# Effect of a Mobile-Based Rehabilitation Programme on Quality of Life among Cardiac Patients

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## Abstract

**Background:** Cardiac rehabilitation programmes have demonstrated efficacy in the treatment of individuals afflicted with cardiovascular illness; nevertheless, only a meagre 10% of the eligible patient population partakes in such initiatives. The widespread adoption of internet connectivity and cellular telephony has presented possibilities for patient interaction and bridging geographical gaps. **Aim:** This study aimed to evaluate the effect of a mobile-based rehabilitation programme on quality of life among cardiac patients. **Research design:** The present study was designed using a quasi-experimental research approach that involved a single group receiving both pretest and posttest assessments. **Setting:** The study was undertaken in the cardiology inpatient ward and outpatient clinic of the Specialised Medical Hospital at Mansoura University Hospitals in Egypt. **Subjects:** A purposive sample of 50 patients with cardiac diseases was enrolled in this study. **Tools:** Data was collected using five tools: a demographic and health-relevant data questionnaire, a dietary instrument for nutritional evaluation, a hospital anxiety and depression scale, a general self-efficacy scale, and health-related quality of life measures. **Results:** The results indicate a statistically significant improvement in participants' quality of life after six months in comparison with basal parameters ($p = 0.002$). In addition, at the 6-month mark following the intervention, noteworthy enhancements were observed in the step count. **Conclusion:** The present study ascertained that a mobile-based rehabilitation programme was effective in improving overall quality of life among cardiac patients. **Recommendation:** Healthcare institutions should integrate virtual technology like mobile into cardiac rehabilitation to positively affect patients on various clinical outcomes.

**Key words:** Mobile-Based, Rehabilitation Programme, Quality of Life, Cardiac Patients

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## Introduction

Cardiovascular diseases (CVDs) are a prominent cause of morbidity and mortality on a global scale. Effective management of CVDs entails a multifactorial approach that encompasses crucial treatment components such as risk factor modification, lifestyle modifications, and medical therapy. In instances where medical treatment fails to alleviate symptoms, revascularization may be considered an intervention. Nevertheless, despite its potential efficacy in symptom management, its effectiveness in mitigating significant cardiovascular events remains unproven when compared to medical therapy **(Picard, Sayah, Spagnoli, Adjedj, & Varenne, 2019).**

Health-related quality of life (HRQoL) is a commonly employed patient-reported outcome in cardiovascular care and other medical contexts. The evaluation of HRQoL serves as a significant metric for measuring the consequences of CVDs. Individuals with CVDs encounter a host of physiological and psychological manifestations, including dyspnea, fatigue, edoema, insomnia, depression, and thoracic discomfort. These aforementioned symptoms hinder patients' daily functioning and social engagement, ultimately leading to diminished HRQoL. Additionally, poor HRQoL has been found to be significantly associated with increased rates of hospitalisation and mortality **(Bahall, Legall, & Khan, 2020).**

Cardiac rehabilitation programmes (CRP) have been linked to improved HRQoL among individuals with CVDs. These programmes have demonstrated efficacy as a therapeutic intervention for patients with CVDs, exhibiting reduced instances of adverse cardiac events and premature mortality in such populations. Cardiac rehabilitation programmes constitute a crucial component in the recuperation process following a significant cardiac episode **(Thomas et al., 2019).**

Cardiac rehabilitation entails a confluence of elements that possess similarities with conventional care, encompassing the regulation of lipids, blood pressure, and diabetes mellitus, in addition to the provision of cardio-protective medications such as antiplatelet agents, β-blockers, angiotensin II receptor antagonists, and statins. Serum lipid biomarkers, such as triglycerides and cholesterol, which are pervasive and readily measurable in circulation, are established indicators of cardiovascular health in traditional medical practise **(Powell-Wiley et al., 2021).**

Cardiac rehabilitation programmes encompass multifaceted interventions, comprising exercise-based rehabilitation, education, modification of lifestyle habits, and self-management coaching. These interventions are aimed at enabling patients to effectively adapt to long-term lifestyle changes and manage their condition optimally. These programmes set out to empower patients to achieve their objectives of enhancing physical activity, cultivating better dietary habits, adhering to medications as prescribed, ceasing smoking, and ultimately attaining optimal psychosocial well-being **(Chindhy, Taub, Lavie, & Shen, 2020).**

The burden of CVDs is witnessing a swift escalation in developing nations. Nonetheless, the accessibility of cardiac rehabilitation and secondary prevention (CR/SP) in such countries is constrained. Accessibility to CR/SP services in low- and middle-income countries is currently at an extremely low level, with less than 25% of said countries equipped with CR/SP programmes. Several obstacles to engagement in these programmes have been recognised within the scholarly discourse **(Casas et al., 2021).**

The principal cause of rehospitalization, morbidity, and mortality lies in the underutilization of CRP. The attendance of individuals in rehabilitation and therapy programmes is frequently challenged by the difficulty of the aforementioned programmes. Despite the potential advantages that CRP offer, attendance rates for such programmes are frequently suboptimal, primarily as a consequence of geographical constraints. According to certain scholarly investigations, a majority exceeding two-thirds of patients who have been referred for CRP exhibit non-adherence or early withdrawal **(Dorje et al., 2018).**

The pressing need to address the service gap necessitates the exploration of low-cost and readily accessible alternative delivery models. Various technological advancements have been integrated into healthcare settings to enhance the quality of care and optimise patient experiences and treatment outcomes. Recent studies have shown that utilising mobile-based interventions represents a viable and effective alternative strategy for administering CR/SP programmes to individuals afflicted with CVDs **(Patterson et al., 2022; Yerrakalva, Yerrakalva, Hajna, & Grifn, 2019).**

Therefore, it is imperative to acknowledge the significance of adaptable and inventive technology-driven interventions that are geared towards mitigating the risk factors associated with SP. Hence, it can be posited that the use of a mobile-based rehabilitation programme (MBRP) could be a fitting complement to a conventional CRP.

## Significance of the study

Globally, CVDs constitute the main factor in morbidity and early mortality. The heightened incidence of CVDs imposes supplementary demand on healthcare systems, particularly in the current atmosphere of fiscal stringency prevailing throughout Europe **(Vos et al., 2020).** Cardiovascular diseases have been the predominant contributor to untimely mortality in Egypt since the 1990s. In the year 2017, CVDs represented 46.2% of the total deaths within Egypt. The ageing of the population and the efficacy of extending the life expectancy of individuals afflicted with coronary events have resulted in an increasingly significant and expanding public health concern in the form of heart failure **(Hassanin, Hassanein, Bendary, & Maksoud, 2020).**

The implementation of CRP represents a significant multidisciplinary secondary intervention strategy with the primary goal of reducing risk factors associated with CVDs, fostering the adoption of healthy lifestyle behaviours, and mitigating the disability burden in individuals diagnosed with CVDs. The latest recommendations pertaining to CVDs endorse the adoption of a multifaceted strategy that encompasses various aspects such as exercise training, dietary counselling, smoking cessation, risk factor modification, and psychosocial support **(Abreu et al., 2019).**

The swift advancement of information and communication technologies presents a promising solution for surmounting obstacles in the realm of cardiac rehabilitation. It is proposed that a mobile-based rehabilitation programme represents a viable, secure, and economical intervention that yields long-term improvements in CVD risk factors, decreases in healthcare expenses, and enhanced adherence to CRP participation **(Batalik et al., 2021).**

## Aim of the study:

The present study aimed to evaluate the effect of a mobile-based rehabilitation programme on quality of life among cardiac patients.

### Research hypotheses:

H1: Users of a mobile-based rehabilitation programme would positively alter their lifestyle behaviours.

H2: Users of a mobile-based rehabilitation programme would experience improved overall quality of life.

### Operational definition:

**A mobile-based rehabilitation programme:** In this study, MBRP is a novel intervention that involves the application of telecommunication networks and the internet to deliver rehabilitation services. The programme utilises cellular phones as a medium for patients to access educational videos and mobile applications, such as pedometer and step counter apps, for the purpose of facilitating their recovery and overall improvement of health, and MBRP was measured by Tool I, Part B, and Tool II–IV.

**Quality of life:** The concept of quality of life can be defined as the functional impact of an illness and its resulting therapy on a patient, as subjectively perceived by the patient themselves. This notion encompasses both the physical and emotional ramifications of the illness and its treatment and highlights the individualised nature of the patient experience. In the current study, quality of life was measured using Tool V.

### Subjects and methods:

**Research Design:** To accomplish the objective of the study, a quasi-experimental research design employing a one-group pre- and post-test methodology was employed. Quasi-experimental research endeavours seek to assess interventions without resorting to randomization. In the field of medical informatics, the quasi-experimental design is a frequently employed methodology for assessing the advantages of particular interventions, so this design is the best for achieving the aim of this study **(Reichardt, 2019).**

**Research Setting:** The current study was conducted at the cardiology inpatient department in addition to the outpatient clinics situated at the Specialized Medical Hospital, Mansoura University Hospitals' affiliated facility in Egypt. Egypt's Mansoura University was established in 1972 and is situated in the heart of the Nile Delta. The hospital was built in accordance with University Council No. 246's decision, which was made on January 31, 1995. Given his experiences in various fields, medicine has expanded its therapeutic services to include the Dakahlia Governorate and neighbouring provinces. However, it has since spread to all provinces (Delta and Channel) and some southern provinces, encompassing more than 8 million people. This hospital serves the city of Mansoura and some centres surrounding it, with a census of no more than one million people (**Mansoura university, 2021**).

**Subjects:** A sample of 50 patients, purposefully chosen from the previously described hospital, met the following criteria:

**Participants' inclusion criteria**: Conscious, adult patients at the age of 20–60 years from both genders who had a confirmed diagnosis of heart disease and were able to engage in verbal communication, exhibited a willingness to partake in the study, and demonstrated a consistent level of internet accessibility.

**Participants' exclusion criteria:** Patients with other complicated medical diseases, such as end-stage renal diseases, end-stage hepatic diseases, or patients with mental disorders.

**Sample size calculation:** The determination of a suitable sample size may involve consideration of a level of significance of 5% and a study power of 80%. The calculation of sample size is commonly conducted using a formulaic approach with the assistance of appropriate software such as MedCalc 15.8. The computation was predicated on antecedent research conducted by **Dorje and colleagues (2018).** Upon careful consideration of the cumulative count of cardiovascular patients admitted to the aforementioned healthcare facility in the year 2019, statistical parameters such as an alpha error of 5% (at a confidence level of 95%), a beta error of 20%, and a study power of 80% were factored in to ascertain the requisite sample size. The calculated sample size comes out to be 43 patients. To account for expected drop-outs, an additional seven patients were added, so the sample size was 50 patients.

**Tools of data collection**

The instrument for data collection included five tools:

**Tool I: Demographic and health-relevant data questionnaire**

The researchers developed this tool after reviewing national and international reviews **(Cleland, Ferguson, Ellis, & Hunter, 2018; Lear, 2018).** This tool included two parts:

**Part A:** This part consisted of four questions, including those about the patients' age, gender, level of education attained by participants, and occupation.

**Part B:** This part contained nine questions, including weight, height, body mass index (kg/m2), current smoking status, previous CRP, level of physical activity, energy expenditure (EE) measurement, lipid profile, and daily steps.

In energy expenditure measurement, individual EE is estimated (in kcal) by multiplying body weight (kg) by the duration of physical activity (minutes).

**Tool II: Dietary Instrument for Nutritional Evaluation**

This tool was adopted from Roe et al. (1994). This instrument has been verified as a reliable method to evaluate the consumption of fat and dietary fibre. It contains 19 food groups, representing fat and fibre. The study's participants were requested to select the frequency of consumption for various food groups from a set of multiple-choice response options **(Hooson et al., 2020).**

**Tool III: Hospital Anxiety and Depression Scale (HADS)**

**Zigmond and Snaith (1983)** devised tool III. This tool contained 14 items to measure anxiety and depression. The Hospital Anxiety and Depression Scale comprises seven anxiety-related items and seven depression-related items, each measured on a four-point Likert scale with a range of 0 to 3. According to prevailing standards, a score of less than eight is deemed to fall within the realm of normalcy. However, scores between eight and ten, which signify moderate symptoms, could potentially imply the existence of a condition. On the other hand, a score of eleven or more, suggestive of severe symptoms, typically indicates a probable disorder **(Stern, 2014).**

**Tool IV: General Self-Efficacy Scale (GSE)**

Schwarzer and Jerusalem created GSE in 1995. The goal of the GSE scale was to appraise an individual's overall perceived capacity to execute tasks and overcome challenges in order to forecast their ability to deal with everyday annoyances as well as their adjustment after encountering various forms of taxing life situations. The instrument consisted of a total of ten items, which were assessed by means of a 4-point Likert scale, wherein respondents were prompted to rate their level of agreement with the statements presented using the following scoring rubric: 1 (not all true), 2 (hardly true), 3 (moderately true), and 4 (exactly true). The ultimate result encompassed a gamut of values ranging from 10 to 40, whereby elevated scores indicated an enhanced level of self-efficacy **(George, Locasto, Pyo, & Cline, 2017).**

**Tool V: Health-related quality of life measures**

Tool V consisted of two parts:

**Part A: The MacNew questionnaire**

This tool was developed by **Höfer, Lim, Guyatt, and Oldridge, 2004**. The **MacNew** questionnaire encompasses a set of twenty-seven items specifically designed to evaluate an individual's perceived level of emotional, physical, and social well-being. The quantification of HRQoL was conducted utilising a 7-point scoring system, whereby lower scores were indicative of a diminished HRQoL status **(Baldi, De Vecchis, & Ariano, 2016).**

**Part B: Seattle Angina Questionnaire (SAQ)**

Spertus and colleagues created the SAQ in 1995 to measure quality of life in patients with heart disease. The SAQ instrument consisted of a total of 19 queries that were subdivided into five distinct domains, namely physical limitations (9 items), angina stability (1 item), angina frequency (2 items), treatment satisfaction (4 items), and disease perception (3 items). Individuals with higher scores on a health assessment questionnaire display a better overall health status, while those with lower scores exhibit a poorer health status **(Thomas, Jones, Arnold, & Spertus, 2021).**

**Scoring system:** The scoring of the five dimensions is achieved through the assignment of an ordinal value to each response, commencing with one for the response that indicates the lowest level of functioning. The approach involves the summation of all items within each of the five scales. The scale scores were subsequently converted to the 0-100 range through a multi-step process involving the subtraction of the minimum attainable score, division by the scale's span, and multiplication by a factor of 100. An aggregate measure of performance is not produced.

**Validity and reliability**

A team of five experts possessing specialised knowledge in medical-surgical nursing, critical care nursing, and medical biostatistics assessed the validity of the content. The tools were amended by the experts to improve their clarity, relevance, thoroughness, simplicity, and application. Tools were first independently evaluated, after which contentious issues were thoroughly debated until an agreement was reached. Up until the final format employed in the current study was obtained, all proposed alterations were made to increase the validity of the questionnaire. Cronbach's alpha was used to assess the validity of the suggested study tools (tool II: 0.70; tool III: 0.80; tool IV: 0.73; tool V, part A: 0.95; and tool V, part B: 0.78).

**Pilot study**

An initial pilot study was conducted, involving a sample of 10% of the target population of patients, who were subsequently excluded from the study. The purpose of this preliminary investigation was to assess the clarity, feasibility, and applicability of the research tools as well as to estimate the time required for completing and submitting them. Drawing from the findings of the preliminary investigation, necessary improvements and alterations were implemented in advance of the data accrual process.

**Ethical considerations and Human Rights:**

The participants were informed of the voluntary nature of their participation in the study and were assured of their unrestricted prerogative to withdraw from the activity at any point without incurring any adverse consequences. Each subject was given the opportunity to give their verbal informed permission before the study began after being fully informed of its purpose, advantages, risks, and methodology. The data's confidentiality and anonymity were guaranteed, and it was solely used for study.

**Fieldwork and Data collection:**

Fieldwork is a process consisting of four distinct phases, which are sequentially undertaken in order to achieve its aims.

**Preparatory phase**

The current phase entails crafting the research instruments through a thorough examination of scholarly literature. Subsequent to the ultimate rendition of the tool in English, it underwent the process of being translated into the Arabic language and was subsequently subjected to the process of back translation into the English language. Furthermore, the reliability and content validity of the aforementioned tool were put to the test. Subsequent to this, the conclusive Arabic iteration of the instrument was deemed suitable for the purposes of data acquisition. Obtaining written approval from the pertinent authorities was secured prior to the commencement of the study.

**Planning Phase**

The instructional content, expected outcome, educational video, and MBRP were prepared by the researchers in simple Arabic form based on a review of recent literature **(Lear, 2018; Moulson et al., 2020).**

**Implementation Phase**

- The researchers attended the cardiology inpatient department and outpatient clinics. All participants who satisfied the specified parameters for inclusion were incorporated into the study.
- The MBRP consisted of two educational sessions and one practical session; at the first educational session, the researchers started by introducing themselves to the patients and giving them a brief idea of the aim and nature of the study. An oral consent from each participant was obtained, and then the researchers conducted physical baseline outcome assessments, which included weight, blood pressure, and body mass index (BMI), among other metrics.
- The present study garnered baseline data for the purpose of establishing specific, personalised objectives that concentrate on diverse facets of personal health, notably exercise (i.e., attaining a state of physical activity for 30 minutes, five times a week), diet (i.e., increasing the consumption of fruits and vegetables while simultaneously minimising the intake of salt), emotional well-being (i.e., coping with stress and detrimental emotions), and smoking cessation (e.g., reducing cigarette smoking if relevant).
- During the second educational session, patients were enlightened on various aspects of heart disease, including its aetiology, risk factors, recommended exercise routines, suitable dietary practises, appropriate sexual conduct, permissible driving limitations, re-entry into the workforce, effective smoking cessation techniques, as well as essential coping mechanisms for managing stress and anxiety. The information was delivered via diverse instructional strategies such as brainstorming and interactive discussion, as well as the utilisation of illustrated media such as videos and pictures. The duration of this session was approximately 40 minutes.
- At the practical session, the researchers make sure the patient's phone number is registered and that he or she has internet access.
- Then, the researchers help patients download pedometer and step counter apps. The present mobile application utilises the in-built sensor equipped in the smartphone to quantify the number of steps, monitor the incineration of calories, and evaluate the distance and duration of pedestrian locomotion, among other metrics. The data presented was readily apparent in graphical format, thereby enabling its dissemination to researchers via screenshots.
- During the practical session, the researchers teach the patient how to use the app by just tapping the start button, and it starts

counting steps. The automated recording of patients' steps, even when the phone is in disparate locations such as the hand, bag, pocket, or armband, is a feature that persists regardless of whether the screen is locked.

- Upon attainment of their designated goals, users were felicitated for their progress. During the programme, objectives were adjusted or adapted in accordance with prior performance.
- Participants initiate contact with the researchers for advice and support by joining a scheduled synchronised chat room held on a weekly basis with continuing messages throughout the week to encourage lifestyle modification.
- Follow-up was done with each patient individually in the outpatient clinic to follow patients' progress and carry out a post-test.
- If a patient had not forwarded his or her data for more than one week, a warning message was sent. Participants who failed to record self-monitoring data for a duration exceeding four consecutive weeks despite receiving warning messages were excluded from the study.
- The recruitment of participants and subsequent tracking of outcomes were executed from October 2020 until November 2021.
- The researchers gathered both primary and secondary outcome measures at baseline, at 12 weeks, and subsequently at 6 months.
- Primary outcome measure was the daily average step count change at baseline, 12 weeks, and the 6-month follow-up to estimate physical activity.
- Secondary outcome measures included EE, blood pressure, lipid profile, and body mass index, which were measured using conventional instruments.
- Other outcomes included measures of daily fat and fibre consumption, levels of anxiety and depression, self-efficacy, and HRQoL.
- The present study incorporated a fasting serum lipid profile comprising assessments of total cholesterol, HDL, LDL, and triglycerides.

**Evaluation Phase:**

The effect of the MBRP on lipid control and HRQoL among cardiac patients was assessed through comparisons between the pre- and post-tests after 12 weeks and after 6 months using Tools I through V.

**Statistical design:**

The researchers entered the data using suitable personal computers. All data were entered into Excel for figures and statistical tools for the social sciences (SPSS) version 20.0 for analysis. The researcher examined, categorised, and then coded each tool's content. Numbers and percentages were used to define categorical variables, and paired nominal data described by the McNemar test—a nonparametric test—with a p-value of 0.05 or above was deemed statistically significant.

## Results

**Table 1** reveals the percentage distribution of demographic and health-relevant data among participants. The present study involved the enrollment of fifty patients, who participated and completed the trial. The final analysis encompassed the said cohort, which had a mean age of 45.33 ± 8.29; more than half of the sample were men (56.0%), and two-thirds of them were employed (66.0%); illiteracy predominated among slightly more than half of them (52.0%), and only 32.0% were smokers. The majority of the studied sample was physically active (60.0%), and previous CRP was done for only 18.0% of them.

**Table 2** compares the lipid profile and blood pressure level of participants pre- and post-programme implementation. Regarding the lipid profile, there was a statistically significant improvement in total cholesterol, triglycerides, HDL, and LDL levels after 6 months of the MBRP compared with baseline (0.05). The research data indicated a notable reduction in both systolic and diastolic blood pressure levels following a 12-week and a 6-month period of MBRP implementation, when contrasted with baseline readings (0.002), with greater significant improvements in step count at 6 months after intervention.

**Figure 1** shows that there was a significant increase in EE among participants post-implementation of MBRP in comparison with basal parameters (P = 0.05).

Similarly, in **figure 2**, the mean score of participants' self-efficacy was significantly improved at the 6-month follow-up (P < 0.05).

**Figure 3** illustrates that at 6-month follow-up, participants had greater improvements in nutritional habits, with a significant reduction in fat consumption and an increase in fibre intake (0.02).

**Figure 4** compares mean changes in body mass index and clarifies that participants had a statistically significant decrease in body mass index after six months of intervention compared with baseline measurements (P = 0.05).

**Table 3** demonstrates that there were significantly lower levels of anxiety (0.001) and depression (0.03) among participants six months after MBRP compared with baseline.

The findings presented in **Figure 5** demonstrate a noteworthy enhancement in the quality of life of participants subsequent to the implementation of MBRP when contrasted with the basal parameters (p = 0.002), and this difference is observed to be statistically significant.

**Figure 6** compares participants' clinical change in relation to quality of life subscales before and after programme implementation. There was a significantly greater improvement in angina frequency and stability, disease perception, treatment satisfaction, and physical limitation score after MBRP implementation (0.03).

**Table 1: Demographic and health-relevant data among participants (N=50)**

| Items | Number | (%) |
|---|---|---|
| **Age group** | | |
| 20 < 40 years | 10 | 20.0 |
| 40 < 50 years | 12 | 24.0 |
| 50-60 years | 28 | 56.0 |
| Age (Years) (Mean ± SD) | **45.33 ± 8.29** | |
| **Gender** | | |
| Male | 28 | 56.0 |
| Female | 22 | 44.0 |
| **Occupation** | | |
| Employed | 33 | 66.0 |
| Unemployed | 17 | 34.0 |
| **Educational level** | | |
| Literate | 24 | 48.0 |
| Illiterate | 26 | 52.0 |
| **Current smoking status** | | |
| Yes | 16 | 32.0 |
| No | 34 | 68.0 |
| **Previous cardiac rehabilitation** | | |
| Yes | 9 | 18.0 |
| No | 41 | 82.0 |
| **Level of physical activity** | | |
| sedentary | 20 | 40.0 |
| Active | 30 | 60.0 |
| Hyper active | 0 | 0.0 |

**Table 2: Comparison of the lipid profile and blood pressure level of participants pre- and post programme implementation (N = 50)**

| Physiologic parameters | Baseline | 6 Months | MCN | P |
|---|---|---|---|---|
| **Lipid profile** | Mean ± SD | | | |
| **Total cholesterol** | 257.39 ± 24.15 | 176.17 ± 22.55 | 8.321 | < 0.05 * |
| **TGs** | 192.24 ± 7.33 | 146.63 ± 12.18 | 12.442 | < 0.05 * |
| **HDL** | 31.53 ± 5.45 | 48.32 ± 2.25 | 7.994 | < 0.05 * |
| **LDL** | 130.93 ± 19.11 | 89.77 ± 9.45 | 11.844 | < 0.05 * |
| **Blood pressure** | Mean ± SD | | | |
| **Systole** | 136.69 ± 10.11 | 113.7 ± 5.64 | 4.644 | 0.002* |
| **Diastole** | 75.3 ± 8.54 | 76.6 ± 8.2 | 4.591 | 0.002* |
| **Daily steps** | Mean ± SD | | | |
| | Baseline | 12 Wk. | 6 months | P |
| | 5214 (2106) | 5710 (2607) | 6500 (2957) | < 0.05 * |

TGs. Triglycerides, HDL. High density lipoprotein, LDL. Low density lipoprotein, P: probability, MCN: McNemar test

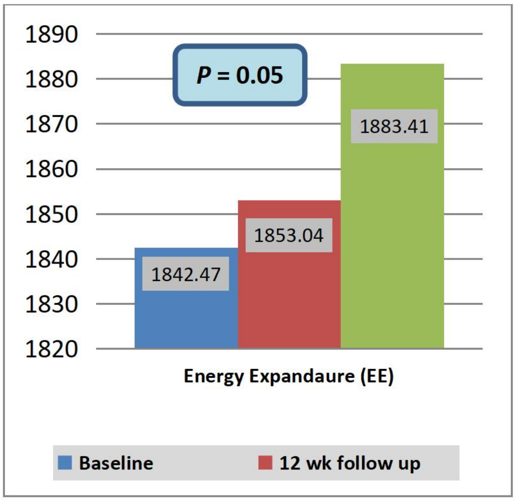



**Figure 1: Energy expenditure measurement among participants pre- and post-programme implementation**

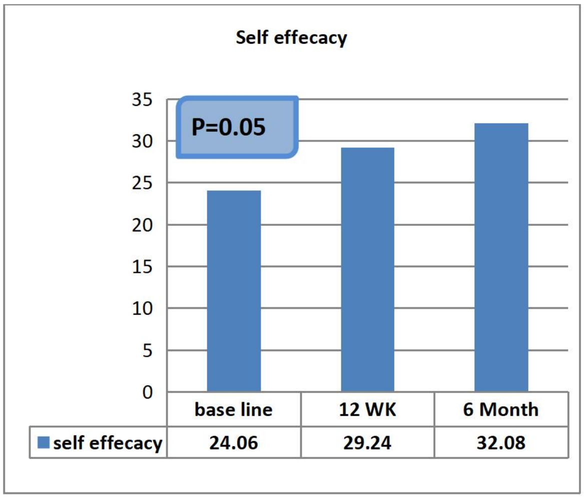
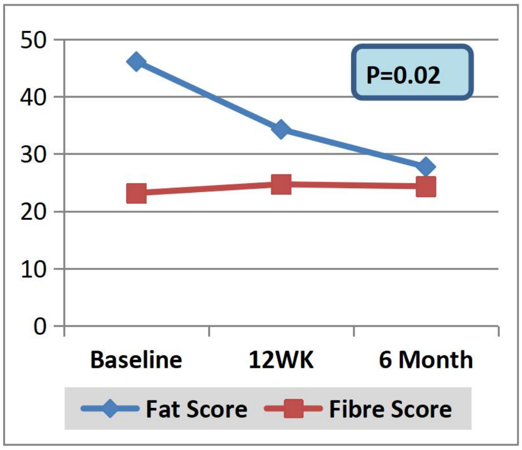



**Figure 2: Self-efficacy level among participants pre- and post-programme implementation**



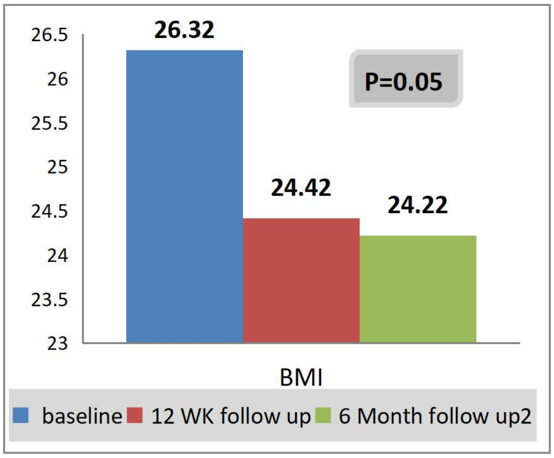
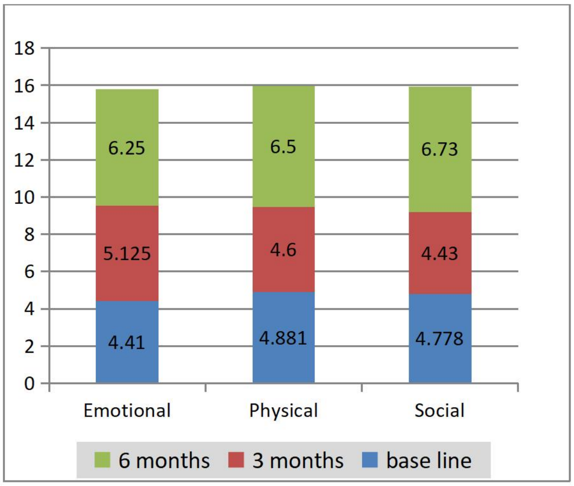




**Figure 3: Nutritional evaluation among participants before and after programme implementation**

**Figure 4: Body mass index among participants, pre- and post-programme implementation**

**Table 3: Anxiety and depression levels among participants pre- and post-programme implementation**

| | | Baseline | 12 wk. | 6 months | P |
|---|---|---|---|---|---|
| **Anxiety (HADS-A)** | Normal range (<8) | 54.5 % | 88.6 % | 95.3 % | |
| | Moderate symptoms (8–10) | 40.5 % | 9.2 % | 4.2 % | |
| | Severe symptoms (≥11) | 5.0 % | 2.2 % | 0.5 % | 0.001 ** |
| **Depression (HADS-D)** | Normal range (<8) | 95.2 % | 100 % | 100 % | |
| | Moderate symptoms (8–10) | 4.8 % | 0.0 % | 0.0 % | |
| | Severe symptoms (≥11) | 0.0 % | 0.0 % | 0.0 % | 0.03 ** |



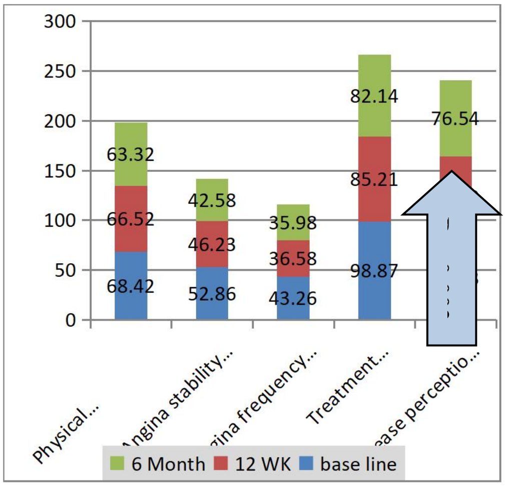




**Figure 5: Evaluation of quality of life among participants before and after programme implementation**

**Figure 6: Comparison of participants' clinical change in r[illegible]uality of life subscales before [illegible] programme implementation**

**P= 0.03**

## Discussion

Worldwide, CVDs constitute the main factor in morbidity and early mortality. Despite the significant advancements in modern medical interventions for CVDs, the number of programmes that aim to ameliorate SP and mitigate risk remains limited. Cardiac rehabilitation and self-paced physical activity are proven practises with empirical evidence demonstrating their effectiveness in augmenting risk factor modification, fostering compliance towards cardioprotective medications, and enhancing HRQoL. These practises can reduce cardiovascular mortality by up to 26% and hospital admissions by 18% **(Hu et al., 2018).**

Despite the well-established advantages of CRP, its adoption remains limited due to a significant impediment, namely, the influence of geographic location. The widespread availability of cost-effective communication technologies, such as the internet and mobile devices, has engendered a broad spectrum of possibilities for patient communication while simultaneously surmounting the barriers imposed by geographical separation. The aforementioned technologies possess considerable potential to enhance the accessibility of healthcare services. This is primarily due to their pervasive nature, limited infrastructure and financial requisites, and the ease with which they can be expanded to cater to large populations **(Lear, 2018).**

The study at hand pertains to evaluating the effect of MBRP on HRQoL among patients with cardiac conditions. The results confirm our hypothesis that users of MBRP would positively alter their lifestyle behaviours and experience significant improvements in their lipid profiles and HRQoL.

The present study ascertained that the average age of the participants was 45.33 ± 8.29. The rationale underlying this discovery pertains to the particular age criteria established for enrollment within the parameters of the present study. In this study, more than half of the participants were men. This finding may be because CVDs have long been seen as a condition primarily affecting men **(Peters, Muntner, & Woodward, 2019).** In addition, in this study, about two-thirds of the participants were employed. This result may be explained by the fact that in Egypt, the percent of the male labour force was 67.4 in 2020 based on the World Bank statistics **(Labour Force Participation Rate, 2021).**

The present study has evinced that over fifty percent of the participants exhibited illiteracy, while a mere 32.0% exhibited a smoking habit. The reason behind this outcome could be attributed to the notable rise of the literacy rate in Egypt, which has reportedly increased by 1.92% from 2017, with the current percentage ascertained at 73.09% in the year 2021 **(Egypt literacy rate, 2021).** The majority of the studied participants were physically active, and previous CRP was done for only 18.0% of them. From the researcher's perspective, the small percentage of previous CRP highlighted a gap in the health care system that should be reinforced.

These findings are consistent with a cross-sectional study carried out by **Nabutovsky, Nachshon, Klempfner, Shapiro, and Tesler (2020),** who assessed attitudes, perceptions, and behavioural intentions towards remote digital CRP and clarified that more than two-thirds of their participants were male patients, with more than half of them being physically active. Furthermore, these discoveries are consistent with an investigation carried out in London by **Suskin et al. In the year 2019**, researchers conducted an analysis to investigate the correlation between involvement in a hybrid CRP and the likelihood of experiencing mortality or a significant cardiac event subsequently and arrived at the conclusion that a considerable number of patients had no knowledge about cardiac conditions five years prior to the cardiac event.

The present outcome diverges from the observations made by **García-Bravo et al. (2020),** who evaluated the impact of virtual reality on CRP for ischemic heart disease and reported that their participants' mean age was 51.20 (±8.82) years. Also, the present result disagrees with the result of **Jóźwik, Cieślik, Gajda, and Szczepańska-Gieracha (2021),** who reported that more than one-third of their sample was highly educated.

The results of the current study proved that participants who received MBRP experienced significant improvements in their lipid profiles and a noticeable increase in their steps count and EE at six-month follow-up. Interestingly, patients have better control over systolic and diastolic blood pressure after 12 weeks and six months of MBRP compared with baseline. From the perspective of the researcher, the alterations were apparent and can be ascribed to the programme's elevated degree of utility and approval. The present findings serve as compelling evidence to support the efficacy of MBRP.

In agreement is the trial of **Dalli-Peydró, Gisbert-Criado, Amigó, Sanz-Sevilla, & Cosín-Sales (2022),** who used a smartphone application to provide guidance on exercise regimens, nutritional habits, and communication with patients through text messaging. The results indicated that a 10-month cardiac telerehabilitation programme was effective in reducing the ratio of triglycerides to high-density lipoproteins.

Moreover, the present findings establish concordance with a Chinese study conducted by **Dorje et al. (2018),** who studied the impact of smartphones and social media on CR and SP and summarised that incorporating these technologies into CRP resulted in improved cardiac patients' functional capacity and exercise tolerance, as demonstrated by the distance covered at six months of follow-up. Moreover, it was correlated with a heightened systolic blood pressure and an ameliorated lipid profile.

In addition, **Su and Yu's (2021)** investigation pertains to the examination of a nurse-led eHealth CRP's impact on health outcomes in patients suffering from coronary heart disease. The study findings revealed that six weeks post-intervention, the intervention group exhibited a considerable enhancement in their daily step count.

Oppositely, the result of **Widmer et al. (2017),** who evaluated the outcome of using digital health interventions on CRP, reported that after intervention there was no overwhelming benefit on their patients' blood pressure and lipid profiles.

In the present study, the mean score of participants' self-efficacy was significantly higher at follow-up than at baseline after MBRP implementation. The present findings corroborate the findings of **Su and Yu's (2021)** investigation, wherein their experimental cohort exhibited a significantly superior enhancement in self-efficacy vis-à-vis the control counterpart at the termination of the study.

This result is in contrast to the finding of **Ganeshan et al. (2022),** who undertook a comparison of the impact of hybrid and virtual CRP with respect to alterations in performance on the 6-minute walk test from initial enrollment to programme completion. The findings of the study demonstrated that there were no statistically significant variations in cardiac self-efficacy.

Going with this context, the results of the current study proved that, at six months follow-up, participants had greater improvements in nutritional habits with a significant reduction in fat consumption and increase in fibre intake, along with a significant decrease in body mass index compared with baseline measurements. Henceforth, it can be posited that the maintenance of MBRP is pivotally significant in effectively managing lifestyle-associated risk factors.

Concurrently, the research conducted by **Widmer et al. (2017),** who emphasised that CRP based on digital health intervention was viable and powerful in terms of reducing body weight and improving BMI.

Likewise, similar findings were reported in a study conducted by **Skobel et al. (2017),** who evaluated the feasibility of a smartphone-guided training system for patients with coronary artery disease and reported that the participants demonstrated marked enhancements in their exercise capacity, evinced lowered levels of cholesterol, and displayed ameliorations in the quality of their dietary intake.

When considering the effectiveness of MBRP, in the current study, there were significantly lower levels of anxiety and depression among participants six months after MBRP implementation compared with baseline.

The observations made by the researchers suggest that MBRP presents potential avenues for patient communication, surmounting geographical barriers, and enhancing the availability of healthcare provisions.

In the same direction, a systematic review carried out by **Subedi, Rawstorn, Gao, Koorts, and Maddison (2020)** evaluated the efficacy of implementing cardiac telerehabilitation interventions. The findings of the review indicated that these interventions are effective in enhancing patients' health outcomes and reducing levels of depression and anxiety.

Despite the outcomes of the current study, **Carney and Freedland's (2017)** research reveals that the application of telerehabilitation training yields no apparent benefits with regards to ameliorating negative anxiety and depression.

With respect to the HRQoL of the participants, the findings of the present study reveal a statistically significant enhancement in their HRQoL six months following the implementation of MBRP. From the researcher's point of view, improving participants' health risk factors and clinical outcomes may positively affect HRQoL.

In a similar vein, **Su and Yu (2021)** derived a comparable result, as their study illuminates that the intervention group demonstrated a noticeable advancement in HRQoL compared to the control group upon culmination of the research.

It has been consistently demonstrated that patients who have undergone a CRP experience significant improvement in their functional capacity and quality of life across a range of domains. Specifically, improvements have been observed in scores related to the mental component, physical functioning, physical performance, general health, vitality, social functioning, and mental health outcomes **(Dibben et al., 2021).**

This outcome is congruent with the findings of **Li, Hui, Zheng, Yu, and Zhang (2022),** who outlined that recent technological developments in the telecommunications industry have facilitated the potential for telehealth interventions delivered by CRP, thereby enabling the circumvention of temporal and geographic obstacles. Henceforth, it is apparent that telerehabilitation can enhance the cardiopulmonary function of individuals by augmenting their capacity for physical activity and exercise, thereby yielding advantageous outcomes for their HRQoL.

This study finding clarifies that there was also a significantly greater improvement in five SAQ subscales at six-month follow-up: angina frequency and stability, disease perception, treatment satisfaction, and physical limitation score.

It is also worth noting that the current result is backed by a retrospective analysis study conducted by **Zhang et al. (2021),** who evaluated the long-term viability and security of cardiopulmonary work-out testing combined with the efficient instruction of the CRP approach for patients post-coronary stenting and detailed that both recently and after intercession, scores for the five components of the SAQ were higher for the CRP bunches versus control bunches.

In the opposite direction, a retrospective cohort study by **Kureshi et al. (2016)** inspected the affiliation of participation in CRP and health status outcomes after acute myocardial infarction and stated that those who did and did not take part in CRP had comparable detailed wellbeing status during the year following acute myocardial infarction.

Finally, the current study findings shed some light on the importance of virtual CRP like mobile and internet in terms of positively changing cardiac patients' lifestyle behaviours and leading to significant improvements in lipid profiles and HRQoL. These discoveries are similar to those made in the past in several healthcare settings around the world.

## Limitation of the study

The data collection procedure was limited to Specialised Medical Hospital; hence, its findings cannot be generalised.

## Conclusion

In conclusion, the current study highlighted sufficient evidence that MBRP was effective in behavioural change, health outcome, and HRQoL among cardiac patients. The results also pointed out its noteworthy impact on diminishing patients' depression and anxiety levels and the possibility to safely integrate the programme into clinical practise to control cardiac patients' overall health status and may offer an alternative self-management approach to conventional CRP. The programme is additionally likely to offer a lower-cost frame of intervention and the use of a web-based alternative.

## Recommendations

A huge, practical trial is required to look at the viability and cost-effectiveness of this intervention. The current study should be done once more with a bigger sample size and in a diverse healing centre for generalisation of the results. We would propose to repeat the current study with prolonged follow-up.

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