

Impact of Intervention on Changes in Physical Activity among Individuals with Type 2 Diabetes Mellitus

Lalnuntluangi Hnamte¹, F. Lalnunmawia², Dr. Lalnunpui³

¹Research scholar, Department of Botany, Mizoram University (A central University), Aizawl, Mizoram – 796004, India
Email: [tluangiHnamte\[at\]gmail.com](mailto:tluangiHnamte[at]gmail.com)

²Professor cum Head, Dept. of Botany, Mizoram University (A central University), Aizawl, Mizoram – 796004, India
Email: [fmawia\[at\]rediffmail.com](mailto:fmawia[at]rediffmail.com)

³Clinical Psychologist, Hope Rehabilitation Centre, Brigade Road, Aizawl, Mizoram – 796004, India

Abstract: *The present study aims to assess and compare the HbA1c level of individuals and impact of intervention on changes in physical activity among individuals with type 2 Diabetes Mellitus of Aizawl, Mizoram. A quasi - experimental design with a pre - test and post - test control group was conducted on May 2023 to September 2023 at OPD of ZMC & H, Falkawn, Mizoram with a total of 200 type 2 DM patients (100 in experimental and 100 in control group) who are not on insulin. The intervention was on a video consisting of importance of changes in physical activity and its impact on maintaining glycaemic outcome. A simple random sampling technique was used. Among all participants (N=200), a significant main effect of time was found, $F(1, 198) = 40.11$ ($p < .001$) indicating that HbA1c levels significantly changed from pre - test to post - test. A DSMQ was used to assess the impact of intervention. The mean difference between the pre - test and post - test for the control group was -0.311 ($SE = 0.16$) ($p < 0.05$) and for the experimental group it was -1.650 ($SE = 0.16$), which are both statistically significant, ($p < 0.01$). The 95% confidence interval for the mean difference ranged from -1.96 to -1.34 . Hence, the results shows that there is a large, statistically significant increase in physical activity in the experimental group as compared to the control group. The current study may be introduced to a wider setting with more interventions for a much - improved outcome for the society.*

Keywords: Insulin, glycaemic outcome, physical activity, DSMQ, HbA1c

1. Introduction

Diabetes mellitus is a group of metabolic diseases characterized by increased levels of glucose in the blood (hyperglycaemia) resulting from defects in insulin secretion, insulin action or both. Normally a certain amount of glucose circulates in the blood. The major sources of this glucose are absorption of ingested food in the gastrointestinal tract and formation of glucose by the liver from food substances. A hormone produced by the pancreas, insulin, is responsible for controlling and regulating glucose level in the body. In individuals having diabetes mellitus, the insulin production is either altered, or reduced or insufficient. Diabetes has been classified mainly as type1 and type 2 where type diabetes mellitus occurs more commonly among people who are older than 30yrs and obese. In type 2, people have decreased sensitivity to insulin (called insulin resistance) and impaired beta cell functioning resulting in decreased insulin production. In type 2 Diabetes mellitus, physical activity, diet management, self - awareness and regular compliance to treatment regimens plays a crucial role in managing the blood glucose level as well as glycaemic control. Glycaemic control is found to be linked with regular physical activity in previous studies, depending on the type of exercises practiced by the patients, irrespective of their age, gender, sedentary lifestyle etc. It was clinically proven that regular physical activity reduce chances of complications due to diabetes and prevent cardiovascular disorders. In view of this, we have adopted an interventional video on physical activity among type 2 diabetes patients and achieved profound and significant results.

2. Objectives/ Aims of the Study

The study aims to assess and compare the HbA1c result and to find the impact of interventions on changes on physical activity among individuals with type 2 diabetes mellitus

3. Methodology

For the present study, a quantitative experimental research approach was used to examine the impact of intervention among individuals with type 2 diabetes mellitus. A quasi - experimental design (pre - test post - test control group) was found to be most suitable for the research design where individuals were divided into two groups and randomly assigned to experimental and control group by using simple random sampling technique. A total of 200 type 2 diabetes patients were recruited from the outpatient department (OPD) and inpatients of ZMC & H, Falkawn. HbA1c levels were collected from medical records in the OPD and inpatients at ZMC & H, Falkawn. The data were recorded at two time points - Pre - intervention: Baseline HbA1c levels before the intervention and Post - intervention: HbA1c levels after the intervention.

After taking a written informed consent from each of the participants, they were detailed regarding the study and the HbA1c records were taken from the records and were asked to complete the Diabetes Self - Management Questionnaire (DSMQ) and self - management behaviours were assessed alongside. The experimental group received interventional video on physical activity via WhatsApp message/email (to

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patient and patient party) after an explanation of the purpose and importance of the video and their cooperation towards it. After the intervention period, HbA_{1c} levels were assessed after 3 months prior to pre - test, where the DSMQ was introduced again, focusing on the questions related to compliance to physical activity. The statistical analysis was done using **descriptive Statistics** - Means and standard deviations for HbA_{1c} levels, subscale and overall DSMQ scores, and overall questionnaire scores. Counts and percentages for categories of poor and good HbA_{1c} control. Repeated **mixed - design ANOVA** is used to compare the HbA_{1c} levels across groups (experimental vs. control) and time points (pre - test vs. post - test) and also used to evaluate the changes in physical activity levels before and after the intervention in both experimental and control groups. All analyses was calculated using **SPSS, V.22** with a significance level of $\alpha = 0.05$.

4. Results

1) Comparison of HbA_{1c} levels of individuals with Type 2 Diabetes in Aizawl based on condition (experimental vs. control) and time (pre - test vs. post - test).

A summary of the descriptive statistics for HbA_{1c} levels at pre - test and post - test is provided in Table 1.1. The control group (N = 100) had a pre - test mean HbA_{1c} level of M = 8.11 (SD = 2.43), which slightly decreased to M = 8.05 (SD = 2.21) following the post - test. The experimental group (N = 100) had a pre - test mean of M = 7.75 (SD = 2.21), which decreased more notably to M = 7.30 (SD = 1.71) in the post - test. The overall mean for both groups at pre - test was M = 7.93 (SD = 2.32), and at post - test, the mean decreased to M = 7.68 (SD = 2.00).

Table 1.1: Descriptive Statistics on HbA_{1c} Levels Pre - Test and Post - Test for Control and Experimental Groups

Condition	N	Pre - Test Mean	SD	Post - Test Mean	SD
Control Group	100	8.11	2.43	8.05	2.21
Experimental Group	100	7.75	2.21	7.30	1.71
Total	200	7.93	2.32	7.68	2.00

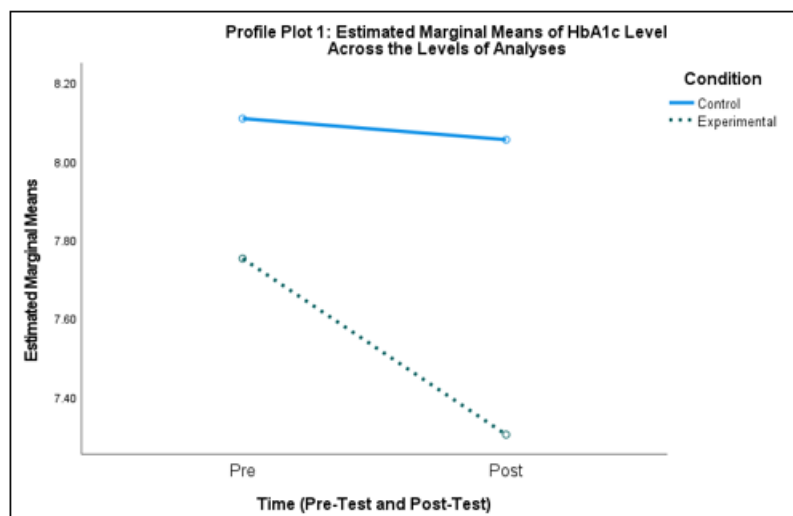
A repeated mixed ANOVA was conducted to examine the effects of time (pre - test and post - test) and condition (control vs. experimental) on HbA_{1c} levels. The results from Table 1.2 and Profile Plot 1 reveal significant main effects for time, time × condition interaction, and condition (with a trend for condition).

- A significant main effect of time was found, $F(1, 198) = 40.11$, $p < .001$, $\eta^2 = 0.17$, indicating that HbA_{1c} levels significantly changed from pre - test to post - test.

- The interaction between time and condition was also significant, $F(1, 198) = 24.76$, $p < .001$, $\eta^2 = 0.11$, suggesting that the change in HbA_{1c} levels from pre - test to post - test differed between the control and experimental groups.
- There was a trend for the main effect of condition, $F(1, 198) = 3.37$, $p = 0.07$, $\eta^2 = 0.02$, which was not statistically significant at the 0.05 level.

Table 1.2: Results of the Repeated Mixed ANOVA Showing the Effects of Time (Pre - Test and Post - Test) and Condition (Experimental on HbA_{1c} Levels)

Source	Type III SS	df	Mean Square	F	Sig.	Partial Eta Squared
Time	6.32	1	6.32	40.11	0.00	0.17
Time* Condition	3.90	1	3.90	24.76	0.00	0.11
Error (Time)	31.21	198	0.16			
Condition	30.74	1.00	30.74	3.37	0.07	0.02
Error	1805.05	198.00	9.12			



A simple effects analysis was conducted to examine the effect of time within each level of condition (control and

experimental group) on HbA_{1c} levels. The results from Table 1.3 indicate significant changes for both groups:

- The control group showed a significant reduction in HbA_{1c} levels from pre - test (M = 8.11) to post - test (M = 8.05), with a mean difference of - .070 (SE = 0.029), $p = 0.018$. The confidence interval for this difference ranged from - 0.128 to - 0.012.
- The experimental group experienced a significant reduction in HbA_{1c} levels from pre - test (M = 7.75) to post - test (M = 7.30), with a mean difference of - .449 (SE = 0.060), $p < 0.001$, and a confidence interval ranging from - 0.56 to - 0.34.

Table 1.3: Result of the Simple Effects Analysis of Time Within Each Level of Condition

Condition	Time I	Time J	Mean Difference (I - J)	Std. Error	Sig. ^b	95% Confidence Interval ^b	
						Lower Bound	Upper Bound
Control Group	Pre - Test	Post - Test	- .070*	0.029	0.018	- 0.128	- 0.012
	Post - Test	Pre - Test	.070*	0.029	0.018	0.012	0.128
Experimental Group	Pre - Test	Post - Test	- .449*	0.06	0.00	- 0.56	- 0.34
	Post - Test	Pre - Test	.449*	0.06	0.00	0.56	0.34
*. The mean difference is significant at the .05 level.							
b. Adjustment for multiple comparisons: Bonferroni.							

Summary of Findings:

- There was a significant reduction in HbA_{1c} levels across time for both the control and experimental groups.
- The experimental group showed a more substantial reduction in HbA_{1c} levels than the control group.
- The interaction between time and condition was significant, suggesting that the change in HbA_{1c} levels from pre - test to post - test differed between groups.

2) Assessing the impact of the experimental intervention on changes in physical activity in individuals with Type 2 Diabetes, comparing pre - test and post - test scores for both the experimental and control groups.

Table 2.1 provides the descriptive statistics for physical activity at both the pre - test and post - test for the control and experimental groups. The results are as follows:

- The control group had a pre - test mean score of 4.94 (SD = 2.10) and a post - test mean of 5.25 (SD = 2.16), indicating a slight increase in physical activity.
- The experimental group had a pre - test mean score of 5.13 (SD = 2.38), and a post - test mean score of 6.78 (SD = 1.68), showing a more substantial increase in physical activity.
- Total: Across all participants, the pre - test mean score was 5.03 (SD = 2.24), and the post - test mean score was 6.01 (SD = 2.08).

Table 2.1: Descriptive Statistics on Healthcare Use Pre - Test and Post - Test for Control and Experimental Groups

Condition	N	Pre- Test Mean	SD	Post - Test Mean	SD
Control Group	100	4.94	2.10	5.25	2.16
Experimental Group	100	5.13	2.38	6.78	1.68
Total	200	5.03	2.24	6.01	2.08

Table 2.2 and Profile Plot 4 presents the results of the repeated mixed ANOVA examining the effects of time (pre - test vs. post - test) and condition (experimental vs. control) on physical activity. The key findings are:

- The main effect of time was significant, $F(1, 198) = 78.30$, $p < 0.01$, with a moderate effect size (partial eta squared = 0.28). This indicates a significant change in physical activity from pre - test to post - test across both groups.
- The interaction between time and condition was also significant, $F(1, 198) = 36.50$, $p < 0.01$, with a moderate effect size (partial eta squared = 0.16). This suggests that the change in physical activity over time varied depending on whether participants were in the experimental or control group.
- There was a significant main effect of condition, $F(1, 198) = 9.75$, $p < 0.01$, with a small effect size (partial eta squared = 0.05). This indicates a significant difference in physical activity between the control and experimental groups at both time points (pre - test and post - test).

Table 2.2: Results of the Repeated Mixed ANOVA Showing the Effects of Time (Pre - Test and Post - Test) and Condition (Experimental on Healthcare Use)

Source	Type III SS	df	Mean Square	F	Sig.	Partial Eta Squared
Time	96.15	1	96.15	78.30	0.00	0.28
Time* Condition	44.82	1	44.82	36.50	0.00	0.16
Error (Time)	243.14	198	1.23			
Condition	73.67	1.00	73.67	9.75	0.00	0.05
Error	1495.83	198.00	7.55			

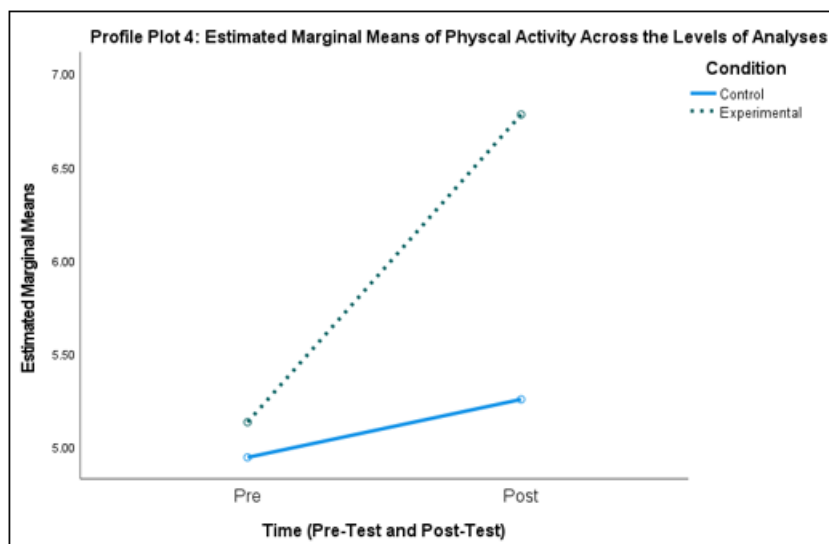


Table 2.3 presents the results of the simple effects analysis of time within each condition. The findings are as follows:

- The mean difference between the pre - test and post - test for the control group was - 0.311 (SE = 0.16), which was statistically significant, ($p = 0.05$). The 95% confidence interval for the mean difference ranged from - 0.62 to 0.00. This indicates a small but statistically significant increase in physical activity in the control group.
- The mean difference between the pre - test and post - test for the experimental group was - 1.650 (SE = 0.16), which was also statistically significant, ($p < 0.01$). The 95% confidence interval for the mean difference ranged from - 1.96 to - 1.34. This suggests a large, statistically significant increase in physical activity in the experimental group.

Table 2.3: Result of the Simple Effects Analysis of Time Within Each Level of Condition

Condition	Time I	Time J	Mean Difference (I - J)	Std. Error	Sig. ^b	95% Confidence Interval ^b	
						Lower Bound	Upper Bound
Control Group	Pre - Test	Post - Test	- .311*	0.16	0.05	- 0.62	0.00
	Post - Test	Pre - Test	.311*	0.16	0.05	0.00	0.62
Experimental Group	Pre - Test	Post - Test	- 1.650*	0.16	0.00	- 1.96	- 1.34
	Post - Test	Pre - Test	1.650*	0.16	0.00	1.34	1.96

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Summary of Findings:

- The results indicate that both the control and experimental groups showed significant changes in physical activity from pre - test to post - test, but the experimental group exhibited a more substantial improvement.
- This suggests that the intervention applied to the experimental group may have had a more pronounced effect on physical activity compared to the control group.

5. Discussion

The findings of this study align with and expand upon existing research on diabetes management interventions. The intervention applied in the experimental group demonstrated significant improvements across multiple domains, including HbA_{1c} levels, glucose management, dietary control, physical activity, healthcare use, and overall diabetes self - management. These findings support the growing body of evidence emphasizing the importance of structured educational and behavioural interventions in diabetes care (Hilliard et al., 2016). However, the study found minimal correlations between demographic variables and self - management outcomes, suggesting that individual behavioural modifications and intervention effectiveness may transcend demographic differences.

The improvement in HbA_{1c} levels in the experimental group supports previous studies showing the efficacy of structured interventions in glycaemic control. The decrease in HbA_{1c} levels from pre - test to post - test aligns with research indicating that patient education and lifestyle modifications significantly reduce long - term glycaemic markers (Salama et al., 2023). The significant difference between the experimental and control groups further confirms that targeted interventions improve glycaemic outcomes beyond standard diabetes care.

The study's findings on physical activity suggest that behavioural interventions can effectively promote physical activity adherence, consistent with the findings of Zhang, X. &. (2018). The greater increase in physical activity levels among the experimental group participants shows the role of structured physical activity education in diabetes management, as supported by systematic reviews demonstrating that increased physical activity significantly improves glycaemic control and reduces diabetes complications (Colberg et al., 2016).

6. Conclusion

For the conclusion, the study mainly represents the importance of changes in physical activity and its impact in

controlling glycemic outcome and blood sugar level for type 2 diabetic individuals. The results and findings are analyzed from 200 samples with limited access to the sampling frame and poor follow-up to the interventional videos due to inconvenience from the samples may bring to the study limitations. However, for improvement of results outcome, more studies need to be done in a respective time framed.

Acknowledgement

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Ethical consideration

The Mizoram University Human Ethics Committee and to the IEC (Institutional Ethics Committee), ZMC & H gave its clearance in conducting the present study. Informed written consent was taken from each of the participants after thorough explanation of the study.

Declaration

The present study is an extract of PhD thesis of Lalnunluangi Hnamte who is the main author, not published in any form any other purposes.

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