Research Article

Metabolic Syndrome: Effectiveness of E-Health Interventions

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Abstract

Background: Metabolic syndrome or insulin resistance (IR) syndrome is a set of one or more of the following four pathologic conditions: abdominal obesity, insulin resistance, hypertension, and hyperlipidemia. MetS is becoming a huge public health concern because it is strongly associated with cardiovascular diseases and diabetes. Many patients in remote areas face challenges in accessing consistent healthcare services. E-health interventions, particularly telemedicine, have emerged as promising tools for enhancing treatment accessibility, lower expenses, and promote better self-management.

Objectives: The aim of this study is to evaluate the effectiveness of e-health interventions in improving quality of life and metabolic profile of patients with metabolic syndrome.

Methods: A single-group pre-test post-test design was employed and was carried out at the Liver Clinic of pubic hospital of Lahore, over a two-month period. The sample size was determined to be 30 participants using G*Power software. A consecutive non-probability sampling method was used, and all participants met the NCEP ATP III criteria. Informed consent was obtained from participants diagnosed with metabolic syndrome, who then completed a standardized Quality of Life questionnaire. Baseline measurements such as age, fasting glucose, BMI, blood pressure, waist circumference, and weight were recorded, with the same questionnaire used for post-test assessment to compare QoL scores. Pre-test and post-test parameters were compared using t-test and p-value <0.05 was considered significant.

Results: A significant improvement in the waist size, BMI, Systolic and diastolic blood pressure was observed but fasting blood glucose levels did not show significant improvement.

Conclusion: The study conducted suggests that e health interventions have positive impact on quality of life of patients with MetS.

Keywords: Metabolic syndrome, E-health interventions, Telemedicine, Quality of life

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Introduction

Metabolic syndrome, also called insulin resistance (IR) syndrome, is defined by WHO as a constellation of mainly four pathologic conditions: abdominal obesity, insulin resistance, hypertension, and hyperlipidemia, where insulin resistance was felt to be an absolute requirement for the patient to have metabolic syndrome.[1-3] However recently, a new criterion was published by the International Diabetes Foundation (IDF) that is used for identifying patients with MetS.

syndrome where in addition to the insulin resistance as given by WHO, obesity was hailed as equally important for the existence of metabolic syndrome in a patient.

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(Zimmet et al., 2005) It has been useful as a screening approach to better diagnose susceptible individuals with cardiovascular disease and type-2 diabetes mellitus.[4] Modifying dietary patterns and habits is extremely important in metabolic syndrome.[5]

There is more to e-health than just computers and medicine. It is a developing reality that, in addition to health services, the Internet provides a way of networking and global thinking which paves the way for way for better health care.[6] Many studies conducted indicate a positive interaction between e-Health and various healthcare facilities.[7]E-health has the potential to enhance service accessibility, lower expenses, and promote better chronic illness self-management.[8] It utilizes services like apps, social media, or online where a relatively recent trend, gamification focuses on integrating game principles into healthcare settings to engage patients, enhance illness self-management, and advance e-health objectives.[9,10] Interventions involving physical activity have been

demonstrated to be beneficial for cardiometabolic diseases after 12 weeks or longer.[11] Studies have shown significant variations in BMI, weight circumference, and systolic blood pressure also significant improvements in the fasting blood glucose levels in the patients with type 2 diabetes mellitus.[13]

Numerous studies on e-learning interventions related to metabolic syndrome have been conducted. The rationale and procedure of this study demonstrate how an intervention in lifestyle facilitated by telemedicine reduces the chances of developing CVS disorders and diabetes Type2.[14]Another study demonstrates that the correlation between sedentary time spent in front of screens and MetS in the teenagers of Brazil is altered by the consumption of unhealthy snacks.[15] This study assesses an E-learning-based weight-loss program for obese junior high school pupils.[16]
To our knowledge, the results of using telemedicine intervention on MetS patients have not been extensively studied in Pakistan. This study is set out to assess the constructive effects of telemedicine on the lifestyle of participants with MetS.

Methods

This study employed a single-group pre-test post-test design and was carried out at the Liver Clinicof public hospital in Lahore, over a two-month period. The sample size was determined to be 30 participants using G*Power software, which indicated that for a one-tailed paired-samples t-test, a minimum of 27 participants would be necessary to obtain a statistical power of 0.8, with an alpha level of 0.05 and a medium effect size (d = 0.5). A consecutive non-probability sampling method was used, and all participants met the NCEP ATP III criteria, a widely recognized standard for diagnosing metabolic syndrome.

Participants were eligible for inclusion if they were diagnosed solely with metabolic syndrome (MetS), could use mobile phones and answer calls, were cooperative and willing to return to the hospital for follow-up measurements after two months. Participants were excluded if they had any Cardiac Disease, had been diagnosed with Type 1 Diabetes Mellitus, were undergoing chemotherapy or radiotherapy, were pregnant, had circulatory problems.The NCEP ATP III criteria were used to select study participants. Metabolic syndrome is a group of conditions that includes hyperglycaemia, atherogenic dyslipidaemia, hypertension, obesity or insulin resistance, and is commonly diagnosed using the NCEP ATP III definition. An individual needs to have three or more of the following conditions in order to meet the criteria for metabolic syndrome: hypertriglyceridemia (triglyceride level of 150 mg/dL or above); truncal obesity (waist size over 35 inches for women and over 40 inches for men); raised blood sugar levels (fasting blood sugar of 100 mg/dL or greater, indicating prediabetes or Type 2 diabetes if over 125 mg/dL); abnormally decreased HDL cholesterol (less than 40 mg/dL for men, or less than 50 mg/dL for women) and excess blood pressure (if the systolic pressure has raised till 130 mmHg or higher and diastolic pressure has raised till 80 mmHg or higher.) (17-18). Data collection was initiated by obtaining informed consent from each participant, who reviewed and signed the consent document. Participants, all diagnosed with metabolic syndrome, completed a WHOQOL-BREF questionnaire. The same questionnaire was used in the assessment done post-test and the Quality of life scores were compared. During the initial assessment, we recorded baseline measurements, including fasting blood glucose level, systolic and diastolic blood pressure, BMI, truncal obesity/waist, age and weight.
Our research employed a telemedicine-based e-health intervention. Participants were contacted biweekly, where they received advice on maintaining a balanced diet, reducing sugar intake, engaging in a 15-minute walk after each meal, incorporating exercise into their daily routine, and adhering to their medication schedules. Approval for this study was taken through Institutional Review Board (IRB). Participants were subsequently enrolled in the telemedicine program. Each research team member was trained and highly skilled to record the health parameters effectively and accurately. This ensured uniformity and minimized errors in the data collection. Two months later,

Table 1: *Summary of Pre-test and Post-test Means, Mean Differences, and Statistical Significance for Key Variables*

Variable	Pre-test Mean	Post-test Mean	Mean Difference	t	p-value	Correlation
Weight (kg)	84.77	81.15	3.62	5.753	<0.001	0.963
Waist Circumference (cm)	40.97	39.05	1.92	5.739	<0.001	0.866
BMI (kg/m²)	31.50	30.68	0.81	2.600	0.015	0.934
Fasting Glucose (mg/dL)	147.93	138.03	9.90	1.777	0.086	0.682
Systemic Blood Pressure (mmHg)	136.63	128.50	8.13	3.420	0.002	0.702
Diastolic Blood Pressure (mmHg)	90.20	85.53	4.67	2.351	0.026	0.618

participants returned to the hospital for follow-up measurements.

IBM SPSS version 27 software was employed for the analysis of data. Percentages and frequencies were calculated for several qualitative variables. Mean and standard deviation was calculated for quantitative variables (fasting blood glucose, weight, truncal obesity, BMI and blood pressure). Pre-test and post-test parameters were compared using t-test and p-value <0.05 was considered significant.

Results

A set of 30 participants(11 male and 19 females) were enrolled in the study who met the NCEP ATP III criteria of MetS. The maximum and minimum age of participant was 38 and 70 respectively with a mean age of 52.8667. We compared the health parameters(weight, waist, fasting blood glucose, BMI and blood pressure) and QOL of the 30 participants before and after the telemedicine intervention. After the intervention, there were significant improvements in these health parameters and QOL as well. Our study reveals the changes in the participant's BMI, weight, waist, blood pressure and fasting blood glucose before and after giving intervention over a period of 8 weeks. There was a significant reduction in weight and waist circumference with $p < 0.001$. (BMI) Body Mass Index showed a modest but significant reduction with a p value = 0.015. Fasting glucose levels decreased by 9.90 mg/dL; however, this change was not statistically significant with a p value = 0.086. Both systolic and diastolic blood pressures showed significant reductions, with systolic blood pressure with a p value = 0.002 and diastolic blood pressure with a p value of 0.026.

Details regarding the individual mean values of pretest and posttest, mean differences and significance are given in Table 2.

All variables have high correlations between their pre-test and post-test values, with correlations ranging from 0.618 to 0.963, and all the correlations are statistically significant ($p < 0.05$). The descriptive statistics show a significant rise in the Quality of Life (QoL) scores, with the mean increasing from 64.23 (SD = 6.36) in the pre-test to 83.87 (SD = 8.17) in the post-test. Statistical Significance of the increase in QoL Scores is confirmed by the paired sample t-test results, with a mean difference of 19.63 = 9.618, $p < 0.001$), highlighting a notable improvement in QoL scores following the intervention. Table 3 presents the individual QoL scores for both the pre-test and post-test.

Table 2: *Paired Samples Statistics for Quality of Life (QOL) Before and After Intervention*

QOL Scores	Mean	N	Std. Deviation	Std. Error Mean
Pretest	**64.2333**	**30**	**6.36089**	**1.16133**
Posttest	**83.8667**	**30**	**8.16525**	**1.49076**

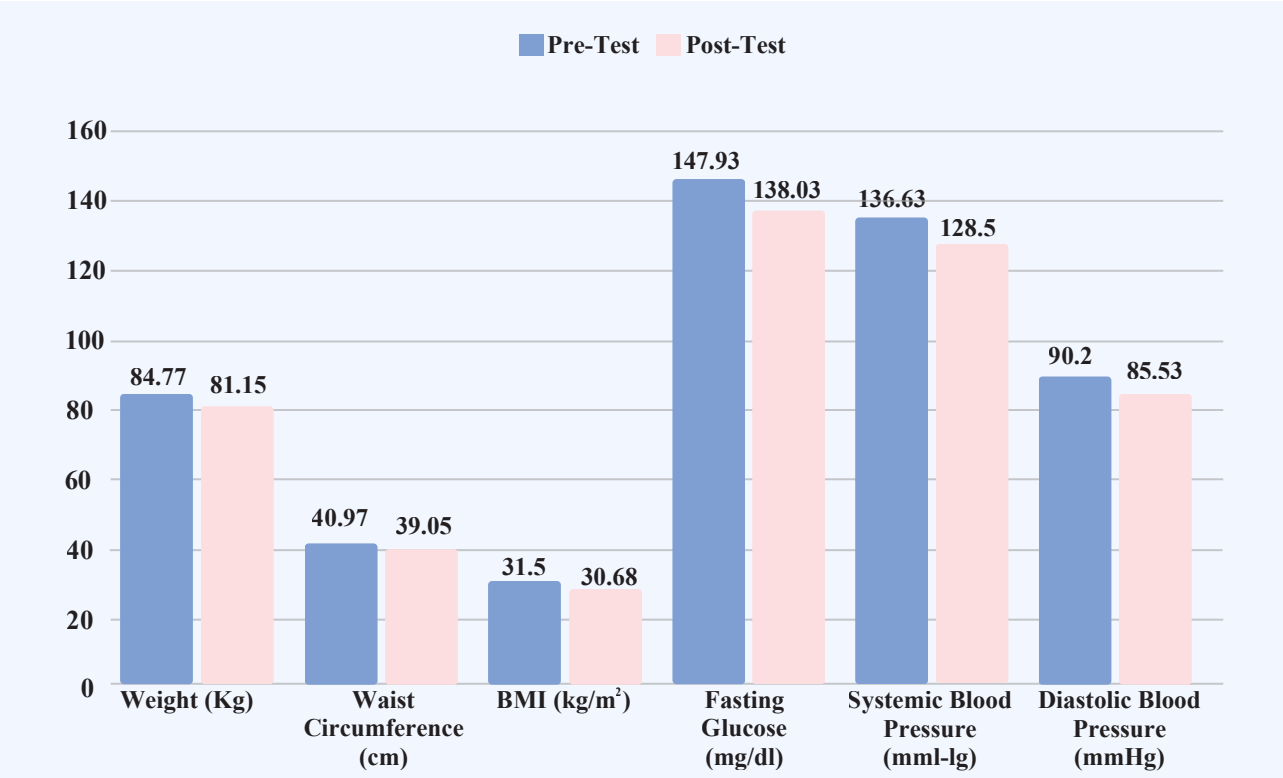

Figure 1: *mean pre-test and post-test of weight, waist circumference, BMI, Fasting Glucose, Systemic Blood Pressure and Diastolic Blood Pressure*

Discussion

Our study shows that e-health interventions significantly improve the health parameters (weight, waist, BMI and blood pressure) in patients with metabolic syndrome . Additionally, it demonstrates that telemedicine shows a significant increase in the mean Quality of Life (QoL) score.

E-health interventions significantly decrease weight in patients of MetS. These findings align with the results of the study by Gerstel et al.[20] This improvement can be attributed to the interactive and regular patient engagement of telemedicine. This finding is valuable because easy accessibility of personalized healthcare in the form of telemedicine positively impacts the dietary choices and encourages the patients to involve in regular physical exercise and workout sessions, all leading to a healthy weight reduction.[21]

Our study also indicates a statistically significant reduction in waist circumference as well as in BMI. This is similar to the findings reported by Izquierdo.[22] Regular weight and waist circumference monitoring combined with effective guidance and support via telemedicine leads to increased frequency of physical exercise and intake of healthy diet by the patients.

E-health interventions also significantly decreased the blood pressure in hypertensive patients. Patients received regular advice about taking active steps to improve their cardiovascular health without having to visit their doctor in-person. Low sodium diet, daily blood pressure monitoring and regular workout session improved the cardiovascular indicators.[22,23] Telemedicine also decreased the fasting blood glucose levels. However, it yielded non-significant results. This finding is similar to the finding in the CHARMS trial by Chirinos. This can be owing to the multifactorial nature of diabetes mellitus, insulin resistance (23) and/or due to non-compliance on the patient's end.=23

Telemedicine also improved the mean Quality of Life (QoL) score in the participants. Improved cardiovascular health, effective weight management and regulated blood sugar levels decrease morbidity and increase the quality of life, thereby, supporting the use of telemedicine and e-health interventions in the management of patients with metabolic syndrome.[24]

The study had several strengths, including the use of the WHOQOL-BREF instrument, which demonstrated strong internal consistency and validity with a Cronbach's alpha score of 0.91. Quality of life (QOL) scores significantly improved from the pre-test to the post-test, according to the data, demonstrating the beneficial benefits of e-health interventions on patient outcomes. Furthermore, the exact inclusion criteria of the study guaranteed that the participants were a true representation of the intended population. The quasi-experimental design of the study, which lacked a control group and thus could not establish causality, the small sample size of only 30 participants, which limited generalizability, and the scant discussion of confounding variables like age, gender, and socioeconomic status are some of the study's limitations A bigger sample size should be used in future study to improve its validity and generalizability. A randomized controlled trial is recommended to establish causality more clearly. Controlling for potential confounding variables will strengthen the study's findings, and the availability of more resources would facilitate more effective investigations.

Conclusion

The study conducted in liver clinic public hospital suggests that e health interventions have positive impact on quality of life of patients with metabolic syndrome. There was a significant improvement in the BMI, waist circumference, systolic BP , diastolic BP levels but fasting blood glucose levels were not improved that much.

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Authors Contribution:
MS: Involved in conceptualization of study.
AS, AH, AA, AZ: Involved in data collection.
AA, TD Involved in manuscript writing.

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