# Effects of Combined Aerobic and Virtual Reality-Based Cognitive Training on 76 Years Old Diabetic Male with Mild Cognitive Impairment

Raana Ali Mirza[1] and Irum Yaqoob[2]

## ABSTRACT

Aging, along with Type 2 Diabetes Mellitus (T2DM), is a risk factor for the development of mild cognitive impairment (MCI) among older adults. Physical activity is found beneficial for improving the cognitive status among adults with MCI and in even those having dementia. Combined aerobic-cognitive interventions are an engaging substitute or add-on to existing pharmacological management regimens. A 76-year diabetic male having MCI, followed 12 weeks of aerobics-virtual reality (VR)-based cognitive training programme (3days/week). The session comprised of 30 minutes of interactive gaming via xbox-360 Kinect followed by the aerobic phase of 30 minutes using stationary cycle, maintaining the intensity of 40-60% of heart rate reserve (HRR). The cognitive testing included tools for assessing global cognition and executive function. Random plasma glucose level was also noted at baseline, after 6 weeks and 12 weeks post-interventions while vitals including pulse rate, oxygen saturation and blood pressure were documented at baseline and at the end of intervension. Results depict that 12 weeks of aerobic-VR training was effective in improving the cognitive status along with random plasma glucose levels of the patient.

**Key Words:** *Cognition. Diabetes. Virtual reality.*

## INTRODUCTION

Type 2 diabetes mellitus (T2DM) is found to be associated with the development of cognitive impairments.[1] The effect on cognitive domains including executive function, attention and memory, contribute to the development of mild cognitive impairment (MCI) that may even progress to dementia in severe cases.[2] Aerobic exercises are found beneficial at improving the cognitive status, especially global cognition and executive functioning as well as glucose metabolism and blood pressure in older adults having T2DM.[3-5] Kinect-based exercise programmes are effective at improving cognition by enhancing the executive functions among elderly population.[6] Studies have shown that combined forms of physical activity trainings, i.e. aerobics along with cognitive training programmes, yield better cognitive outcomes than single intervention programme.[7] Although lots of studies have been done to determine the effectiveness of aerobic exercises on diabetic population, but literature is deficient in determining the effects of X-box virtual reality training on blood pressure and random plasma glucose in patients with T2DM. This case report describes the effects of combined aerobic and virtual reality-based cognitive training on cognition, blood pressure and plasma glucose levels (PGLs) of a 76-year diabetic male with MCI.

[1] *Department of Rehabilitation, University of Lahore, Islamabad.*
[2] *Department of Rehablitation, Riphah College of Rehabilitation Sciences (RCRS), Riphah International University, Islamabad.*

*Correspondence: Dr. Irum Yaqoob, Lecturer, Rehabilitation Department, Riphah College of Rehabilitation Sciences (RCRS), Riphah International University, Islamabad.*
*E-mail: irum.memo@gmail.com*

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## CASE REPORT

The subject was a 76-year male diagnosed with T2DM, almost 3.5 years back. Subject also presented with the history of hypertension for, which he was on anti-hypertensive medication. He was using metformin to control blood glucose levels with no change in medications since last 3 months. The participant was enrolled in 12-week programme at Railway Research and Rehabilitation Center after taking signed consent. Subject was screened for cognitive impairment using standardised Mini Mental State Examination test (MMSE) and a score of 23 was recorded (score of <25 = MCI). Montreal cognitive assessment tool (MOCA) were used to assess global cognition. Other tools were trail making test part A (TMT-A) for speed of processing; trail making test-B (TMT-B) for executive function; and verbal fluency (VF) (semantic/phonemic) for verbal functioning and executive function.

The combined aerobic-VR cognitive training programme comprised of virtual reality (VR)-based exercise session (30 mins/day, 3 days/week) with X-box-360 Kinect using Dr. Kawashima's brain and body exercise.[8] The session included 5-minute warm up, 20-minute interactive gaming, and 5-minute cool down. This gaming session was followed by 30 minutes of aerobic exercises (AE) (30 mins/day, 3 days/week) using stationary cycle maintaining the intensity of 40-60% of heart rate reserve

(% HRR). Baseline measures including cognitive tools were documented 1 day before the start of session while vitals and PGL were documented on the same day of starting the protocol. Cardiac monitor (Operon OM-12) was used to monitor pulse rate, oxygen saturation ($O_2$ sat) and blood pressure before, after and during the session, pulse rate, blood pressure and $O_2$ sat were documented before and after every session. PGL was measured using standard glucometer, before each session.

The data was collected using standardized tools and measures prior to the start of intervention (baseline) and then after 6 and 12 weeks of combined VR and aerobic training as shown in Table I.

**Table I:** Cognitive tools including MMSE, MOCA, verbal fluency, trail making.

| Variables | Baseline scores | Week 6 | Week 12 |
|---|---|---|---|
| MMSE | 23 | 26 | 26 |
| MOCA | 24 | 24 | 26 |
| Verbal Fluency | | | |
| Semantic | 12 | 13 | 16 |
| Phonemic | 04 | 04 | 06 |
| Trail Making Test | | | |
| Trail A | 2 min 26 secs | 1min 06 secs | 56 sec |
| Trail B | 3 min 02 secs | 3min | 2 min 14 secs |

*Table shows improvements in all variables at 6 and 12 weeks post-intervention.*

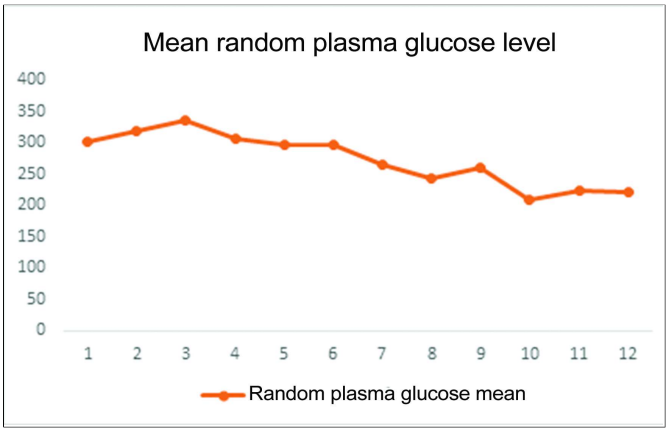


**Figure 1:** The mean plasma glucose level (mg/dl) values from baseline to week 12.

Table shows improvements in all variables at 6 and 12 weeks post-intervention. Improvement were also observed after 12 weeks of intervention in mean values of PGL (Figure 1).

Table II shows increase in mean pulse rate and oxygen saturation at each week, post-exercise and the resting heart rate is reduced over the 12 weeks. Pre-mean systolic pressure decreased from 46 to 140 mmHg and post-mean systolic pressure from 153 to 142 mmHg, while mean diastolic blood pressure was maintained between 80 and 83 mmHg during the intervention.

## DISCUSSION

The results of current report are consistent with the previous studies. In the past, studies have shown that aerobic exercises and cognitive training through interactive gaming are helpful in improving global cognition.[4,9] It is also observed that 12 weeks of combined aerobic and cognitive training were effective in improving cognitive status, especially executive function among older adults with mild dementia.[10]

Improvement in PGL and cognitive measures are important findings of the study. After 12 weeks of intervention, improvements were recorded in PGL as well as cognitive tools. Improvements in cognition can be correlated with the improvements in PGL as it is seen that high levels of blood glucose can have negative impact on the cognition,[11] and that improving the hyperglycemic state can also improve the cognitive status among elderly diabetics.[12]

The results of this study show an increase in the mean pulse rate at each week. In response to exercise, the heart rate of individual increases as a result of increased demand of oxygen and nutrients in exercising muscles.[13] These muscles are supplied by energy through break down of glycogen and triglycerides, hence getting the required oxygen.[14] After prolonged aerobic training, it is observed that the resting heartrate is reduced.[15] Blood Pressure (BP) including systolic and diastolic BP was also recorded after every session of exercise training programme. Although 12 weeks of

**Table II:** Mean of pre- and post-vitals including pulse rate, oxygen saturation, and blood pressure.

| Weeks | Mean Pre PR/min | Mean Post PR/min | Mean Pre $O_2$ sat. % | Mean Post $O_2$ sat % | Mean Pre BP mmHg | Mean Post BP mmHg |
|---|---|---|---|---|---|---|
| 1 | 91 | 95 | 96 | 97 | 146/81 | 153/80 |
| 2 | 88 | 96 | 98 | 97 | 153/81 | 160/88 |
| 3 | 86 | 93 | 97 | 97 | 140/78 | 142/80 |
| 4 | 85 | 93 | 97 | 97 | 130/76 | 132/75 |
| 5 | 87 | 92 | 97 | 98 | 148/80 | 150/83 |
| 6 | 80 | 94 | 98 | 97 | 146/81 | 148/83 |
| 7 | 79 | 98 | 97 | 97 | 140/78 | 140/80 |
| 8 | 88 | 94 | 97 | 97 | 140/73 | 142/78 |
| 9 | 79 | 89 | 98 | 98 | 141/78 | 147/78 |
| 10 | 77 | 90 | 97 | 97 | 141/77 | 147/77 |
| 11 | 83 | 90 | 98 | 98 | 141/81 | 147/83 |
| 12 | 87 | 95 | 98 | 99 | 140/80 | 142/83 |

aerobic and VR results is slight decrease in BP, but does not bring BP in the range which is considered normal. A study documented the results in which diabetic population was divided into 3 groups, and blood pressure in aerobic training group was not decreased significantly as compared to baseline.[16]

Around 12 weeks of aerobic-VR-based cognitive training was effective in improving the cognitive status along with random plasma glucose levels of a 76-year diabetic male. The most significant changes are observed in the domains of executive function and speed of processing.

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