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Effect of Home-Based Cardiac Rehabilitation in a Lower-Middle Income Country

RESULTS FROM A CONTROLLED TRIAL

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2 **The effect of Home-based Cardiac Rehabilitation in a Lower Middle Income Country: Results**
3 **from a Controlled trial**

4

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30

31 ABSTRACT

32 Purpose: Cardiovascular disease is the leading cause of mortality and morbidity in lower middle
33 income countries (LMIC), including Bangladesh. Cardiac Rehabilitation (CR) as part of secondary
34 prevention of cardiovascular disease has been shown to improve mortality, morbidity, quality of life
35 and exercise capacity. However, to date very few controlled trials of CR have been conducted in
36 LMIC.

37 Methods: A quasi-randomised controlled trial comparing home-based CR plus usual care to usual care
38 alone was undertaken with patients following coronary artery bypass graft (CABG) surgery. The CR
39 group received an in-hospital CR class and were introduced to a locally developed educational booklet
40 with details of a home-based exercise programme, then received monthly telephone calls for 12
41 months. Primary outcomes were coronary heart disease (CHD) risk factors, health-related quality of
42 life (HRQL) and mental well-being. Maximal oxygen uptake as a measure of exercise capacity was a
43 secondary outcome.

44 Results: 142 participants out of 148 eligible, participated in the trial (96%); 71 in each group. At 12
45 months follow-up, 61 (86%) patients in the CR group and 40 (56%) in the usual care group provided
46 complete outcome data. Greater improvements in CHD risk factors, HRQL, mental well-being and
47 exercise capacity were seen for the CR group compared to usual care.

48 Conclusions: In the context of a single centre LMIC setting, this study demonstrates the feasibility of
49 home-based CR programmes and offers a model of service delivery that could be replicated on a larger
50 scale.

51 CONDENSED ABSTRACT

52 A quasi-randomised controlled trial comparing home-based cardiac rehabilitation to usual care was
53 undertaken with patients following coronary artery bypass graft surgery, in Bangladesh, a lower to
54 middle income country. The trial found cardiac rehabilitation was feasible and provided similar patient
55 benefits to trials of cardiac rehabilitation based in high-income countries.

56 INTRODUCTION

57 Cardiovascular disease is the leading cause of non-communicable disease death globally¹. Over 80%
58 of these deaths occur in low, and lower middle income countries (LMIC), including Bangladesh²⁻⁴.

59 Like many LMIC, Bangladesh is passing through an epidemiological transition from communicable to
60 non-communicable diseases⁵. The rates of communicable disease have fallen while mortality due to
61 cardiovascular disease including coronary artery disease has risen thirty-fold⁵.

62 LMICs including Bangladesh have made impressive gains in public and private health care services,
63 offering sophisticated technology-based diagnostic and therapeutic procedures for coronary artery
64 disease including percutaneous coronary interventions and coronary artery bypass grafting (CABG)⁶.
65 However, the provision of evidence-based preventive strategies including cardiac rehabilitation (CR) is
66 running alarming behind⁷.

67 CR is a comprehensive approach to rehabilitation and secondary prevention involving activities that
68 improve the physical, mental and social well-being of patients as well as targeted secondary preventive
69 strategies to reduce the risk of future cardiovascular events⁸. Exercise-based CR and secondary
70 prevention have been shown in multiple studies to improve cardiovascular mortality, morbidity, health-
71 related quality of life (HRQL) and exercise capacity and reduce cardiovascular disease risk in high-

72 income countries^{9,10}. Despite the clear benefits of CR, there is low availability in LMIC, with only 23%
73 of LMIC having CR programmes compared with 68% in high-income countries¹¹.

74 There also remains limited evidence for the effectiveness of CR in the LMIC settings. Following a
75 literature search in 2013, Turk-Adawi and Grace found only two randomised controlled trials of CR
76 conducted in LMICs¹. The majority of the studies described in the review were in upper-middle income
77 countries with only two studies placed in the same, lower-middle income bracket as Bangladesh, as
78 defined by the World Bank as economies with a gross national income per capita between \$1,026 and
79 \$4,035¹². One study in India, used in-patient CR followed by home based CR compared to usual
80 care¹³. They found significant improvements in 6-minute walk distance and HRQL following the
81 intervention compared to control group¹³. Another, in China, found improvements in walking ability
82 and coronary heart disease (CHD) risk factors following a six-month nurse led CR programme¹⁴. CR
83 studies in upper-middle income countries have shown significant reductions in triglycerides, total
84 cholesterol, low density lipoproteins, body mass index, systolic and diastolic blood pressure as well as
85 significant improvements in high density lipoproteins, exercise capacity and HRQL¹⁵⁻¹⁷.

86 However, it cannot be assumed that results in high or middle income countries will be directly
87 transferable to a Bangladeshi population due to the potential differences in culture, health, transport,
88 environment and communication infrastructure. Patients in Bangladesh may be required to travel for
89 several days by scarce public transport and may need to stay overnight to attend hospital appointments.
90 They may also have caring responsibilities at home or require time off from work to attend CR. The
91 indirect costs (loss of earnings and transport) of healthcare have been shown to be much higher than the
92 direct costs for people in Bangladesh and those costs are even higher for those from rural areas¹⁸.

93 Facilities to undertake CR within the hospital or local community are also limited. A report in 2012

94 identified only one CR programme in Bangladesh, based in a private hospital⁷. A small number of
95 studies investigating home-based CR suggest it may be equally effective as centre-based CR, in terms
96 of clinical outcomes and HRQL¹⁹. Home-based CR has also been suggested as overcoming some of
97 the barriers to participation caused by limitations in transport, time or cost of attendance¹⁹⁻²¹. This
98 quasi-randomised controlled trial design was undertaken to and impact of home-based CR on patients
99 following CABG surgery in Bangladesh. The study had two objectives: Firstly, to evaluate the
100 feasibility of a home-based CR program in addition to usual care (UC) in post-CABG surgery patients
101 in Bangladesh. Secondly, to test the hypothesis that the addition of a CR intervention would lead to
102 greater improvements in CHD risk factors, HRQL, mental well-being (primary outcomes) and exercise
103 capacity (secondary outcome), compared to UC alone.

104

105 **METHODS**

106 The trial was not preregistered in a formal trial registry nor published, in part due to the level of
107 research expertise of the research team and also the lack of infrastructure in registering clinical trials in
108 2012, in Bangladesh. However, a protocol was prepared, based on existing literature, and submitted to
109 the Institutional Review Board of Ibrahim Cardiac Hospital & Research Institute (ICH&RI) (hospital
110 ethics committee), from whom ethical approval for the study was obtained (REF: IEC
111 032/ICHRI/2012). All trial participants received written information describing the study and
112 implications in detail and a signed consent form was obtained. The trial is reported here according to
113 the Consolidated Standards of Reporting Trials (CONSORT)– extension for randomised trials of non-
114 pharmacologic treatment²².

115

116 A quasi-random method was used to allocate patients to either a home-based CR programme in
117 addition to UC or UC alone. Allocation was done according to patients' given week of surgery, with
118 every other week allocating patients to either CR group or UC group. Allocation was done by the
119 research team and was not influenced by the preferences of the research team, patients or relatives.
120

121 The study was based at ICH&RI in Dhaka, where all patients pay for their treatment, including the
122 study participants. There are 22 cardiac institutions in Bangladesh with 18 of these based in Dhaka.
123 Very few institutions outside Dhaka offer CABG surgery hence patients may travel long distances by
124 public transport and require overnight accommodation, to attend hospital appointments. Dhaka is one
125 of the most densely populated cities in the world. Hence, travel to the hospital, even within Dhaka, may
126 take several hours. Thus, a home-based CR programme was considered more feasible than a centre-
127 based programme.

128

129 All patients who were admitted from July 2012 to July 2013 were screened for inclusion in the study
130 (Figure 1.). Patients were included if they were admitted for elective CABG surgery, aged between 25-
131 65 years and understood Bangla. Patients were excluded if they were admitted for emergency CABG or
132 revision CABG surgery or if they had any neurological problems, severe co-morbidities or were not
133 planning on staying in Bangladesh for one year after CABG surgery. Eligible participants were
134 approached by a member of the research group following their surgery.

135

136 Patients allocated to the CR group participated in a 45 minute in-hospital CR class and were provided
137 with an educational booklet in Bangla. The materials were based on the Monash Heart Cardiac
138 Education Booklet²³ and developed by the research team (cardiologists, cardiac surgeons,

139 physiotherapists and specialist nurse) to fit the specific needs of patients in Bangladesh. The booklet
140 described the home exercise training programme including upper and lower limb exercises, breathing
141 exercises, chest movements and aerobic exercise (walking program). The educational booklet provided
142 information about safe levels of activity, details of personal risk factors, useful telephone numbers,
143 advice on when to seek medical advice and how to manage recurrent breathlessness or chest pain. The
144 CR programme was delivered in the physiotherapy department in groups of 6-10 patients, 7-8 days
145 after surgery. The medical team confirmed that patients were medically fit for CR before attending.

146

147 Patients allocated to the CR group received a monthly telephone call for twelve months. Calls were
148 made by qualified physiotherapists trained by the research team on the CR advice booklet and exercise
149 programme. The physiotherapists answered any questions subjects may have, reminded them to follow
150 the CR advice booklet and exercise programme, and to attend their next hospital appointment. The
151 phone calls did not follow a script nor did the physiotherapists individually tailor the progression of the
152 CR plan. In addition to the intervention, the CR group received UC. UC consisted of conventional
153 hospital discharge care including drug treatment and routine follow-up hospital visits. The physician
154 who discharged and saw the patient for follow-up visits was responsible for initiating or adjusting
155 medication. Follow-up hospital visits occurred at 7 days, 6 weeks, 3 months, 6 months and 12 months
156 post-op. Appendix 1 provides further details of the in-hospital CR class, UC and home-based CR
157 programme.

158

159 Prior to discharge and before allocation to either the CR or UC group, baseline data were collected on
160 each patient. (Table 1.) Due to the short time available when patients returned for follow-up hospital
161 appointments, it was decided to collect selected outcomes at each follow-up appointment (Table 2.).

162 CHD risk factors were collected routinely at the 6 month follow-up appointment; this required patients
163 to fast 12-24 hours before they had the blood test, and then eat breakfast. They then undertook the
164 maximal oxygen uptake test but no further outcomes were possible at this appointment due to time
165 constraints.

166

167 The World Health Organisation Quality of Life– abbreviated, required up to an hour to complete hence
168 it was decided to collect this outcome at the last follow-up appointment, at 12 months.

169 The questionnaire consists of 26 items: the first two questions ask patients about their overall
170 perception of HRQL and the remaining 24 questions address four domains: physical health,
171 psychological health, social relationships, and environmental health. Higher scores represent a higher
172 level of patient HRQL. The Bangla version of this measure has been found to a valid and reliable
173 measure of HRQL in an adult population in Bangladesh²⁴.

174

175 Patients' mental well-being was assessed by using the Patient Health Questionnaire²⁵, with higher
176 scores indicating greater levels of depression and was completed at the 3 months follow-up
177 appointment.

178

179 Exercise capacity was assessed using a single stage treadmill walking test protocol²⁶. Maximum
180 oxygen uptake was estimated using the following equation: $VO_{2max} = 15.1 + (21.8 \times \text{treadmill speed}) -$
181 $(0.327 \times \text{heart rate}) - (0.263 \times \text{treadmill speed} \times \text{age}) + (0.00504 \times \text{heart rate} \times \text{age}) + (5.98 \times \text{gender})$.

182 At the time the study was undertaken it was not possible for patients to undergo exercise testing as in-
183 patients, hence no baseline exercise capacity was collected.

184

185 Statistical analysis

186 Data analyses were performed on an intention-to-treat basis, i.e., comparison of outcomes between UC
187 and CR groups defined according to the initial quasi-random allocation in those patients with complete
188 follow-up data. No imputation of missing follow-up outcome data was performed. Outcomes were
189 compared using an independent two-sample t-test. Where baseline data were collected, we compared
190 groups using the outcome difference between baseline and follow-up. For exercise capacity, groups
191 were compared using outcome values at follow-up. Outcomes were summarised as raw numbers,
192 percentages, or means/standard deviations, and the difference of within group reported as means, 95
193 percent confidence intervals [95% CI] and p-values. We also compared between group differences
194 reported as mean difference [95% CI] and p-value. All tests were two-sided and the level of statistical
195 significance set at a p-value of ≤ 0.05 .

196

197 RESULTS

198 A total of 210 patients were screened for participation in the trial. Of these, 62 were excluded, leaving
199 148 patients eligible. Six patients declined consent, providing a total of 142 participants (96% of
200 eligible patients) of which 71 were allocated to the CR group and 71 were allocated to the UC group.
201 The two groups were well balanced in terms of their demographic characteristics and baseline CHD
202 risk factors. The mean age of participants was 54 years and 93% were male. This CABG population
203 mainly had a normal left ventricular ejection fraction (mean 52%) and 42% had a history of diabetes
204 mellitus. Mean blood pressure was 124/78 mmHg and 54% were smokers at trial enrolment.
205 At 12 months follow-up, 61 (86%) and 40 participants (56%) in the CR and UC group respectively had
206 complete outcome data. The demographic characteristics (i.e., age, gender, level of education) and risk

207 factor levels (family history of CHD, smoking history, diabetes history, serum cholesterol levels, and
208 left ventricular ejection fraction) of patients lost to follow-up were similar to patients with complete
209 data at 12 months.

210

211 **CHD risk factors**

212 In the CR group, mean CHD risk factors at 6 months were all significantly improved compared to
213 baseline (Table 3). In the UC group, only blood pressure and HbA1c significantly improved in the UC
214 group compared to baseline, while mean body mass index and lipid profile remained unchanged.

215 Between group differences showed significant improvements of mean difference in body mass index (-
216 0.61kg/m^2 [95%CI -1.07 to -0.16] $P= 0.008$) and lipid profile (total cholesterol (-52.98mg/dl[95%CI
217 80.41 to 25.55] $P=0.001$; low density lipoproteins: -40.21mg/dl [95% CI -60.26 to 20.15] $P= 0.001$;
218 triglycerides: -53.02mg/dl, [95% CI -86.24 to -19.80] $P= 0.002$; high density lipoproteins: 3.54mg/dl,
219 [95% CI 0.81 to 6.26] $P= 0.01$) in favor of the CR group.

220

221 Changes in blood pressure and HbA1c were not shown to be significantly different in the CR compared
222 to the UC group (Systolic blood pressure: 1.35 mmHg[95%CI -4.21 to 6.90] $P=0.63$; diastolic blood
223 pressure: -0.31 mmHg[95% CI -0.39 to 3.33] $P= 0.86$; HbA1c: -0.49 mg/ml [-1.14 to 0.16] $P= 0.14$)
224 (Table 3).

225 **HRQL**

226 There were significant improvements in the overall perception of quality of life and overall perception
227 of health in both CR and UC groups at 12 months (Table 4). Domain specific scores in the CR group

228 also significantly improved. Domain specific scores in the UC group all showed no significant change
229 except for social relationship which was significantly worse at 12 months.

230 Between group differences showed improvements in the overall perception of quality of life, overall
231 perception of health, and all domain scores were significantly greater for the CR compared to the UC
232 group (Table 4).

233 **Mental well-being**

234 Patient health questionnaire scores from baseline to 3 month follow-up improved significantly for both
235 groups but with significantly greater improvement found in the CR group compared to the UC group
236 (mean difference - 3.53 [95% CI -4.40 to -2.73] $p < 0.001$) (Table 4).

237 **Exercise capacity**

238 Exercise capacity was only measured at 6 months follow-up. Maximal oxygen uptake was significantly
239 higher in the CR group (36 ml/kg/min) compared to the UC group (29 ml/kg/min) (mean difference
240 6.57 [95% CI 1.99 to 11.14] $p = 0.005$) (Table 4).

241 **DISCUSSION**

242 The aim of this controlled trial was to evaluate the feasibility and impact on patients following CABG
243 surgery of a home-based CR programme in the LMIC setting of Bangladesh. The study indicates that
244 CR is feasible within the constraints of a LMIC, i.e. it was possible to provide education to patients
245 following CABG surgery and follow them up at home over the telephone. The study also demonstrated
246 potentially significant benefits to patients of CR compared to UC alone, in terms of CHD risk factors,
247 HRQL, mental well-being, and exercise capacity.

248

249 There are several key limitations that need to be considered. Due to practical restrictions, it was not
250 possible to randomise the allocation of patients to the CR and UC groups, but instead patients were
251 allocated using a quasi-random approach according to the week of their CABG surgery. However, the
252 allocation process was not influenced by the preference of patients, researchers, or clinicians, and we
253 therefore believe the risk of selection bias and confounding to be low. This is supported by the balance
254 in the baseline characteristics of the two groups. Due to the nature of the CR, we were not able to blind
255 patients or clinicians to group allocation which may have introduced bias in terms of patients'
256 responses to outcome questionnaires at follow-up. It is not possible to report potential differences in
257 the improvement of exercise capacity between CR and UC because we did not assess exercise capacity
258 at baseline. The single centre nature of this study means that we must be cautious in generalising our
259 findings to other Bangladeshi or LMIC settings beyond the population at ICH&RI as this was a single
260 site study. Further, data on prescribed medications, participation in exercise during the study period and
261 smoking cessation rates after surgery, were not collected but may have influenced the results. Baseline
262 testing of exercise capacity was not possible hence the difference between groups over time cannot be
263 stated. A high participation rate (96%) was achieved. However, the number of patients lost to follow up
264 during the study was greater in the control group (43% versus 14%) (Table 2). This may be because the
265 CR group received monthly phone calls that included reminding them about their follow-up
266 appointments. Risk of drop-out did not appear to be related to patient demographics, health behaviour,
267 clinical or mental health status.

268

269 This study is one of just a very few controlled trials of CR that has been undertaken to date in
270 LMIC^{13,14}. The results are in concordance with two previous studies showing improvements in exercise

271 capacity and HRQL with home-based CR and cardiac patients^{13,27}. The findings of the study are in
272 agreement with the large evidence base for CR in high-income countries^{9,10}, however, the study did not
273 provide a comprehensive CR programme, (defined as including elements of exercise, psychological
274 and education-based interventions²⁸) as tested in many of the high-income studies, hence a direct
275 comparison of results cannot be made. Recent recommendations on how to delivery CR in low-
276 resource settings promotes the need to expand CR to LMIC and that home or community-based
277 projects led by allied-health professionals may be most feasible²⁹. Our study supports these
278 recommendations but larger, randomised controlled trials on the effectiveness of CR in LMIC are
279 needed before wide-spread implementation can take place. These trials should include economic
280 evaluations, investigate the practical implementation of CR in low-resource settings and test
281 comprehensive CR programmes.

282

283 **CONCLUSION**

284 In the context of a single centre LMIC setting, this study demonstrates the feasibility of home-based
285 CR programmes and offers a model of service delivery that could be replicated on a larger scale. Multi
286 centre randomised controlled studies are needed to assess if these results can be replicated on a larger
287 scale and provide a cost-effective use of resources in these low-resource settings.

288

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293 provided additional information for the purposes of this study.

294

295 **AUTHOR CONTRIBUTIONS**

296 Jamal U, MM, RK, Jalal U, SM and MR contributed to the conception and design of the study and
297 acquisition of data. Jamal U, MM, RK, VLJ, HKR, RST and ADZ contributed to the analysis of the
298 data and drafting of the manuscript. Jamal U, VLJ, HKR, RST and ADZ provided critical revision of
299 the manuscript.

300

301 **REFERENCES**

- 302 1. Turk-Adawi KI, Grace SL. Narrative review comparing the benefits of and participation in
303 cardiac rehabilitation in high-, middle- and low-income countries. *Heart, Lung and*
304 *Circulation*. 2015;24(5):510-520. doi:10.1016/j.hlc.2014.11.013.
- 305 2. Mamun Al M, Rumana N, Pervin K, et al. Emerging Burden of Cardiovascular Diseases in
306 Bangladesh. *J Atheroscler Thromb*. 2016;23(4):365-375. doi:10.5551/jat.30445.
- 307 3. Bleich SN, Koehlmoos TLP, Rashid M, Peters DH, Anderson G. Noncommunicable
308 chronic disease in Bangladesh: Overview of existing programs and priorities going
309 forward. *Health Policy*. 2011;100(2-3):282-289. doi:10.1016/j.healthpol.2010.09.004.
- 310 4. World Health Organization. A prioritized research agenda for prevention and control of
311 noncommunicable diseases. Mendes S, Alwan A, eds. 2011.
- 312 5. Ahsan Karar Z, Alam N, Kim Streatfield P. Epidemiological transition in rural
313 Bangladesh, 1986-2006. *Glob Health Action*. 2009;2(1):1904. doi:10.3402/gha.v2i0.1904.
- 314 6. Islam AKMM, Majumder AAS. Coronary artery disease in Bangladesh: A review. *Indian*
315 *Heart Journal*. 2013;65(4):424-435. doi:10.1016/j.ihj.2013.06.004.
- 316 7. Zahan R. Exercise-based Cardiac Rehabilitation Program: Status in Bangladesh. *The*
317 *Institute of Sport Science and Spor Friedrich-Alexander University Erlangen-Nuremberg*.
318 March 2013:1-135.

- 319 8. Piepoli MF, Corrà U, Benzer W, et al. Secondary prevention through cardiac
320 rehabilitation: from knowledge to implementation. A position paper from the Cardiac
321 Rehabilitation Section of the European Association of Cardiovascular Prevention and
322 Rehabilitation. *Eur J Cardiovasc Prev Rehabil*. 2010;17(1):1-17.
323 doi:10.1097/HJR.0b013e3283313592.
- 324 9. Anderson LJ, Taylor RS. Cardiac rehabilitation for people with heart disease: an overview
325 of Cochrane systematic reviews. *International Journal of Cardiology*. 2014;177(2):348-
326 361. doi:10.1016/j.ijcard.2014.10.011.
- 327 10. Uddin J, Zwisler A-D, Lewinter C, et al. Predictors of exercise capacity following
328 exercise-based rehabilitation in patients with coronary heart disease and heart failure: A
329 meta-regression analysis. *European Journal of Preventive Cardiology*. 2016;23(7):683-
330 693. doi:10.1177/2047487315604311.
- 331 11. Turk-Adawi K, Sarrafzadegan N, Grace SL. Global availability of cardiac rehabilitation.
332 *Nat Rev Cardiol*. 2014;11(10):586-596. doi:10.1038/nrcardio.2014.98.
- 333 12. World Bank Group. World Bank Country and Lending Groups
334 . [https://datahelpdesk.worldbank.org/knowledgebase/articles-world-bank-country-and-lending-](https://datahelpdesk.worldbank.org/knowledgebase/articles-world-bank-country-and-lending-groups)
335 [groups](https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups). [https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-](https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups)
336 [country-and-lending-groups](https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups).
- 337 13. Babu AS, Maiya AG, George MM, Padmakumar R, Guddattu V. Effects of Combined
338 Early In-Patient Cardiac Rehabilitation and Structured Home-based Program on Function
339 among Patients with Congestive Heart Failure: A Randomized Controlled Trial. *Heart*
340 *Views*. 2011;12(3):99-103. doi:10.4103/1995-705X.95064.
- 341 14. Jiang X, Sit JW, Wong TK. A nurse-led cardiac rehabilitation programme improves health
342 behaviours and cardiac physiological risk parameters: evidence from Chengdu, China.
343 *Journal of Clinical Nursing*. 2007;16(10):1886-1897. doi:10.1111/j.1365-
344 2702.2007.01838.x.
- 345 15. Taylor RS, Brown A, Ebrahim S, et al. Exercise-based rehabilitation for patients with
346 coronary heart disease: systematic review and meta-analysis of randomized controlled
347 trials. *The American Journal of Medicine*. 2004;116(10):682-692.
348 doi:10.1016/j.amjmed.2004.01.009.
- 349 16. Lawler PR, Filion KB, Eisenberg MJ. Efficacy of exercise-based cardiac rehabilitation
350 post-myocardial infarction: A systematic review and meta-analysis of randomized
351 controlled trials. *American Heart Journal*. 2011;162(4):571-584.e572.
352 doi:10.1016/j.ahj.2011.07.017.

- 353 17. Oldridge N. Exercise-based cardiac rehabilitation in patients with coronary heart disease:
354 meta-analysis outcomes revisited. *Future Cardiol.* 2012;8(5):729-751.
355 doi:10.2217/fca.12.34.
- 356 18. Pavel MS, Chakrabarty S, Gow J. Cost of illness for outpatients attending public and
357 private hospitals in Bangladesh. *Int J Equity Health.* 2016;15(1):167. doi:10.1186/s12939-
358 016-0458-x.
- 359 19. Dalal HM, Zawada A, Jolly K, Moxham T, Taylor RS. Home based versus centre based
360 cardiac rehabilitation: Cochrane systematic review and meta-analysis. *BMJ.*
361 2010;340:b5631. doi:10.1136/bmj.b5631.
- 362 20. Jolly K, Lip GYH, Taylor RS, et al. The Birmingham Rehabilitation Uptake Maximisation
363 study (BRUM): a randomised controlled trial comparing home-based with centre-based
364 cardiac rehabilitation. *Heart.* 2009;95(1):36-42. doi:10.1136/hrt.2007.127209.
- 365 21. Jolly K, Taylor R, Lip GY, et al. The Birmingham Rehabilitation Uptake Maximisation
366 Study (BRUM). Home-based compared with hospital-based cardiac rehabilitation in a
367 multi-ethnic population: cost-effectiveness and patient adherence. *Health Technol Assess.*
368 2007;11(35):1-118. doi:10.3310/hta11350.
- 369 22. Boutron I, Moher D, Altman DG, Schulz KF, Ravaud P, CONSORT Group. Extending the
370 CONSORT statement to randomized trials of nonpharmacologic treatment: explanation
371 and elaboration. *Ann Intern Med.* 2008;148(4):295-309.
- 372 23. Lacey CM, Tozer J, Cavacas G. *Cardiac Education Booklet.* 2010.
373 <http://www.monashheart.org.au/wp-content/uploads/2015/12/Cardiac-Rehab-Booklet.pdf>.
- 374 24. TSUTSUMI A, IZUTSU T, KATO S, et al. Reliability and validity of the Bangla version
375 of WHOQOL-BREF in an adult population in Dhaka, Bangladesh. *Psychiatry Clin*
376 *Neurosci.* 2006;60(4):493-498. doi:10.1111/j.1440-1819.2006.01537.x.
- 377 25. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity
378 measure. *J Gen Intern Med.* 2001;16(9):606-613. doi:10.1046/j.1525-
379 1497.2001.016009606.x.
- 380 26. Canadian Society for Exercise Physiology. The Canadian Physical Activity, Fitness and
381 Lifestyle Approach Supplement to the third edition. August 2010:1-28.
- 382 27. Chakraborty K, Das KM, Iswarari D, et al. A Comparative Study on the Effects of
383 comprehensive rehabilitation in uncomplicated coronary artery bypass grafting patients
384 from rural and urban India. *IJPMR.* 2007;18(2):34-40.
- 385 28. Corrà U, Giannuzzi P, Adamopoulos S, et al. Executive summary of the position paper of
386 the Working Group on Cardiac Rehabilitation and Exercise Physiology of the European
387 Society of Cardiology (ESC): core components of cardiac rehabilitation in chronic heart

388 failure. *European Journal of Cardiovascular Prevention & Rehabilitation*.
389 2005;12(4):321-325.

390 29. Grace SL, Turk-Adawi KI, Contractor A, et al. Cardiac rehabilitation delivery model for
391 low-resource settings. *Heart*. 2016;102(18):1449-1455. doi:10.1136/heartjnl-2015-309209.

392 Figure 1. CONSORT flow diagram

Table 1. Baseline patient characteristics and risk factor levels

	CR group (n = 71)	UC group (n = 71)
Demographics		
Age in years, Mean (SD)	54 (6)	55 (6)
Gender, Males, N (%)	66 (93)	63 (89)
Level of education, N (5)		
≤ Secondary School Certificate	35 (49)	41 (58)
≥ Higher Secondary School Certificate (16 years)	36 (51)	30 (42)
Modifiable and non-modifiable risk factors		
Family history of CAD, N (%)	27 (38)	36 (37)
Smoking history, N (%)	42 (59)	35 (49)
History of diabetes mellitus, N (%)	42 (59)	45 (63)
Hypertension N (%)	44 (62)	46 (65)
Dyslipidemia*, N (%)	43 (61)	49 (69)
BMI(kg/m ²), Mean (SD)	26 (3)	25 (3)
Clinical risk factors		
HbA1c (mmol/l), Mean (SD)	7(2)	7 (1.5)
Blood pressure (mmHg), Mean (SD)		
Systolic	124 (13)	127 (16)
Diastolic	78 (8)	80 (8)
Cholesterol (mg/dl), Mean (SD)		
Total	178 (53)	179 (56)
HDL	31 (7)	29 (7)
LDL	128 (7)	125 (56)
Triglycerides	173 (114)	183 (76)

LVEF %, Mean (SD)	52 (9.4)	52 (10.50)
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Table 2. Summary of outcome data collection schedule

	Baseline	3 months follow-up	6 months follow-up	12 months follow-up
CHD Risk factors	√	-	√	-
WHOQOL-BREF	√	-	-	√
PHQ-9	√	√	-	-
VO ₂ max	-	-	√	-

√ = outcome collected - = no outcome collected

Table 3. Between group difference in baseline and 6 months follow-up CHD risk factors

Risk factors	CR group, (n=61)				UC group, (n=40)					
	Baseline Mean (SD)	6 months follow-up Mean (SD)	Within group Mean change (95% CI)*	<i>p</i> -value	Baseline Mean (SD)	6 months follow-up Mean (SD)	With group mean change (95% CI)*	<i>p</i> -value	Between group; mean difference (95% CI)*	P-Value
BMI (kg/m ²)	25.54 (2.53)	24.63 (2.26)	-0.91 (-1.75 to -0.07)	0.03	24.77 (2.86)	24.47(2.6 to 8.00)	-0.29 (-1.53 to 0.94)	0.63	-0.6 (-1.07 to -0.16)	0.008
SBP (mm Hg)	122.95 (13.02)	114.42 (6.71)	-8.52 (-12.11 to -4.93)	<0.001	126.75 (15.56)	116.87 (10.23)	-9.87 (-15.66 to -4.08)	0.001	1.35 (-4.21 to 6.90)	0.63
DBP(mm Hg)	77.45 (8.38)	74.01 (5.68)	-3.44 (-6.02 to -0.86)	0.009	79.75 (7.64)	76.62 (6.34)	-3.12 (-6.25 to 0.009)	0.05	-0.31 (-0.39 to 3.33)	0.86
Total cholesterol (mg/dl)	179.98 (53.17)	112.29 (36.40)	-67.68 (-84.42 to -50.95)	<0.001	175.27 (55.96)	160.57 (53.35)	-14.70 (-39.03 to 9.63)	0.23	-52.98 (-80.41 to 25.55)	<0.001

LDL-cholesterol (mg/dl)	131.44 (54.46)	87.14 (23.17)	-44.30 (-59.76 to -28.83)	<0.001	123.14 (56.38)	119.05 (40.31)	-4.09 (-25.61 to 17.43)	0.70	-40.21 (-60.26 to 20.15)	<0.001
Triglycerides (mg/dl)	180.42 (114.36)	108.85 (48.83)	-71.57 (-104.12 to -39.02)	<0.001	179.92 (75.94)	161.37 (64.72)	-18.55 (-49.63 to 12.53)	0.23	-53.02 (-86.24 to 19.80)	0.002
HDL-cholesterol (mg/dl)	30.80 (6.50)	35.34 (4.79)	4.54 (2.51 to 6.56)	<0.001	29.40 (6.53)	30.80 (4.94)	1.00 (-1.77 to 3.77)	0.47	3.54 (0.81 to 6.26)	0.01
HbA1c(mg/ml)	7.46 (2.07)	6.28 (0.92)	-1.18 (1.77 to -0.58)	<0.001	7.11 (1.5)	6.42 (1.03)	-0.68 (0.11 to 1.26)	0.019	-0.49 (-1.14 to 0.16)	0.14

Abbreviations: BMI, Body Mass Index; CR, Cardiac Rehabilitation; DBP, CHD, Coronary Heart Disease; Diastolic Blood Pressure; HDL, High Density Lipoprotein; LDL, Low Density Lipoprotein; SBP, Systolic Blood Pressure; UC, Usual Care.* A reduction is stated as a negative number while an increase is stated as a positive number.

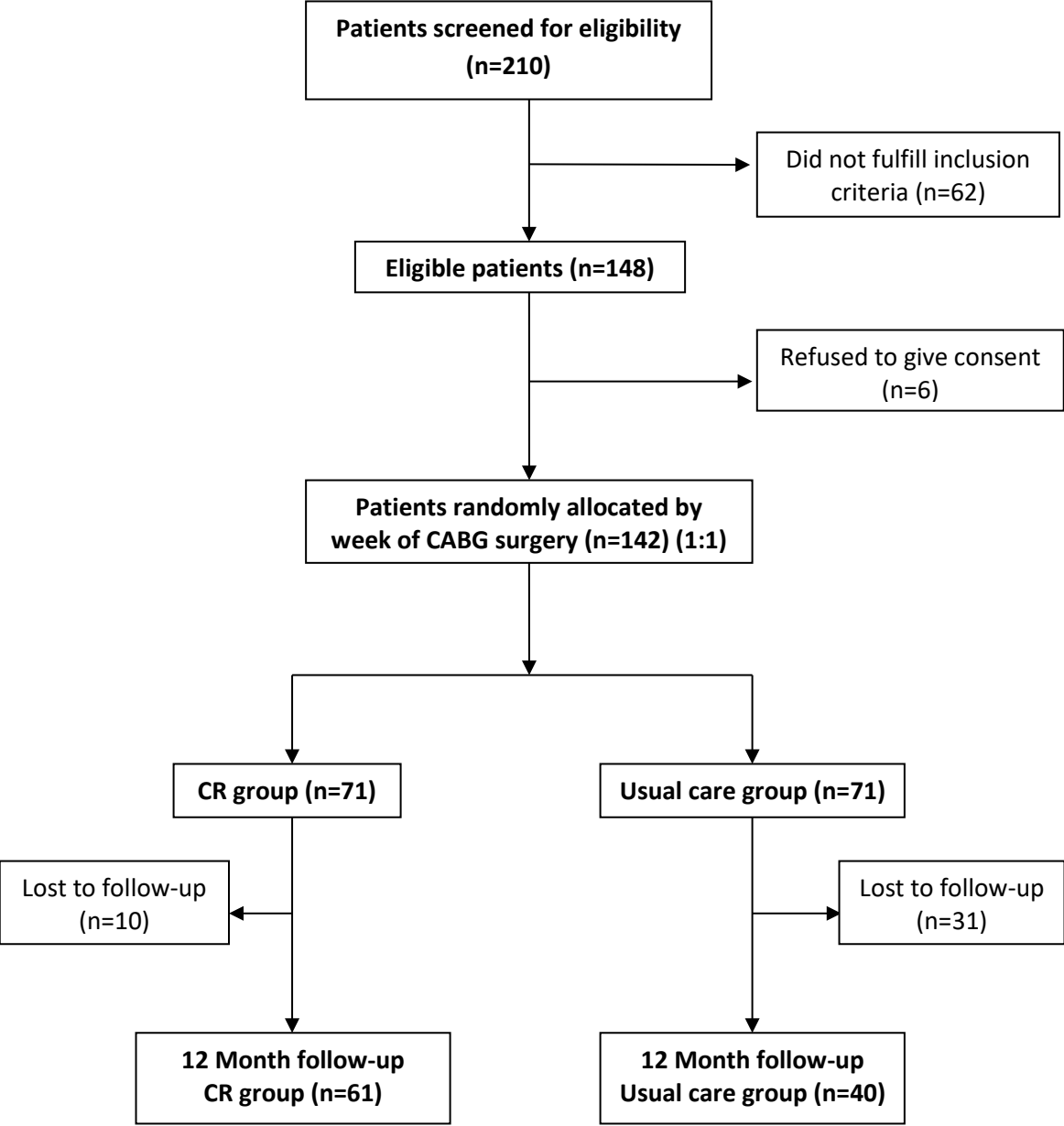
Table 4. Between group difference for PHQ-9 at baseline and 3 month follow-up, WHOQOL-BREF at baseline and 12 month follow-up and for exercise capacity at 6 months follow-up only

	CR Group (n=61)				UC Group(n=40)					
	Baseline Mean (SD)	Follow-up Mean (SD)	Within group Mean change [95% CI]*	P- val ue	Basel ine Mean (SD)	Follo w-up Mean (SD)	Within group Mean change [95% CI]*	P- val ue	Between Group Mean difference [95% CI]*	P-value
PHQ-9 3 months follow-up										
Total score	12.9 (1.83)	4.60 (1.93)	-8.29 (-9.06 to -7.52)	<0. 01	14.40 (2.46)	9.67(1. 83)	-4.72 (-5.68 to -3.76)	<0. 01	-3.53 (-4.40 to 2.73)	<0.01
WHOQOL-BREF 12 months follow-up										
Overall Perception of QoL	2.96 (0.49)	4.03 (0.49)	1.06 (-0.88 to 1.24)	<0. 01	2.85 (0.43)	3.20 (0.82)	0.35 (0.05 to 0.64)	0.0 2	0.71 (0.37 to 1.05)	<0.01
Overall Perception of Health	2.59 (0.67)	4.06 (0.40)	1.47 (-1.28 to 1.66)	<0. 01	2.47 (0.55)	3.17 (0.38)	0.7 (0.48 to 0.91)	<0. 01	0.77 (0.49 to 1.05)	<0.01
Physical Domain	20.81 (2.47)	26.90 (2.88)	6.08	<0. 01	21.67 (1.76)	21.17 (3.35)	-0.50	0.4 0	6.58	<0.01

			(5.14 to 7.02)				(-1.69 to 0.69)		(4.99 to 8.16)	
Psychological Domain	17.67 (2.00)	23.42 (2.84)	5.77 (4.90 to 6.63)	<0.01	18.10 (1.70)	17.87 (3.19)	-0.22 (-1.35 to 0.90)	0.69	5.99 (4.52 to 7.46)	<0.01
Social Relationship Domain	10.13 (1.55)	11.83 (1.25)	1.70 (1.20 to 2.20)	<0.01	12.05 (1.35)	10.75 (0.89)	-1.3 (-1.83 to -0.76)	<0.01	3.15 (2.34 to 3.96)	<0.01
Environmental Domain	23.57 (2.91)	28.80 (4.24)	5.22 (3.92 to 6.53)	<0.01	20.25 (5.48)	21.77 (5.31)	1.52 (-0.87 to 3.92)	0.21	3.70 (1.25 to 6.15)	0.03
Exercise Capacity 6 months follow-up										
VO ₂ max(ml/kg/min)	-	35.70 (10.12)	-	-	-	29.13 (12.95)	-	-	6.57 (1.99 to 11.14)	<0.01

Abbreviations: CR, cardiac rehabilitation; PHQ-9, Patient Health Questionnaire-9; UC, usual care; WHOQOL-BREF, The World Health Organization Quality of Life (BREF: a shorter version of the original instrument). * A reduction is stated as a negative number while an increase is stated as a positive number.

Figure 1. CONSORT flow diagram



Appendix 1

Description of usual care and cardiac rehabilitation intervention

<p>Usual care advice (received by both UC and intervention groups on discharge from hospital.)</p>	<ul style="list-style-type: none"> - Received information on post-heart surgery precautions to be followed for six weeks: Do not lift heavy objects or weight >5Kg. Do not pull or push any heavy object. When lying in bed, use a supine position. - Dietary advice from a dietician.
<p>In-patient cardiac rehabilitation (received in addition to usual care advice)</p>	<p>The in-hospital cardiac rehabilitation class consisted of:</p> <ol style="list-style-type: none"> i. encouraging patients to comply with, and have knowledge of medical advice; ii. Advice about appropriate exercise, the home exercise program and iii. Stress management; iv. Advice on smoking cessation, alcohol intake and diet; and v. Encouragement to resume everyday activities and social interaction, all of which were supported by written information in the form of an education booklet.
<p>Home-based cardiac rehabilitation</p>	<p>The exercise program was based on a phase two CR program:</p> <ul style="list-style-type: none"> - The main exercise time was 30 minutes per day, with a 5-minute warm up and a five-minute cool down, to be completed four days per week. Exercise was undertaken at an intensity of 11 to 13 on the Borg Scale or rate of perceived exertion. Patients could choose activities involving use of large-muscle groups. - Walking for 30 minutes a day, five days a week was also recommended