglycemia.
Carbohydrate-based foods should be readily available during and after exercise.

Laboratory studies were measured pre and post treatment course included: glycosylated hemoglobin, blood glucose (fasting and postprandial) and insulin intake. The normal values for laboratory variables were summarized in table (2).

Table 2:- The normal values for laboratory variables.

Variables	Normal value
HbA1c	4.2% - 6.2%.
FBG	70 - 100 mg/dl.
PPBG	70- 145 mg/dl

Physical Fitness Index (PFI) was measured pre and post treatment course for each child. PFI was calculated by measuring heart rate after performing Harvard step test (HST) which is a common method used to assess cardio - respiratory fitness. It is based on the heart rate recovery following a given work load of 5 minutes. The subject was instructed to step up and down on a 51 cm high bench for 5 minutes or up to exhaustion. Exhaustion is defined as the time when the subject cannot maintain the stepping rate for 15 seconds when the rate of stepping is set at 30 cycles per minute. Each cycle constituted 1step up and 1 step down. Immediately at the end of this protocol, the subject was asked to sit down. The pulse was counted between 1 to 1.5 minutes, 2 to 2.5 minutes and 3 to 3.5minutes. Physical Fitness Index (PFI) was calculated as follows^{17, 18}:

$$PFI = \frac{\text{Duration of exercise in secs} \times 100}{2(\text{pulse 1} + 2 + 3)}$$

For treatment:-

In each training session, the child played aerobics games such Hula Hoop, Basic Step, Basic Run, Super Hula Hoop, Advanced Step, 2-P Run, Rhythm Boxing, Free Step and Free Run based on the interest of the child. Each training session was supervised by a therapist from one of the clinical sites¹¹.

Statistical analysis:-

The mean and the standard deviation will be calculated for each variable. Paired t-test (Mean of difference between each pairs of scores) would be done for each variable to compare the pre and post treatment measures. We used level of significance 0.05.

Results:-

Comparing the pre and post treatment mean values of insulin basal (IB) and insulin regular (IR) was revealed significant improvement as (p<0.05), table (3). Comparing the pre and post treatment mean values of glycosylated hemoglobin (HbA1c), fasting blood glucose (FBG) and postprandial blood glucose (PPBG) was also revealed significant improvement as (p<0.05), table (3). Comparing the pre and post treatment mean values of Physical Fitness Index (PFI) was revealed significant improvement as (p<0.05), table (3).

Table 3:- Pre and post treatment values of measurements variables.

Variables	Mean \pm SD		Mean difference	Percentage of improvement
	Pre	Post		
HbA1c	7.87 \pm 1.13	6.91 \pm 0.96	0.96	12.2%*
IB	20.70 \pm 4.63	19.23 \pm 4.28	1.47	7.10%
IR	26.80 \pm 5.96	25.23 \pm 5.51	1.57	5.86%
FBG	163.50 \pm 29.43	143.53 \pm 24.17	19.97	12.21%*
PPBG	205.17 \pm 32.93	175.00 \pm 28.88	30.17	14.70%*
PFI	44.73 \pm 3.14	56.63 \pm 4.13	11.90	26.6 0%*

HbA1c: glycosylated hemoglobin.

IB: insulin basal.

IR: insulin regular.

FBG: fasting blood glucose.

PPBG : postprandial blood glucose.

PFI: Physical Fitness Index.

*: Significant.

Discussion:-

This study was conducted to determine the effect of Wii training on blood glucose level, insulin dose reduction, glycosylated hemoglobin and physical fitness in children with type 1 diabetes mellitus. Their age ranged from 11 up to 15 years old. Of the thirty patients included in the study, 63.3% were males and 36.7% were females. As puberty period may reflect changes on participants so all patients were chosen at puberty period and their ages were not exceed 15 years old as the patient should be controlled without developing complications.

The results of this study showed a significant decrease between pre and post treatment glycosylated hemoglobin mean values. This reduction was related to several benefits of aerobic exercise on glucose metabolism, increased glucose uptake at the cellular level in skeletal muscle, increased muscle glucose transporters (GLUT4) content, improved insulin sensitivity, which all appears to be associated to reduce glycemic levels and make better glucose control. This confirmed with previous studies conducted for evaluation of different aerobic exercise regimens effect on glycosylated hemoglobin and proved that aerobic exercise enhance glycemic control^{20,21,22,23}.

The result of this study concerning insulin intake dosages (regular and basal) indicated that there was no significant difference in the between pretreatments and post treatment values of insulin intake (regular and basal). The percent of insulin intake dosages reduction may be due to improved insulin sensitivity in response to aerobic exercise which is related to muscle mass development, effectively increasing glucose storage, facilitating glucose clearance from the circulation, and reducing the amount of insulin required to maintain a normal glucose tolerance. The non-significant reduction of insulin intake disagreed to the study conducted by Riddell and Perkins (2006) that had evaluated the applications of exercise physiology for management of patient with T1DM and proved reduction of insulin requirement in response to aerobic exercise due to increased whole-body insulin sensitivity²⁴.

Regarding blood glucose levels “Fasting Blood Glucose (FBG) and Post Prandial Blood Glucose (PPBG)”, there were significant reduction between the pretreatment mean values. These significant reductions of FBG and PPBG may be due to the greater uptake of skeletal muscle glucose during aerobic metabolism in order to generate energy for muscle contraction, which suppresses hepatic gluconeogenesis and thus promotes a decrease in blood glucose levels^{24, 25, 26, 27}.

The results of this study also showed a significant increase between pre and post treatment Physical Fitness Index (PFI) mean values. The aerobic capacity improvement could be represented by heart volume and muscle mass improvements after training²⁸. It can be assessed by maximal oxygen uptake or Physical Fitness Index (PFI)²⁹. Aerobic exercise activities promote energy expenditure, increase lipid oxidation and increase insulin sensitivity²⁸.

Finally, we proved that aerobic Wii training had positive significant changes on children with type 1 diabetes mellitus. Wii games training provide active participation from the children in a fun, enjoyable and paly environment.

Conclusion:-

It may be concluded that Wii training is effective in children with type 1 diabetes mellitus. It had significant improvements on blood glucose level, glycosylated hemoglobin, insulin dose, and physical fitness.

Declaration of interest:- The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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