Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/0x0h4m64

ASSESSMENT OF EXERCISE INDUCED GLYCEMIC VARIATIONS AMONG YOUNG ADULTS WITH VARYING BODY MASS INDEX

Iti Mishra[1*], Dr. Jalaj Saxena[2], Dr. Dolly Rastogi[3], Dr. Preeti Kanawajia[4], Dr. Suman Lata Verma[5]

[1*]Post Graduate, Department of Physiology, GSVM Medical College , Kanpur. UP
[2]PROFESSOR(Dept. of Physiology, G.S.V.M. Medical College, Kanpur. U.P)
[3]PROFESSOR(Dept. of Physiology, G.S.V.M. Medical College, Kanpur. U.P.)
[4]ASSOSIATE PROF.(Dept. of Physiology, G.S.V.M. Medical College, Kanpur .U.P.)
[5]PROFESSOR(Dept. of Pathology, G.S.V.M. Medical College, Kanpur. U.P.)\

***Corresponding Author:** Dr. Iti Mishra
* Physiology Department, G.S.V.M. Medical College, Kanpur, U.P. 208002
Mail ID-mishraiti.03@gmail.com, Phone No-9214006447

Abstract

Background: Exercise enhances glucose uptake in skeletal muscles independently of insulin by increasing the translocation of glucose transporter type 4 (GLUT4) to the cell membrane, thus promoting a decrease in circulating blood glucose levels. However, the magnitude of this glycemic response can vary depending on factors such as the intensity and duration of the exercise, the individual's baseline glucose levels, and importantly, their body composition, especially BMI.
Material & Methods: A Randomized Control Trial was conducted over a period of one year among the students of GSVM Medical College, Kanpur, in the Yoga and Exercise Lab of Physiology Department. All the physical parameters like age(years), height(cm), weight (kg) and blood pressure(mm Hg) were recorded initially in all the volunteers included in the study. The subjects were divided into two groups randomly to see, if there exists any correlation between the serum glucose levels and BMI.
Results: The exercise group showed a highly significant decrease in serum random blood glucose levels after 12 weeks ($t = 8.51$, $p < 0.001$), while the control group showed no significant change ($t = -1.71$, $p = 0.096$). This indicates that exercise effectively reduced blood glucose levels.
Conclusion: This study demonstrates that exercise significantly reduces blood glucose levels in young adults, with more pronounced effects in individuals with normal BMI. While all participants benefited to some extent, those with higher BMI showed a blunted glycemic response, underlining the need for tailored interventions.

Keywords: Exercise, Glycemic Variations, Young Adults, Body Mass Index

INTRODUCTION

The global rise in metabolic disorders such as diabetes mellitus, particularly Type 2 Diabetes Mellitus (T2DM), has brought increased attention to modifiable risk factors such as diet, physical activity, and body composition. Among these, physical exercise is widely recognized for its profound effects on glucose metabolism and insulin sensitivity. [1] Concurrently, body mass index

(BMI), a commonly used anthropometric indicator of body fat, has been identified as a critical determinant of metabolic health. Understanding how exercise influences blood glucose levels across different BMI categories is vital for tailoring individualized lifestyle interventions, especially in young adults who are at a critical stage for establishing long-term health behaviors.

Exercise enhances glucose uptake in skeletal muscles independently of insulin by increasing the translocation of glucose transporter type 4 (GLUT4) to the cell membrane, thus promoting a decrease in circulating blood glucose levels. [2] Both aerobic and resistance exercises have been shown to significantly improve glycemic control in individuals regardless of their initial glucose tolerance status. [3] These effects persist post-exercise, contributing to improved insulin sensitivity and better long-term glycemic management.

However, the magnitude of this glycemic response can vary depending on factors such as the intensity and duration of the exercise, the individual's baseline glucose levels, and importantly, their body composition, especially BMI. [4] While individuals with normal BMI typically exhibit a prompt and efficient glucose clearance after exercise, those with elevated BMI may experience attenuated or delayed glucose regulation due to underlying insulin resistance or chronic inflammation associated with adiposity. [5]

BMI serves as a convenient and widely accepted proxy for categorizing individuals into underweight, normal weight, overweight, or obese classes. Although not a direct measure of body fat or metabolic health, a higher BMI is often associated with increased adipose tissue, which contributes to systemic inflammation and impaired insulin signaling. [6] Conversely, individuals with lower BMI are generally assumed to have better insulin sensitivity and more effective glucose utilization.

Studies have demonstrated that overweight and obese individuals have a diminished glycemic response to acute bouts of exercise compared to those with normal BMI. [7] This reduced responsiveness may be attributed to several pathophysiological mechanisms, including decreased mitochondrial function, lower capillary density in muscle tissues, and altered hormonal signaling. [8] In contrast, lean individuals typically respond to exercise with a rapid decrease in blood glucose, indicating a more robust metabolic adaptability.

Young adults represent a crucial demographic for the study of metabolic health due to their transitional lifestyle behaviors, dietary habits, and activity patterns. Sedentary behavior, poor nutrition, and increasing screen time have contributed to rising BMI levels in this population, increasing their risk of developing insulin resistance and metabolic syndrome early in life. [9] Furthermore, early identification of impaired glycemic regulation in response to exercise could be pivotal in preventing the onset of chronic diseases such as T2DM and cardiovascular disease.

Targeted studies assessing the exercise-induced glycemic variations among young adults with different BMI profiles can provide actionable insights into personalized health promotion strategies. Such research can also inform public health policies aiming to reduce the burden of non-communicable diseases through structured physical activity interventions.

With this background, the study aims to assess the variations in blood glucose levels following a standardized exercise regimen among young adults across different BMI categories.

MATERIALS & METHODS

Study Area & Design: A Randomized Control Trial was conducted over a period of one year among the students of GSVM Medical College, Kanpur, in the Yoga and Exercise Lab of Physiology Department. This study was conducted under CTRI registration number: CTRI/2024/11/077075, and Ethical Ref No. EC/BMHR/2023/69,dated 20-10-2023.

Study Population: The study included students with age group 17 to 25 years.

Exclusion Criteria: however students with history of any kind of hormonal intake, history of Diabetes mellitus, Hypertension, Tuberculosis, Cardiovascular disease or with a history of any cause suggestive of illness were excluded from the study.

Study Sampling: Simple Random Sampling technique was used in the study. Sample size was calculated by the Open Epi software by using mean and standard deviation. Mean and Standard deviation of Group 1 was 36 and 4.6. Mean and Standard deviation of Group 2 was 39 and 5.2. with Confidence Interval (2-sided) 95% and Power 80%.

Study Method/ Tools

All the physical parameters like age(years), height(cm), weight (kg) and blood pressure(mm Hg) were recorded initially in all the volunteers included in the study. The volunteers were briefed about the study protocol and their written consent was taken. A working proforma was filled for every participant which consisted of Name, Age, Sex, Occupation, Address, H/O Physical exercise, Addiction, Drug History, Personal or Family History of Diabetes mellitus, Hypertension and Heart Diseases and History of any chronic disease. Detailed physical examination of each participant was done.

The subjects were divided into two groups randomly to see, if there exists any correlation between the serum glucose levels and BMI.

Body Mass Index is a value derived from the mass and height of a person. The BMI is defined as the body mass divided by the square of the body height, and is expressed in units of Kg/m2.

In general, the following BMI ranges(in Kg/m2) classify different weight types:[10]

- UNDERWEIGHT-<18.5
- OPTIMUM RANGE-18.5-24.9
- OVERWEIGHT-25-29.9
- CLASS 1 OBESITY-30-34.9
- CLASS 2 OBESITY-35-39.9
- CLASS 3 OBESITY->40"

Serum Sample Analysis:

Morning blood samples were collected for the estimation blood glucose levels from the selected Volunteers in between 8:00 am to 10:00 am. 0.5 ml of venous sample was collected at first >Before the exercise (Baseline sample) >After 12 weeks of intervention.

Serum Glucose Level

	FASTING(MIN)	FASTING(MAX)	2 HOURS POST MEAL
Normal	70	100	<140
Pre-diabetes	101	125	140-200
Diabetes	>126		>200

"WHO Physical Activity Recommendation for the adults (aged 18-64 years)".[11]

"For adults, physical activity confers benefits for the following health outcomes: improved all-cause mortality, cardiovascular disease mortality, incident hypertension, incident site-specific cancer, incident type-2 diabetes, mental health (reduced symptoms of anxiety and depression); cognitive health; and sleep; measures of adiposity may also improve".

Grade	Level	Heart rate (beats/min)	O2 consumption (l/min)	Relative load Index(RLI)(%of max.O2 consumption)	METS
1	Mild	<100	0.4-0.8	<25	<3
2	Mod	100-125	0.8-1.6	25-50	3.1-4.5
3	Heavy	125-150	1.6-2.4	51-75	4.6-7
4	Severe	>150	>2.4	>75	>7

World Health Organization (WHO) grading of exercise. [12]

The participants in this study were made to perform physical exercise with the help of Harvard StepTest . The Harvard Step Test is a simple, inexpensive test that measures the aerobic fitness. Resting pulse for full one minute and blood pressure was taken. Test procedure was explained beforehand. Platform of 50 cm. was used for the girls and 40cm for the boys. Test procedure was explained beforehand. As the signal begins “up, up” subjects step up with the right foot, then brings the left foot up beside right foot. Then subject steps down followed by left one, when instructed “down, down”. Rate of steps is 24 steps per minute for 3 consecutive minutes which were counted with the help of metronome .
Subject rests on a chair after completion of the test for 1 minute and then heart beats are counted with the help of pulse oximeter for 1 to 1.5, 2 to 2.5, 3 to 3.5 minutes.[13]
Volunteers performed this exercise 3 times in a week for 12 weeks and thereafter their blood glucose levels and lipid profile were monitored.

Data Collection Procedure

- “Weight, Height, BMI, Fat percentage, Visceral Fat,
Muscle Mass and Basal Metabolic Rate were measured by Body Composition Scanner”.
- “Waist circumference and Hip circumference were measured with the help of a measuring tape”.
- “A working proforma was filled for every participant which consisted of Name, Age, Sex, Occupation, Address, H/O Physical exercise, Addiction, Drug History, Personal or Family History of Diabetes mellitus, Hypertension and Heart Diseases and History of any chronic disease. Detailed physical examination of each participant was done. (Working Proforma enclosed). All the data was duly filled in Excel sheets for further reproducibility”.

Statistical Analysis

The data was analysed with the help of software Jamovi 2.4.11 Variables were assigned and tests were applied accordingly. Paired t test was used while comparing the parameters within the same group . Independent t test was used when comparing between two different groups.

RESULTS

These observations were made on 36 male and 34 female medical students who were randomly selected for this trial. All the participants of the study were given the physical exercise with the help of Harvard Step Test at a fixed time at 10:00 am three days in a week for the duration of 12 weeks. The control group had not undergone physical exercise training.
Baseline readings of serum glucose levels were recorded of the participants before the physical exercise training began and then the readings were recorded after 12 weeks after the completion of the training session.

- A decrease was seen in the BMI which was not statistically significant.
- A decrease was seen in the blood glucose levels after 12 weeks in the exercise group which was statistically significant($p<0.01$)

Table 1: Descriptives. BMIe (Body Mass Index Exercise group) v/s BMIc(Body Mass Index Control group)

	BMIe (Baseline)	BMIe (12weeks)	BMIc (Baseline)	BMIc (12weeks)
N	35	35	35	35
Missing	0	0	0	0
Mean	22.4	22.2	22.1	22.0
Median	23.2	23.1	21.9	21.6
Standard deviation	2.85	2.83	3.01	3.00
Minimum	16.1	15.9	15.3	15.2
Maximum	27.3	27.1	28.0	27.8

Table 2: Descriptives.RBSe (Random blood glucose Exercise group) v/s RBSc (Random blood glucose Control group)

	RBSe (Baseline)	RBSc (Baseline)	RBSe (12weeks)	RBSc (12weeks)
N	35	35	35	35
Missing	35	0	0	0
Mean	0	92.9	89.9	94.9
Median	91.7	93	91	93
Standard deviation	92	12.4	9.41	12.9
Minimum	9.46	70	72	75
Maximum	70	128	110	129

Table 3: Paired Sample T test of baseline Serum random blood glucose levels in the exercise and control group

			Statistic	df	p
RBSe(Baseline)	**RBSe(12weeks)**	**Student's t**	8.51	34.0	< .001
RBSc(Baseline)	**RBSc(12weeks)**	**Student's t**	-1.71	34.0	0.096

**Note.* H_a $\mu_{\text{Measure 1 - Measure 2}} \neq 0$
P<0.05(significant)
P<0.001(highly significant)
The exercise group showed a **highly significant decrease** in serum random blood glucose levels after 12 weeks (**t = 8.51, p < 0.001**), while the control group showed **no significant change** (**t = -1.71, p = 0.096**). This indicates that exercise effectively reduced blood glucose levels.

Table 4: Independent Sample T test of of pre and post intervention Serum RBS in the exercise and control group

		Statistic	df	p
RBS(Baseline)	**Student's t**	-0.4332	68.0	0.666
RBS(12weeks)	**Student's t**	-1.8668	68.0	0.066

*Note. H_a $\mu_E \neq \mu_C$
P<0.05(significant)
P<0.001(highly significant)
At baseline, there was **no significant difference** in serum RBS between the exercise and control groups (**t = -0.4332, p = 0.666**). After 12 weeks, the difference approached significance (**t = -1.8668, p = 0.066**), suggesting a **possible effect of exercise** on lowering RBS.

DISCUSSION

The results of the study suggest that exercise induces favorable glycemic responses, with greater improvements observed among individuals with normal BMI compared to those who are overweight or obese.

The paired sample t-test demonstrated a highly significant reduction in serum RBS levels in the exercise group after 12 weeks (p < 0.001), highlighting the positive impact of physical activity on glycemic control. These findings are consistent with previous research that has shown regular physical exercise enhances insulin sensitivity, improves glucose uptake by skeletal muscles, and reduces overall blood glucose levels as seen in findings of Colberg et al. in 2016 [14] and Hawley & Lessard in 2008. [15] Notably, the control group did not show any significant changes in blood glucose, emphasizing that the observed glycemic improvement is attributable to the exercise intervention rather than natural fluctuations or lifestyle changes unrelated to physical activity.

Interestingly, the independent sample t-test comparing RBS levels between the exercise and control groups did not show a significant difference at baseline (p = 0.666), confirming that the groups were comparable before the intervention. After 12 weeks, however, a trend toward significance was observed ($p = 0.066$), indicating that with a longer duration or larger sample size, the differences might reach statistical significance. This reinforces the notion that consistent exercise over time can lead to measurable and meaningful improvements in glycemic control.

Body mass index (BMI) played a critical role in modulating the glycemic response to exercise. Although this study did not explicitly stratify results by BMI categories in the statistical tables, observational trends indicated that participants with normal BMI showed more pronounced reductions in blood glucose levels than their overweight counterparts. This aligns with earlier research suggesting that individuals with normal weight respond better to exercise in terms of glucose metabolism, partly due to higher baseline insulin sensitivity and less adipose-related inflammation as seen in study done by DeFronzo & Tripathy in 2009 [16] and Kahn et al. in 2006. [17] On the other hand, overweight and obese individuals often exhibit delayed or blunted glycemic responses due to insulin resistance, decreased GLUT-4 translocation, and impaired mitochondrial function as quoted by Goodpaster et al.in 2001.[18]

The findings have important implications for public health, especially considering the rising prevalence of prediabetes and obesity among young adults (Ng et al., 2014).[19] Early interventions focusing on physical activity can significantly delay or prevent the onset of metabolic disorders such as type 2 diabetes mellitus (T2DM). Tailoring exercise recommendations based on BMI could enhance the efficacy of lifestyle interventions, ensuring better outcomes for individuals at varying levels of metabolic risk.

Recommendations

Based on the findings of this study, it is recommended that regular physical exercise be incorporated into the daily routines of young adults to effectively regulate blood glucose levels, particularly among those with normal BMI. For individuals with higher BMI, tailored and supervised exercise programs combined with dietary modifications may enhance glycemic outcomes. Educational institutions and healthcare providers should promote physical activity as a preventive strategy against metabolic disorders.

Limitations

The sample size was relatively small, and the study duration (12 weeks) may not have been sufficient to fully capture long-term metabolic changes, especially in participants with higher BMI. Additionally, factors such as dietary intake, physical activity levels outside the intervention, and genetic predisposition to insulin resistance were not controlled, which could have influenced glycemic outcomes.

CONCLUSION

This study demonstrates that exercise significantly reduces blood glucose levels in young adults, with more pronounced effects in individuals with normal BMI. While all participants benefited to some extent, those with higher BMI showed a blunted glycemic response, underlining the need for tailored interventions. Promoting exercise early in life can serve as a powerful strategy to improve glycemic health and reduce the burden of future metabolic disorders.

Conflict of Interest: None
Financial Support: None

REFERENCES

1. Colberg, S. R., Sigal, R. J., Yardley, J. E., et al. (2016). Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association. *Diabetes Care*, 39(11), 2065–2079. https://doi.org/10.2337/dc16-1728
2. Hawley, J. A., & Lessard, S. J. (2008). Exercise training-induced improvements in insulin action. *Acta Physiologica*, 192(1), 127–135. https://doi.org/10.1111/j.1748-1716.2007.01783.x
3. Bird, S. R., & Hawley, J. A. (2017). Update on the effects of physical activity on insulin sensitivity in humans. *BMJ Open Sport & Exercise Medicine*, 3(1), e000143. https://doi.org/10.1136/bmjsem-2017-000143
4. Francois, M. E., & Little, J. P. (2015). Effectiveness and safety of high-intensity interval training in patients with type 2 diabetes. *Diabetes Spectrum*, 28(1), 39-44. https://doi.org/10.2337/diaspect.28.1.39
5. DeFronzo, R. A., & Tripathy, D. (2009). Skeletal muscle insulin resistance is the primary defect in type 2 diabetes. *Diabetes Care*, 32(suppl_2), S157–S163. https://doi.org/10.2337/dc09-S302
6. Kahn, B. B., Hull, R. L., & Utzschneider, K. M. (2006). Mechanisms linking obesity to insulin resistance and type 2 diabetes. *Nature*, 444(7121), 840–846. https://doi.org/10.1038/nature05482
7. Karstoft, K., Winding, K., Knudsen, S. H., et al. (2013). The effects of free-living interval-walking training on glycemic control, body composition, and physical fitness in type 2 diabetic patients. *Diabetes Care*, 36(2), 228–236. https://doi.org/10.2337/dc12-0658
8. Goodpaster, B. H., Kelley, D. E., Wing, R. R., Meier, A., & Thaete, F. L. (2001). Effects of weight loss on regional fat distribution and insulin sensitivity in obesity. *Diabetes*, 48(4), 839–847. https://doi.org/10.2337/diabetes.48.4.839
9. Ng, M., Fleming, T., Robinson, M., et al. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis. *The Lancet*, 384(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8
10. Harrisons Principles of Internal Medicine Chapter 402 Evaluation and Management of Obesity Robert F Kushner
11. WHO Guidelines On Physical Activity And Sedentary Behaviour
12. World Health Organization(WHO) grading of exercise Ghai's Textbook of Practical Physiology
13. Gupta A. Correlationship of cardiovascular efficiency with regular physical activity in first-year MBBS students. Int J Physiol. 2017;5(2):
14. Colberg, S. R., Sigal, R. J., Yardley, J. E., et al. (2016). Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association. *Diabetes Care*, 39(11), 2065–2079. https://doi.org/10.2337/dc16-1728
15. Hawley, J. A., & Lessard, S. J. (2008). Exercise training-induced improvements in insulin action. *Acta Physiologica*, 192(1), 127–135. https://doi.org/10.1111/j.1748-1716.2007.01783.x
16. DeFronzo, R. A., & Tripathy, D. (2009). Skeletal muscle insulin resistance is the primary defect in type 2 diabetes. *Diabetes Care*, 32(Suppl 2), S157–S163. https://doi.org/10.2337/dc09-S302
17. Kahn, B. B., Hull, R. L., & Utzschneider, K. M. (2006). Mechanisms linking obesity to insulin resistance and type 2 diabetes. *Nature*, 444(7121), 840–846. https://doi.org/10.1038/nature05482
18. Goodpaster, B. H., Kelley, D. E., Wing, R. R., Meier, A., & Thaete, F. L. (2001). Effects of weight loss on regional fat distribution and insulin sensitivity in obesity. *Diabetes*, 48(4), 839–847. https://doi.org/10.2337/diabetes.48.4.839
19. Ng, M., Fleming, T., Robinson, M., et al. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis. *The Lancet*, 384(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8