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1 Patients' preference for exercise setting and its influence on the health benefits
2 gained from exercise-based cardiac rehabilitation.

3
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32

33 **Abstract**

34 *Objective:*

35 To assess patient preference for exercise setting and examine if choice of setting influences the long-term
36 health benefit of exercise-based cardiac rehabilitation.

37 *Methods:*

38 Patients participating in a randomised controlled trial following either heart valve surgery, or radiofrequency
39 ablation for atrial fibrillation were given the choice to perform a 12-week exercise programme in either a
40 supervised centre-based, or a self-management home-based setting. Exercise capacity and physical and
41 mental health outcomes were assessed for up to 24 months after hospital discharge. Outcomes between
42 settings were compared using a time x setting interaction using a mixed effects regression model.

43 *Results:*

44 Across the 158 included patients, an equivalent proportion preferred to undertake exercise rehabilitation in a
45 centre-based setting (55 %, 95% CI: 45% to 63%) compared to a home-based setting (45%, 95% CI: 37%
46 to 53%, p=0.233). At baseline, those who preferred a home-based setting reported better physical health (mean
47 difference in physical component score: 5.0, 95 % CI 2.3 to 7.4; p=0.001) and higher exercise capacity
48 (mean between group difference 15.9 watts, 95 % CI 3.7 to 28.1; p=0.011). With the exception the
49 depression score in the Hospital Anxiety and Depression Score (F(3.65), p=0.004), there was no evidence of
50 a significant difference in outcomes between settings.

51 *Conclusion:*

52 The preference of patients to participate in home-based and centre-based exercise programmes appears to be
53 equivalent and provides similar health benefits. Whilst these findings support that patients should be given
54 the choice between exercise-settings when initiating cardiac rehabilitation, further confirmatory evidence is
55 needed.

58 1. Introduction

59 Over recent years, cardiac rehabilitation (CR) has expanded from simple, single centre programmes into
60 large comprehensive programmes offering centre based and “home-based” delivery options.¹⁻³ Home-based
61 programmes are widely ranging from self-management programmes without any supervision to tele-
62 monitored supervised programmes. These can be delivered either in the patients’ home, or in a local non-
63 hospital location.^{4,5} Common to the expansions of alternative CR settings is an attempt to tailor CR towards
64 the preferences of a broader group of patients^{1,2,4} and, by doing so, tackle the very low uptake and adherence
65 rate that globally is reported in CR.⁶⁻⁹

66 Patient preference is known to determine whether patients participate in a trial and hypothesised to have
67 positive impact on adherence to interventions and outcomes.^{10,11} Evidence from one CR trial showed that
68 half of all patients will choose a home-based rehabilitation programme, when given the choice,¹² which is
69 perhaps surprising given that most CR programmes are delivered in traditional centre-based settings.⁶
70 Qualitative studies report that home-based programmes are preferred by some patients as they align with
71 their everyday life and their employment commitments.^{13,14} In contrast, patients preferring social events and
72 the possibility for specific exercise intensity monitoring are more likely to prefer a centre-based setting.¹³
73 These findings emphasise that it is unlikely that a single standardised CR model will fit all patients.

74 Physical exercise is a key element in CR¹⁵ and its benefits are well documented.¹⁶⁻¹⁹ Based on a systematic
75 review of the studies investigating exercise-based CR, Taylor and colleagues found similar health benefits
76 between centre-based and home-based interventions, at similar costs.²⁰ Hence, the authors concluded that
77 choice of setting should reflect preference of the individual patient.^{10,11} However, this conclusion was based
78 on study designs that randomised patients to either home or centre-based CR and failed to take into account
79 the preference of patients.²⁰ To our knowledge, only the study by Dalal et al.¹² has offered cardiac patients a
80 choice between centre-based rehabilitation classes over eight to ten weeks, or a home-based self-help
81 package of six weeks duration. The results showed no difference in patient outcomes. More evidence is,
82 therefore, needed in order to validate the benefits and consequence of allowing patients a choice between
83 settings for CR.

84 The CopenHeart trials were designed to investigate the effect of a similar comprehensive CR programme
85 across cardiac diagnoses, including atrial fibrillation and valve disease. Patients were randomised to either

86 usual care or a programme consisting of physical exercise training and psycho-education.

88 Once allocated to the intervention groups, patients were then given a choice between a supervised centre-
89 based setting and a self-management home-based programme, thus offering the opportunity to assess the
90 impact of choice.^{21,22}

91 The aims of this study were to assess if the choice of a CR exercise programme delivered either as a
92 traditional rehabilitation program in a supervised centre-based setting, or in a self-management home-based
93 setting would: 1) be equally preferred by patients and 2) provide similar patient health benefits over 24
94 months.

95 **2. Method**

96 *2.1 Design*

97 Data for this explorative study were pooled across the intervention arms from two CopenHeart parallel
98 group randomised controlled trials. All patients were informed about the trials both verbally
100 and in writing. Written informed consent was also obtained. Both trials were approved by the Data
101 Protection Agency (j.nr. 2007-58-0015) and Regional Ethical Committee (j.nr. H-1-2011-135, j.nr. H-1-
102 2011-157) and have been described in detail elsewhere.^{21,22}

103 *2.2 Inclusion criteria*

104 The inclusion criteria in the two trials were: patients who underwent either radiofrequency ablation for atrial
105 fibrillation, or heart valve surgery, age ≥ 18 years, ability to speak and understand Danish, and no
106 musculoskeletal system, or organ disease that would complicate undertaking physical activity.^{21,22}

107 *2.3 The intervention*

108 In the intervention group, a 12 week progressive exercise program three times weekly was begun one month
109 after hospital discharge. The program combined 20 minutes of aerobic training with four resistance
110 exercises. The aerobic training was accomplished on a stationary bike with exercise intensity according to
111 exercise-based guidelines in cardiac rehabilitation.^{15,23} The resistance training combined both strength and
112 strength-related exercises primarily targeting muscles in the lower extremities. Each single exercise session

113 was described in detail in an individual training diary given to patients, along with a heart monitor (Polar
114 Electro, Finland), when introduced to the exercise programme. All patients undertook the first training
115 session in the same tertiary centre hospital (Department of Cardiology). Thereafter, patients continued their
116 programme in one of two settings in accordance to patient preference: either a supervised centre-based
117 setting either at the tertiary hospital, at a local hospital or healthcare centre (across 29 certified collaborating
118 training locations where all personnel were educated and certified in delivering the exercise training
119 intervention), or as a self-management home-based programme performed either at home, or in a local
120 fitness centre with no additional staff supervision.

121 In both exercise setting, all patients were encouraged to perform moderate physical activity of 30 minutes a
122 day during the intervention period. In addition, all patients received one of five psycho-educational
123 consecutive nurse consultations every four to six weeks, during the first six months after discharge. All
124 consultations started within the first month following discharge and were performed either at the same
125 tertiary centre hospital, or by phone.

126 After the 12 weeks intervention period, patients were encouraged to continue exercising by themselves and
127 follow the clinical recommendations of 30 minutes physical activity each day.

128 *2.4 Outcome assessment*

129 We utilised all physical and mental outcomes common to both trials. Physical capacity was measured
130 objectively using a maximum cardiopulmonary exercise test using a ramp protocol on an ergometer bicycle.
131 Further with a six-minute walk test and a Sit-to-Stand (STS) test. Details of these test are described
132 elsewhere.^{21,22} All physical assessments were performed at one month, four months and one year post
133 discharge.

134 The level of physical activity was self-reported using the International Physical Activity Questionnaire short-
135 form (IPAQ).²⁴ The physical and mental component scales of the Short-Form 36 (SF-36) questionnaire²⁵
136 were used to assess self-reported generic mental health and the level of anxiety and depression were assessed
137 using the Hospital Anxiety and Depression Scale (HADS).²⁶ These patient reported outcomes were collected
138 at baseline, one, four, six 12 and 24 months after hospital discharge.

139 Adherence to each exercise session was assessed using a patient training diary and data from the heart rate
140 monitors worn during exercise.²⁷ Adherence to exercise was categorised into two groups in accordance with
141 the recommendation from Beauchamp et al,²⁸ i.e. patients participating in $\geq 75\%$ of the 36 training sessions
142 (i.e., 27 sessions) were categorised as ‘adherent’ and patients participating in $<75\%$ of all training sessions
143 as ‘non adherent’.

144 We assessed disease-specific symptoms using the “New York Heart Association (NYHA) class Functional
145 Classification’ in patients following heart valve surgery, or with a “European Heart Rhythm Association
146 (EHRA) score indicating atrial fibrillation related symptoms’ in patients who underwent an ablation for
147 atrial fibrillation. Level of comorbidity at baseline was calculated using the Charlson comorbidity index.²⁹

148 *2.5 Statistical analyses*

149 An independent two-sample t-test, or a Chi-square test was used to explore differences in patient
150 demographic, medical condition, exercise adherence and adverse events between the centre and home
151 settings. A one sample binomial test was used to compare the proportion of patients who preferred one
154 setting more than the other. We used a linear mixed effects regression model, adjusted for sex, age, and
155 diagnosis, to compare outcome differences at baseline. This same mixed effect model was used to compare
156 outcome differences over time between the two settings by introducing a time x setting interaction. All
157 models were run with and without adjustment for sex, age, and diagnosis. Level of statistical significant was
158 expressed as a $p < 0.05$. All statistical analyses were performed using the software SAS Enterprise Guide 5.1
159 (SAS Institute Inc., Cary, NC, USA).

160 **3. Results**

161 *3.1 Trial flow*

162 A total of 177 patients were allocated to the intervention group in the two randomised trials and were
163 included in the current study. An additional patient was included because they had received the intervention,
164 despite being allocated to the control group. Of these 178 patients, 20 patients had post treatment
165 complications, or voluntary withdrawal from the two trials before they were able to select an exercise setting.

166 Therefore, the results of 158 participating patients were analysed. There was no difference in preference for
167 the settings, i.e. centre-based setting was preferred by 55% (95% CI 45% to 63%) versus 45% (95% CI 37%
168 to 53%), who preferred a home-based setting (p=0.233) (See Figure 1 for study flow). One patient was
169 reported to switch from a centre-based setting and into a home-based setting during the exercise period. This
170 patient was analysed as a centre-based participant as 2/3rds of their exercise intervention was accomplished
171 in a healthcare centre. In the centre-based setting, 64 (74%) patients attended all three test sessions and 68
172 (78%) answered their questionnaire booklet, at all times points during the study period. In comparison, these
173 numbers were 60 (85%) patients attended all three test sessions and 57 (78%) answered their questionnaire
174 booklet at all times points during the study period in the home-based setting.

175 *3.2 Patient characteristics*

176 Baseline characteristics by settings are reported in Table 1. Patients who underwent heart valve surgery more
177 often preferred a centre-based setting and vice versa for patients' that underwent an ablation (p=0.002). No
178 other baseline demographic was found to be significantly different.

179 The adjusted mixed model showed better physical performance and health at baseline in patients who
180 preferred a home-based setting expressed by increased maximum watt level during bicycle testing (mean
181 difference 15.9 (95 % CI 3.7-28.1; p=0.011) and increased SF-36 physical component scale score (mean
182 difference 5.0 (95 % CI 2.3-7.6; p=0.001)). No other outcome variables were found to be different at
183 baseline between the two settings.

184 The results of exercise adherence, based on the individual exercise diary and HR-monitor, were similar
185 between the two settings (p=0.435). Approximately 60% of all patients participated in $\geq 75\%$ of the 36
186 training session (see Table 1). No adverse events as a consequence to the exercise intervention were
187 reported. Fifteen adverse events were reported but no different were found between the two settings (centre-
188 based settings: 6 events versus home-based setting; 9 events, P=0.218). One patient in both of the two
189 settings reported atrial fibrillation in relation to the exercise intervention. Remaining events were
190 musculoskeletal primarily in the lower extremities.

191 *3.3 Over time differences between the centre and home based setting*

192 Mean physical and patient-reported outcomes over time are shown in Figures 2 and 3 and detailed in e-
193 Tables (appendix A and B). There was evidence of higher HADS depression score in the centre-based group
194 ($F(3.65)$, $p=0.004$) (Figure 3b). No other outcomes differed over time between the two settings. Adjustments
195 for sex, age and diagnosis did not affect the interpretation of these results.

196 **4. Discussion**

197 This study provides important insights into patient's choice for alternative modes for provision in exercise-
198 based CR and the impact that such choice is likely to have. We found an equivalent proportion of patients
199 choose a traditional centre-based setting or a self-management home-based setting, with similar
200 improvements in health benefits in the two settings after two years, with the exception of HADS depression.

201 Our findings suggest that there is no difference in patients' outcome between centre and home-based CR
202 with the exception of a small difference in HADS depression. This result of no difference between the two
203 settings is in accord with Dalal et al, who previously investigated the influence of self-preferred setting in
204 CR.¹² However, where Dalal and colleagues offered a different intervention in the a centre-based setting
205 compared to the home-based setting (i.e. either hospital-based rehabilitation classes over eight to ten weeks,
206 or a self-help package of six weeks duration supported by a nurse), we offered the same structured exercise
207 intervention based upon CR guidelines in the two settings. Despite the variation between studies, they both
208 suggest that patients can prefer a CR setting and archive similar health benefits.

209 Based on evidence from randomised control trials, it is suggested that the exercise setting should reflect
210 patients' preference.²⁰ Randomisation to exercise settings will reduce types of systematic bias between
211 setting but can result in eliminating motivational variables, such as preference to a specific setting.^{10,11} Thus,
212 our paper is the first to investigate if same structured exercise intervention performed in a home-based
213 setting will provide comparable clinical benefits to those in a centre-based setting, when choice of setting
214 reflects the preference of the individual patient.

215 Evidence investigating the long-term effects in CR (≥ 1 year follow up) across CR settings is sparse. Similar
216 to our findings, Marchionni et al³⁰ and Jolly et al^{31,32} report no difference in patient outcomes between home
217 and centre-based settings after 14 months and, 12 and 24 months respectively. In contrast, Smith and
218 colleagues report better maintenance of patient benefits and higher physical activity in those who have been
219 allocated to home-based programs after one and six years.^{33,34}

220 The proportion of patients who preferred a home-based setting in this study may seem high. However, Dalal
221 et al¹² reported slightly higher percentage of patients (57% of 126 patients) preferring a home-based CR
222 program compared to centre-based.

223 Our study shows that diagnosis may affect preferences in CR as patients who underwent heart valve
224 replacement preferred traditional centre-based setting and patients who underwent ablation for atrial
225 fibrillation preferred home-based CR. Dalal et al¹² reported that patients with acute myocardial infarction had
226 a higher preference to perform a self-management CR manual at home. In addition, qualitative studies show
227 that a home-based setting is preferred by patients who would appreciate a programme that can be
228 incorporated into their everyday life, or by patients who find participating in traditional CR restrictive.^{13,14}
229 Furthermore, patients with higher income appear to choose a home-based CR programme.³⁵ The results of
230 this study strengthen the current evidence by offering further insight into the patient characteristics,
231 suggesting that patients with better physical condition and health prefer the home-based setting.

232 *4.1 Strength and limitations*

233 An important strength in the present study is the possibility for patients to undertake the exercise intervention
234 in a centre-based environment located closer to home as routinely offered in everyday clinical practice. A
235 single-centre design would have influenced the preference for the exercise intervention, due to longer
236 distances to the centre-based training location.³⁶ An additional strength is the exploration of long-term effects
237 between exercise settings (24 months) where evidence is sparse. Nonetheless, our findings need to be
238 interpreted with caution. Firstly, as this is an explorative study it only allow us to express trends in the data.³⁷
239 Given the explorative design and the relative low number of patients, post hoc analysis were not performed
240 to explore variation between two time points (e.g. differences in settings from 1 month to 4 months).
241 Secondly, being a non-randomised study with allocation based upon patients' preference to either a home, or
242 a centre-based setting, selection bias or confounding is likely to occur when comparing the outcomes
243 between the two settings. We considered this by adjusting for important potential confounders, i.e. age,
244 gender, diagnosis. In addition, we found no baseline difference in employment status, marital status, disease
245 severity or HADS depression or anxiety scores. Nevertheless, given the non-randomised nature of the
246 comparison in this study we recognise that other unmeasured psychosocial factors may have confounded our
247 results. Thirdly, the data used in this study were taken from two randomised controlled trials not designed

249 for the purpose of this paper. Thus, only the follow-up assessments and outcomes common for both trials
250 were included for analysis (e.g., objective measures of physical capacity were not obtained at 24 months and
251 measurement of disease-specific quality of life was excluded).

254 Finally, data are limited to patients who had undergone either heart valve surgery or treatment for atrial
255 fibrillation. Thus, the results may not be generalisable to all cardiac diagnoses. In addition our patient group
256 was somewhat younger compared to other CR patient groups. However, Oerkild et al³⁸ have reported that
257 elderly (≥ 65 years) patients with coronary heart disease also experience similar effects when participating in
258 CR in a home-based setting compared to a centre-based setting. Still, we acknowledge that age could impact
259 the results of this study, especially in relation to patients choice of exercise setting.³⁹

260 **5. Conclusion**

261 This study investigated patients' preference for undertaking a 12-week CR programme delivered in either a
262 supervised centre-based setting, or a self-management home-based setting and how this impacted on long-
263 term health benefits. Whilst we found that, on average, both settings were preferred equally among
264 participants, it is noted, that the preference of individual patients are likely to be influenced by their
265 diagnosis and physical condition. Despite these potential differences in the preference of individual patients,
266 similar health benefits are achieved in both settings. Our results support future tailoring of CR programmes
267 towards patients' needs and preferences. Further research is needed to inform the implementation of patient-
268 preferred approaches to cardiac rehabilitation.

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278 **7. Conflict of interest**

279 The authors report no relationships that could be construed as a conflict of interest.

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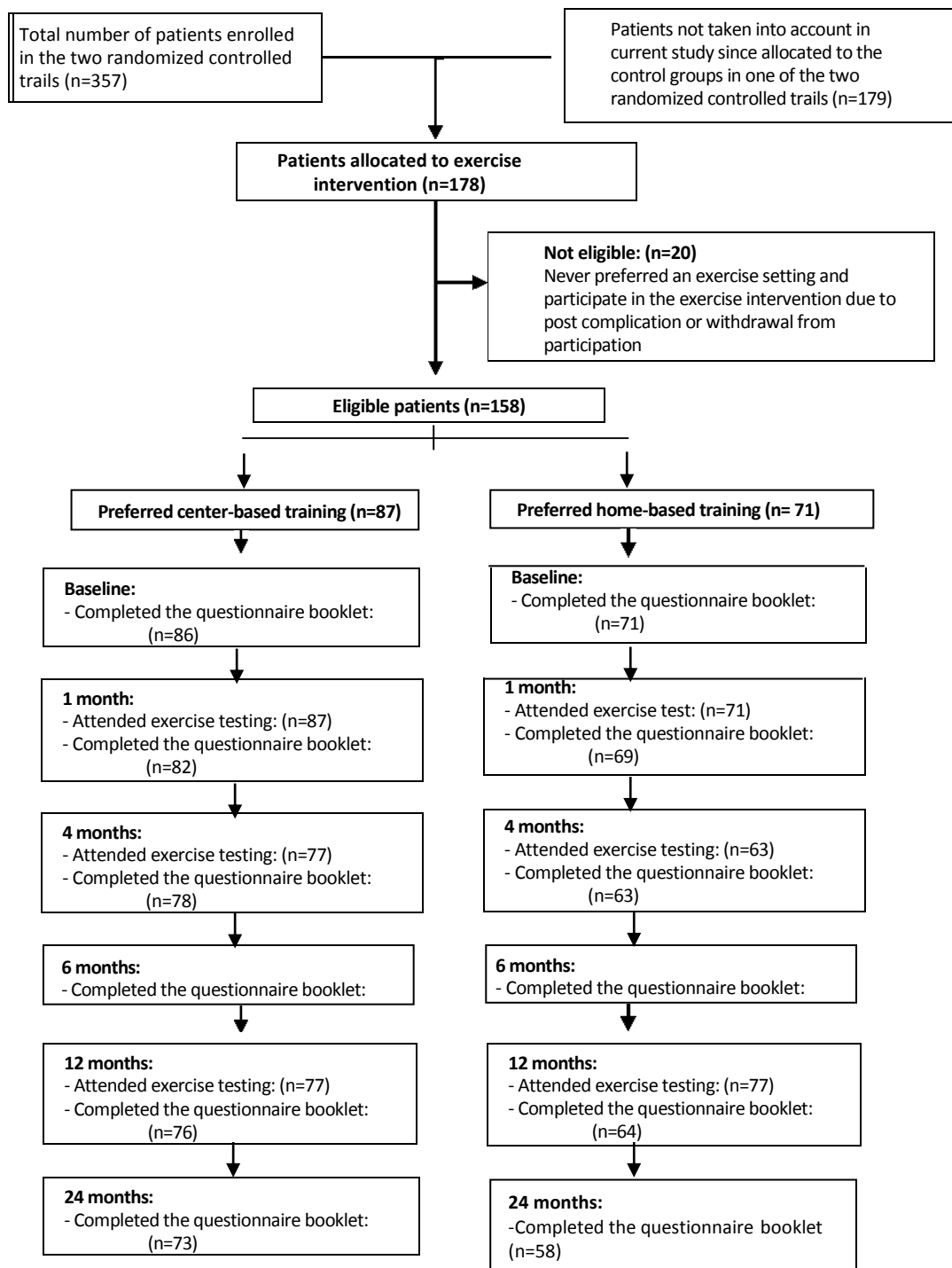
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384 **Figure legend:**

385 **Figure 1:** The exact numbers of patients that attended exercise testing and answered the questionnaire

386 booklet throughout the study period



389 **Figure 2:** Physical test outcomes presented over time and divided between the two exercise
390 settings.

391 *Figure citations:*

392 Data is presented as mean and the standard deviation.

393 P-values represent the test for time x setting interaction adjusted for adjusted for sex, age, and diagnosis

394

394

Insert figure 2a here

Insert figure 2b here

Insert figure 2c here

Insert figure 2d here

395 **Figure 3:** Patient reported outcomes by the Hospital Anxiety and Depression Scale (HADS), The short-form
396 36 (SF-36) and the International Physical Activity Questionnaire short-form (IPAQ) presented separately for
397 the two exercise settings over time.

398 *Figure citations:*

399 HADS and IPAQ is presented as median and Interquartile range.

400 SF-36 is presented as mean and the standard deviation.

401 P-values represent the test for time x setting interaction adjusted for adjusted for sex, age, and diagnosis

402

403

Insert figure 3a here

Insert figure 3b here

Insert figure 3c here

Insert figure 3d here

Insert figure 3e here

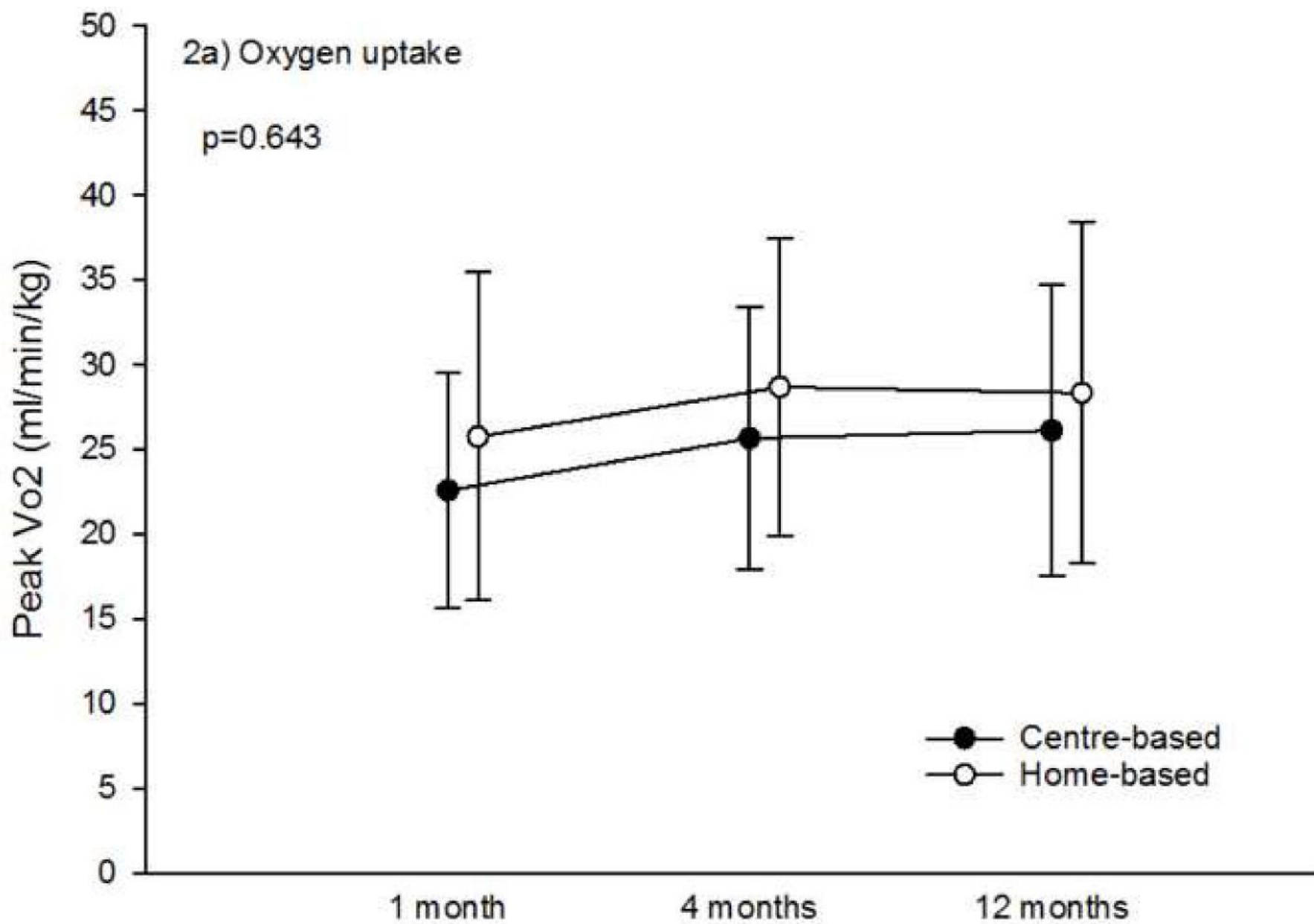
404 **Tables**
405

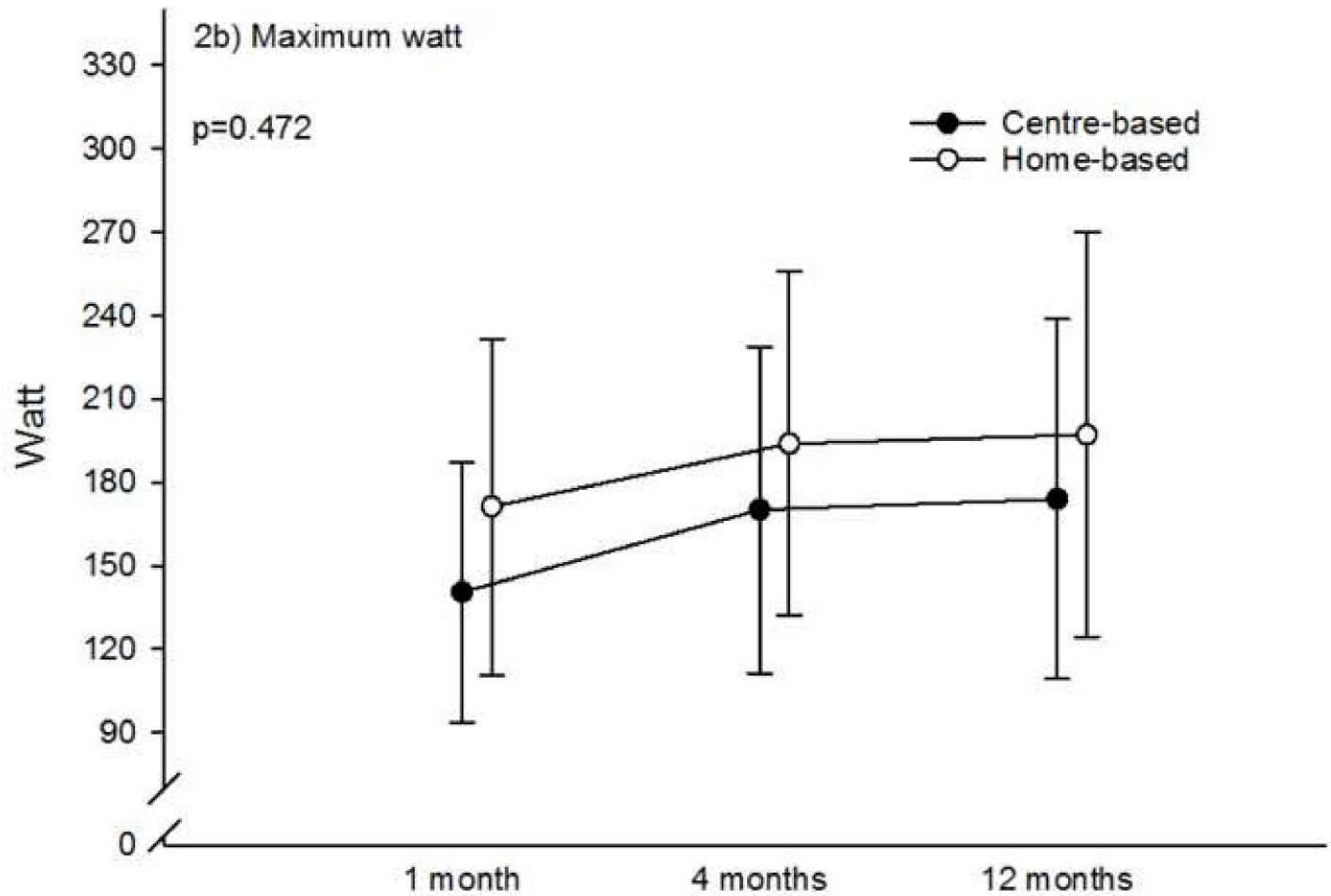
Table 1: Patients demographic, medical condition and exercise adherence compared between settings

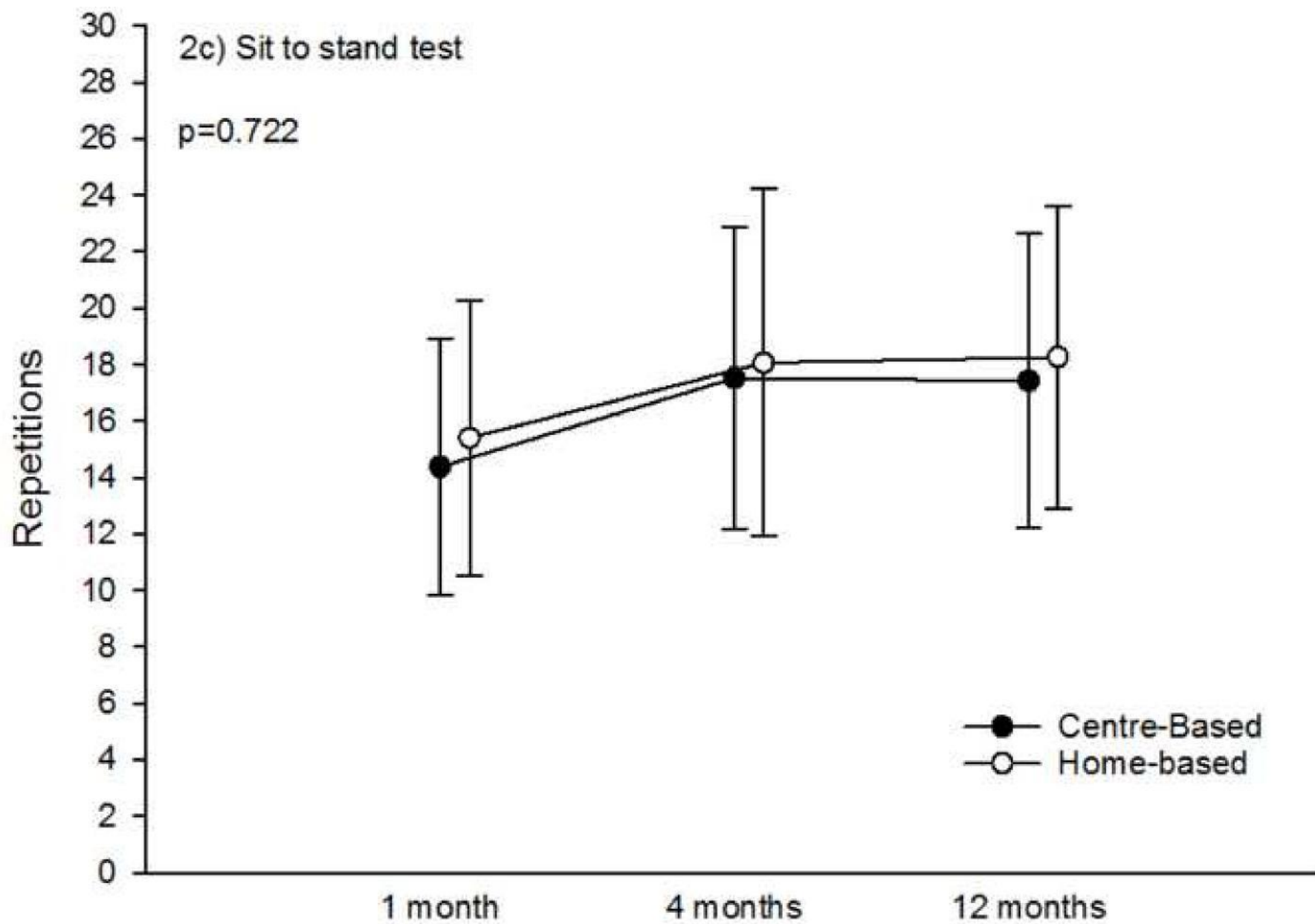
	Centre-based (n=87)		Home-based (n=71)		p-
	n	Mean (±SD)	n	Mean (±SD)	
Demographic data					
Age	87	62.0 (10.3)	71	58.9 (9.8)	0.058
BMI	87	25.9 (4.2)	71	26.1 (4.2)	0.725
Sex (Female/Male)	23/64		17/54		0.720
Employment status					
		(%)		(%)	
Employed	42	(48%)	37	(52%)	0.631
Unemployed	45	(52%)	34	(48%)	
Marital status					
Living alone	14	(16%)	13	(18%)	0.713
Living with a partner	73	(84%)	58	(82%)	
Patient type					
Radiofrequency ablation	43	(49%)	52	(73%)	0.002
Valve replacement	44	(51%)	19	(27%)	
NYHA/EHRA class*					
I	41	(47%)	25	(35%)	0.163
II	32	(37%)	26	(37%)	
III	12	(14%)	19	(27%)	
IIII	2	(2%)	1	(1%)	
The Charlson comorbidity index					
0	79	(91%)	69	(97%)	0.187
≥1	8	(9%)	2	(3%)	
Medical Records					
Warfarin	71	(82%)	58	(82%)	0.990
B-Blockers	32	(37%)	39	(55%)	0.023
Calcium antagonists	23	(26%)	10	(14%)	0.057
Statin	34	(39%)	14	(20%)	0.009
Exercise adherence					
Participating in ≥27 exercise sessions	46	(56%)	40	(63%)	0.435

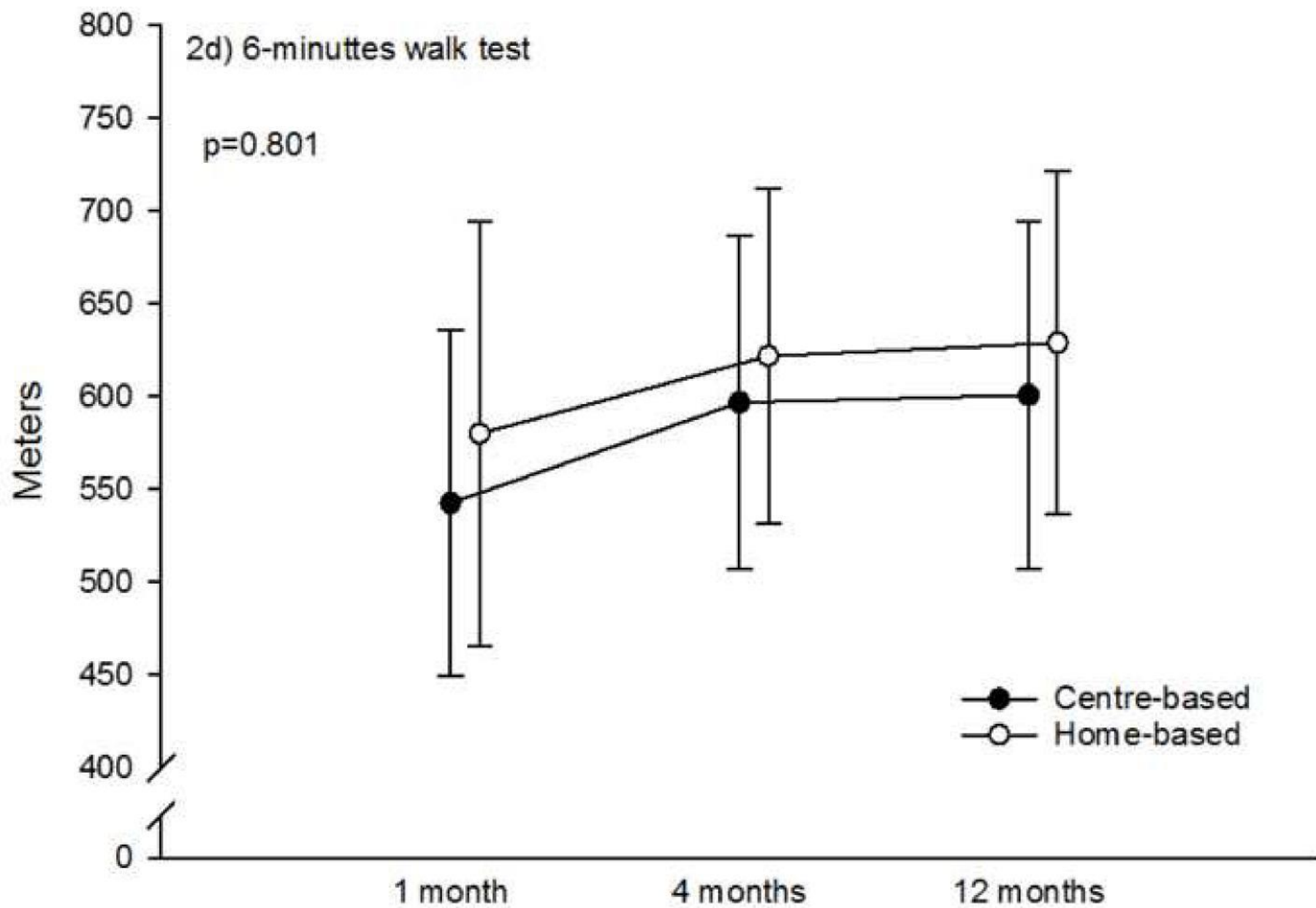
*Fischer Exact test

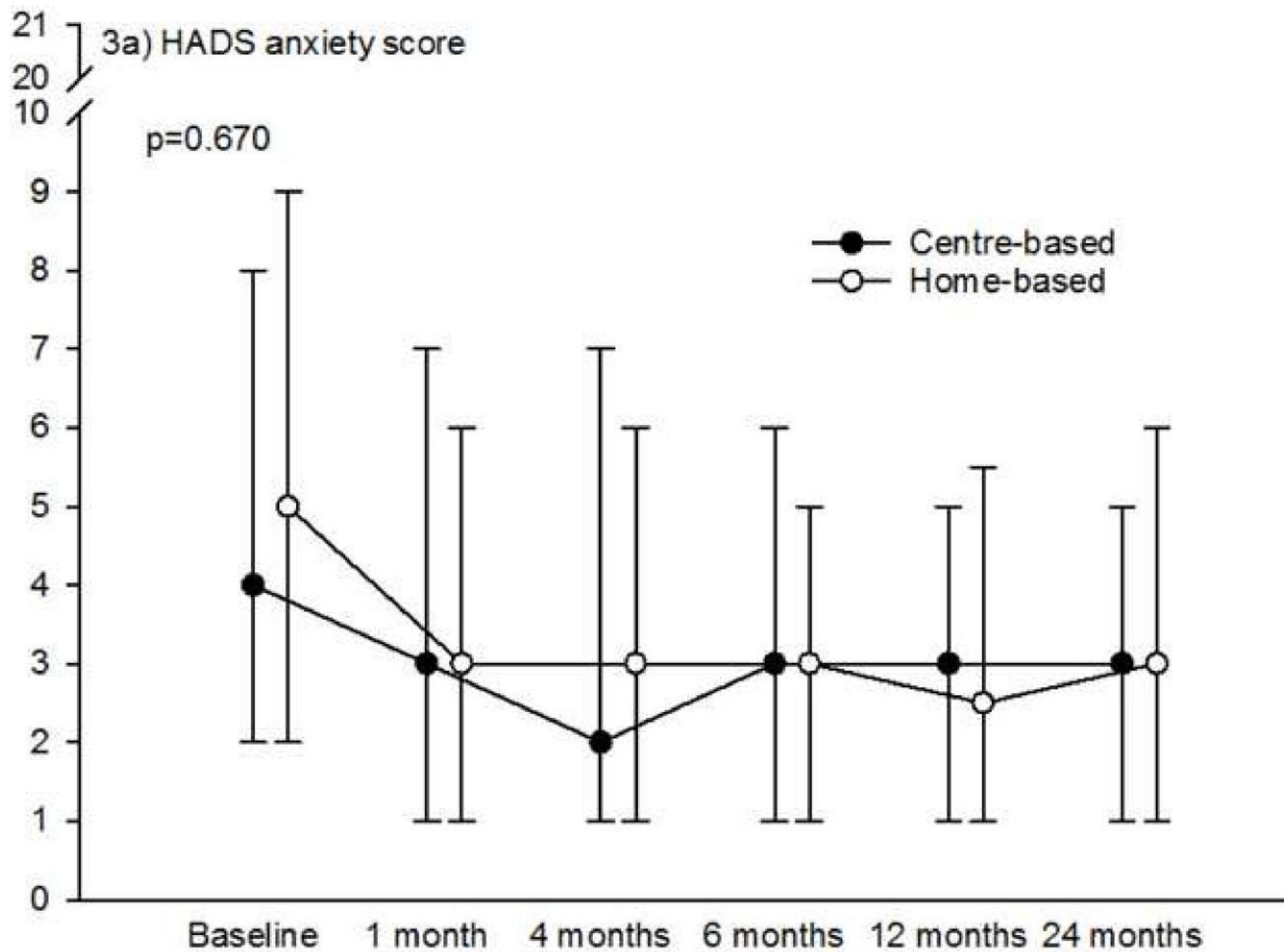
NYHA/EHRA class :The New York Heart Association (NYHA) Functional Classification/ European Heart Rhythm Association (EHRA) score of atrial fibrillation related symptoms

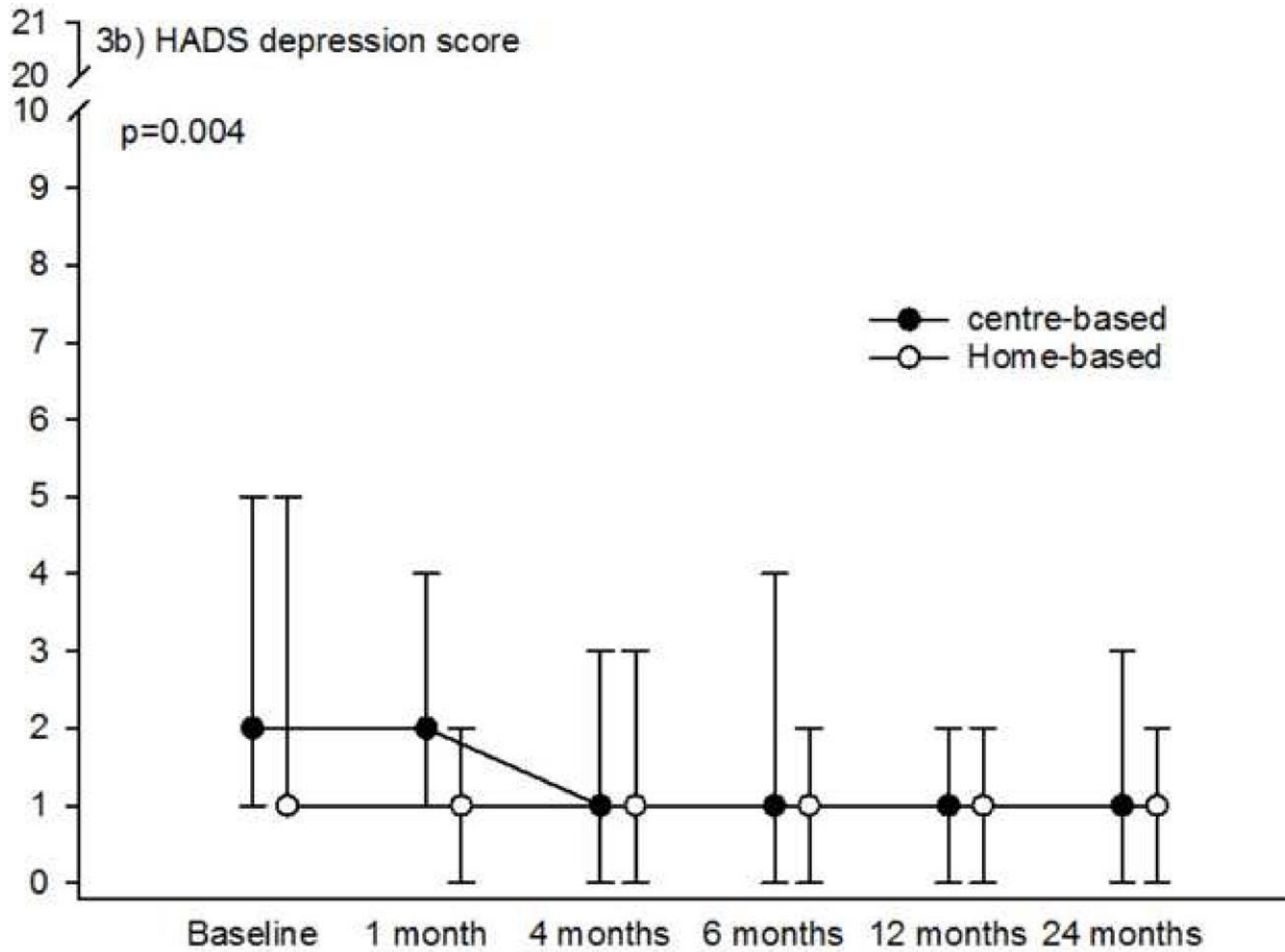


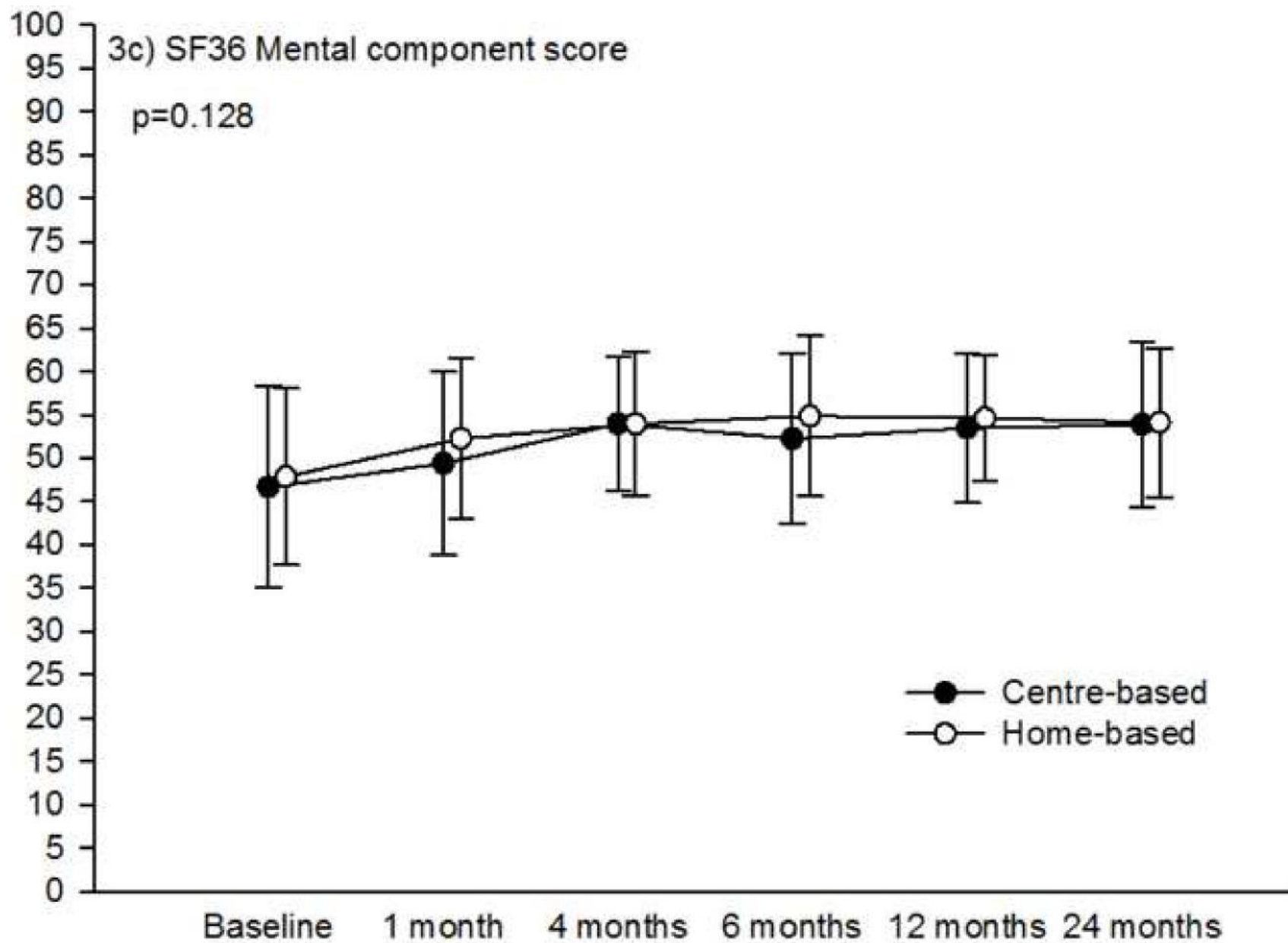


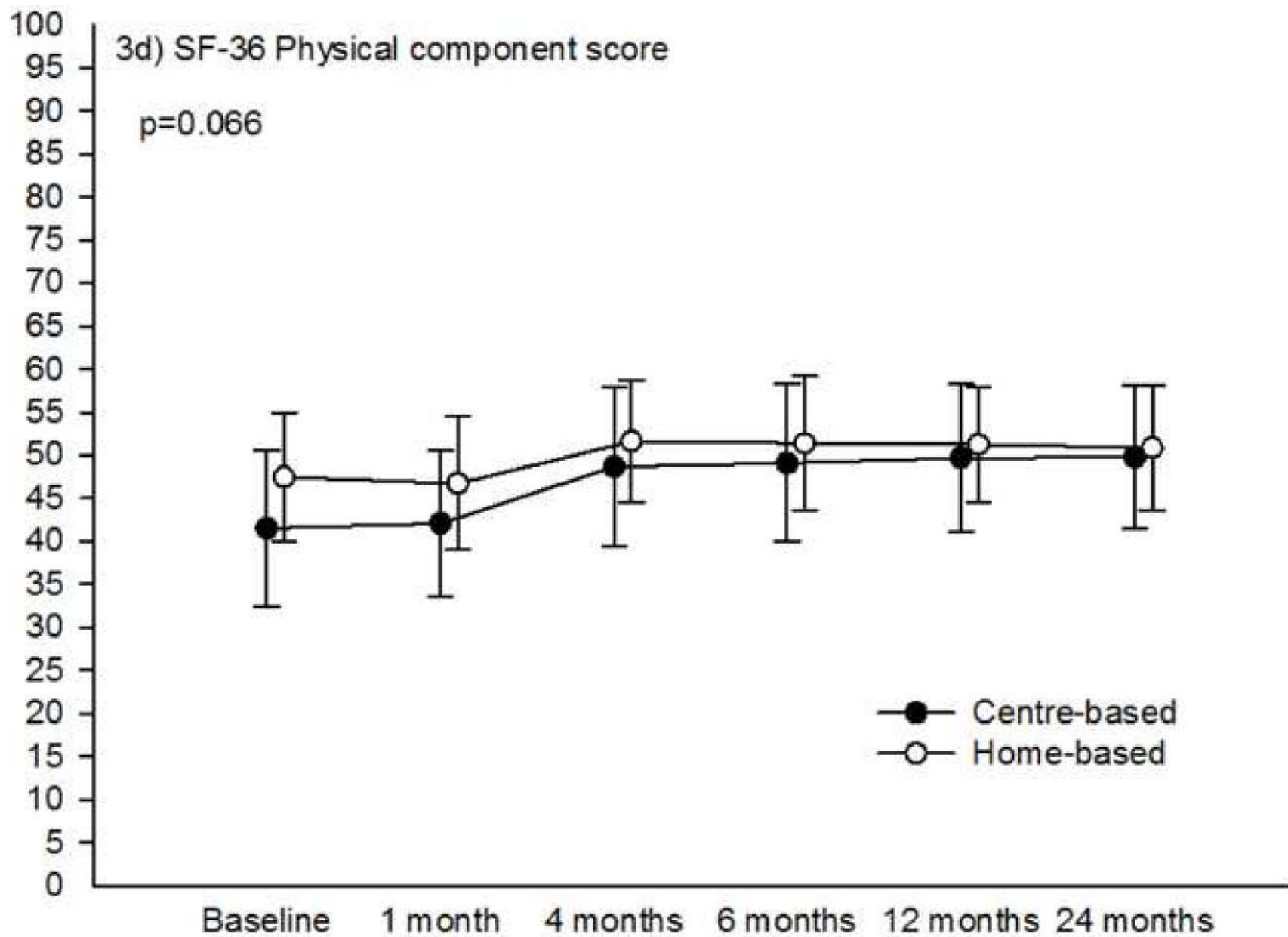


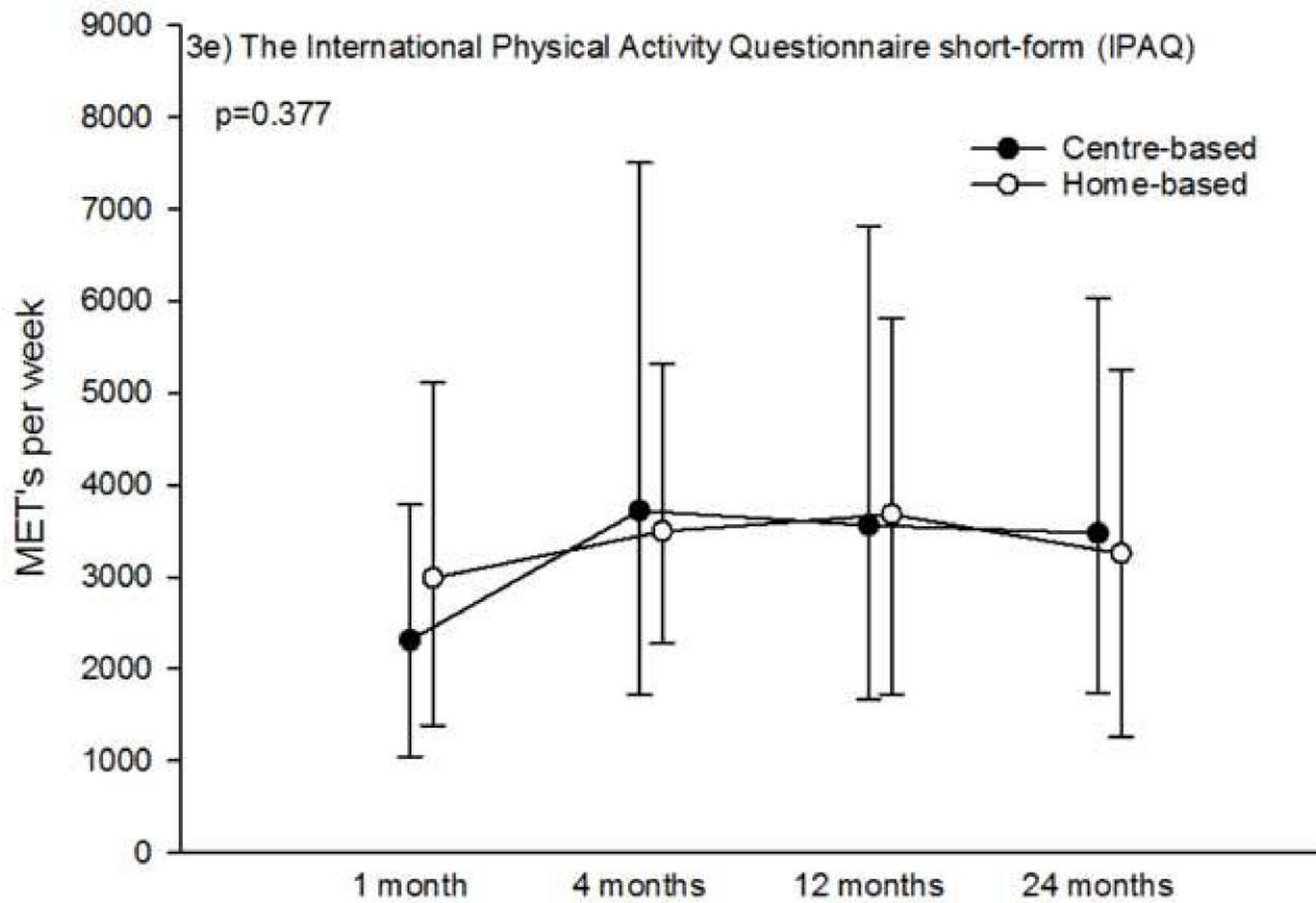












e-component

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e-component

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