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Tomlinson, OW, Shelley, J, Trott, J, Bowhay, B, Chauhan, R and Sheldon, CD

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### Article

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1 **THE FEASIBILITY OF ONLINE VIDEO CALLING TO ENGAGE PATIENTS WITH**  
2 **CYSTIC FIBROSIS IN EXERCISE TRAINING**

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15

16 **RUNNING TITLE:** Using Skype to deliver exercise in cystic fibrosis

17

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24

25 **CONFLICT OF INTEREST**

26 The authors declare no conflict of interest.

27 **ABSTRACT**

28 *Introduction:* Physical activity (PA), including structured exercise is an essential component  
29 in the management of cystic fibrosis (CF). The use of telehealth such as video-calling may be  
30 a useful method for the delivery of exercise and PA interventions, though the feasibility of this  
31 remains unknown.

32 *Methods:* Nine patients with CF (three female, six male,  $30.9 \pm 8.7$  years) volunteered to  
33 participate. Participants completed an 8-week exercise training intervention conducted via  
34 Skype, using personalised exercises, with all sessions supervised by an exercise therapist.  
35 Feasibility was assessed by demand, implementation, practicality and acceptability. Changes  
36 in anthropometric, pulmonary, PA and quality of life (QoL) variables were also assessed.

37 *Results:* Two male participants withdrew from the study, citing lack of available time.  
38 Remaining participants found use of Skype useful, with a mean satisfaction rating of 9/10, and  
39 three participants requesting to continue the sessions beyond the duration of the study. Mean  
40 compliance with sessions was 68%, with mean duration of sessions being 20 minutes. A total  
41 of 25% of calls suffered from technical issues such as video or audio lags. Anthropometric,  
42 pulmonary, PA and QoL variables remained unchanged over the course of the study period.

43 *Discussion:* The use of Skype to deliver an exercise intervention to patients with CF was found  
44 to be technologically feasible, and acceptable among participants. Findings have implications  
45 for clinical practice and could allow care teams to engage patients remotely in exercise. Further  
46 research is required to assess the efficacy of this modality on increasing PA and associated  
47 health outcomes.

48

49 **KEYWORDS:** exercise, Skype, intervention, personalised training, telehealth, acceptability

50

51

52 **1. INTRODUCTION**

53 It is well established that physical activity (PA) – which includes structured exercise – is  
54 beneficial for patients with cystic fibrosis (CF), with increased PA being associated with higher  
55 levels of aerobic fitness (1) and slower rates of decline in lung function (2). Patients are  
56 therefore recommended to remain physically active and exercise frequently, with global PA  
57 guidelines of 150 minutes of moderate-vigorous PA (MVPA) per week for adults, and 60  
58 minutes of MVPA daily for children also being appropriate for patients with CF (3). However,  
59 adherence rates to treatment (including exercise) are variable (4) and it has subsequently been  
60 suggested that supervision of exercise, and its subsequent incorporation into the home  
61 environment, could improve adherence (5).

62

63 Telehealth technologies, including video-calling software such as Skype, self-care and  
64 monitoring applications can potentially change how patients with CF engage with healthcare  
65 services and reduce burden of care (6), improve monitoring (7) and potentially reduce costs  
66 associated with healthcare delivery (8). Furthermore, factors that may negatively affect health  
67 outcomes, such as risk of cross-infection (9) could potentially be overcome by the use of  
68 telehealth systems.

69

70 Previous research suggests that patients with CF are willing to adopt and utilise such telehealth  
71 technology (10), and that use of an online platform to engage patients in PA is feasible and  
72 acceptable (11). Furthermore it feasible for both patients and practitioners to assess exercise  
73 capacity remotely (12). Whilst this data provides evidence for the feasibility of remote  
74 monitoring of PA and exercise capacity, the feasibility of delivering a supervised exercise  
75 intervention is yet to be explored.

76

77 Supervised exercise training is effective in improving lung function and exercise capacity in  
78 patients with CF (13). However, the gym- and hospital-based nature of these interventions can  
79 burden patients with increased travel and parking costs, gym membership fees and exposure to  
80 cross-infection risks through regular hospital visits. Home-based interventions may also  
81 positively affect lung function in patients with CF (14) and therefore warrant further  
82 investigation and implementation.

83

84 It is currently unclear whether implementing supervised, online, exercise sessions using  
85 telehealth is feasible or acceptable among patients with CF. Therefore, this study sought to  
86 assess the feasibility of utilising an online video-calling platform to engage patients with CF in  
87 a personalised exercise regimen. This was primarily assessed by demand, implementation,  
88 practicality and acceptability of the intervention; and secondly by identifying issues associated  
89 with the online delivery of the intervention.

90

## 91 **2. METHODS**

### 92 *2.1. Study Population*

93 Nine patients (three females, six males;  $30.9 \pm 8.7$  years, range = 15.5 – 42.1) with CF were  
94 recruited from outpatient clinics at the Royal Devon and Exeter NHS Foundation Trust  
95 Hospital. Participants were eligible to participate if they were  $\geq 14$  years of age and clinically  
96 stable at the time of recruitment. To minimise impact upon usual clinical service, recruitment  
97 was staggered over seven months (March – October 2017). Participant characteristics are listed  
98 in Table 1.

99

### 100 *2.2. Ethics Approval*

101 All participants provided written informed consent (or assent, with parental consent where

102 applicable) upon enrolment. Ethics approval for this study was provided by an NHS Regional  
103 Ethics Committee (Cornwall & Plymouth REC) and the Health Research Authority  
104 (16/SW/0175).

105

### 106 *2.3. Timeline*

107 The period of investigation lasted 12-weeks, with a video-calling intervention occupying the  
108 first 8-weeks, and a further 4-week observation period. Figure 1 details when measurements  
109 associated with the study were taken, and when the intervention period occurred.

110

### 111 *2.4. Intervention*

112 All participants undertook 8-weeks of video-calls (Skype™, Microsoft, Luxembourg),  
113 supervised by the same exercise therapist, receiving up to 3 supervised exercise sessions per  
114 week.

115

116 Skype was chosen as it was freely available for all participants and provided secure end-to-end  
117 encryption (therefore falling in line with hospital requirements for computer software). All  
118 exercise sessions were booked as per any regular outpatient appointment, being pre-arranged  
119 between participant and therapist at convenient times for both parties, provided these were a)  
120 within working hours for the therapist (0800 – 1700) for security and safety reasons, and b) the  
121 gymnasium facility was available. All sessions were placed upon the hospital ‘Patient  
122 Administration System [PAS]’ as per usual clinical appointments. For the exercise therapist,  
123 sessions were delivered on a laptop connected to the hospital Wi-Fi network, in a small  
124 gymnasium on an outpatient therapy ward that could be booked by any staff member within  
125 the ‘Therapy Services’ division of the hospital trust.

126

127 Exercise sessions were intended to be 30 minutes in duration, as per national PA guidelines  
128 (3). All sessions were undertaken in participants own home, on a one-to-one basis with the  
129 exercise therapist. Content of each session was personalised to each participant for the purposes  
130 of this study, dependent on equipment available in participants homes. Some participants  
131 utilised equipment such as bikes and treadmills, with others using free-weights, resistance-  
132 bands or body-weight exercises. The frequency, intensity and timings of exercises throughout  
133 the sessions were aligned with participants own preferences and capabilities, although a broad  
134 ‘interval’ approach to exercises was adopted as this has shown to be beneficial to individual  
135 with CF (15), and provides regular breaks for individuals to recover.

136

### 137 *2.5. Anthropometric and Pulmonary Measures*

138 Stature was measured to the nearest 0.1 cm (Holtain stadiometer, Crymych, UK) and body  
139 mass to the nearest 0.1 kg (Seca, Birmingham, UK), with body-mass index (BMI) subsequently  
140 calculated. Body-fat percentage (and subsequent fat-free mass) was identified using bio-  
141 electrical impedance (Quadscan 4000; Bodystat, Douglas, Isle of Man). Estimates of arterial  
142 blood oxygenation (SaO<sub>2</sub>) were recorded using a pulse-oximeter (Nellcor; Medtronic,  
143 Minneapolis, USA). Measures of forced expiratory volume in one-second (FEV<sub>1</sub>), forced vital  
144 capacity (FVC) were obtained using a spirometer (Vitalograph Alpha; Vitalograph,  
145 Buckingham, UK and COPD-6, Vitalograph, Buckingham, UK) and normalised to percentage  
146 of their predicted value (16).

147

### 148 *2.6. Physical Activity Measurement*

149 PA was recorded for 7 days at each time point (baseline, 4, 8, 12 weeks), using an accelerometer  
150 (GENEActiv; ActivInsights, Kimbolton, UK) worn on the participants non-dominant wrist.  
151 Participants were asked to wear it during all waking hours and complete an activity log to

152 qualitatively describe activity undertaken. Data was analysed in 60-second epochs, using pre-  
153 validated cut points (17, 18) and data from at least two days with ten hours each (19) was  
154 included for analyses to determine time spent (in minutes, and as percentage of wear time) in  
155 sedentary, light, moderate and vigorous PA domains.

156

### 157 *2.7. Quality of Life*

158 QoL was assessed using the CF Questionnaire-Revised (CFQ-R) (20), providing an indication  
159 of QoL across a range of domains. A value of 100 represents an optimal score.

160

### 161 *2.8. Assessment of Feasibility*

162 Feasibility and satisfaction of using video-calling was assessed at 8-weeks using a feedback  
163 questionnaire developed in conjunction with the local Research and Development team for the  
164 hospital trust (Supplement 1). To determine feasibility, guidelines set by Bowen *et al.* (21)  
165 were utilised. Primary areas of evaluation for this particular intervention were demand,  
166 implementation (study and session completion), practicality (technical issues) and acceptability  
167 (participant feedback). Furthermore, analysis of anthropometric, pulmonary, PA and quality of  
168 life (QoL) variables (described below) was purely descriptive in nature, with means and  
169 standard deviations reported for each variable, but no formal statistical procedures taking place  
170 (due to the feasibility nature of the study and insufficient statistical power).

171

## 172 **3. RESULTS**

### 173 *3.1. Demand*

174 Of the nine participants who undertook exercise sessions, two failed to complete the study.  
175 Both participants were male (42 years, BMI 27.8 kg·m<sup>-2</sup>, FEV<sub>1</sub> 59%<sub>Predicted</sub> and 26 years, BMI  
176 24.2 kg·m<sup>-2</sup>, FEV<sub>1</sub> 23%<sub>Predicted</sub>) and withdrew due to time constraints, one prior to their first

177 scheduled exercise session, and one after their first week of the intervention. In contrast, three  
178 participants requested to continue delivery of exercise sessions beyond the scheduled study.  
179 These participants commenced additional sessions as part of routine clinical care following the  
180 one-month follow up observations. No adverse events related to exercise during the study were  
181 reported by either participants, nor the exercise therapist delivering the intervention.

182

### 183 *3.2. Acceptability of Intervention*

184 Of the participants to undertake exercise sessions, compliance was variable. A total of 88  
185 sessions were booked with participants, with 59 being attended by participants. Individual  
186 compliance varied from 3/9 sessions (33%) to 10/10 sessions (100%) (mean = 68%). Of the 29  
187 sessions not attended, reasons included: illness ( $n = 13$  [45%]; including 9 missed by one  
188 participant's exacerbation leading to admission); work-related commitments ( $n = 8$ ; 28%),  
189 school-related commitments ( $n = 2$ ; 7%), unexplained non-attendance ( $n = 2$ ; 7%), transport  
190 (to home) issues ( $n = 2$ ; 7%), participant cancellation ( $n = 1$ ; 3%) and vacation ( $n = 1$ ; 3%).

191

192 Of the training sessions completed, duration ranged from 12 – 29 minutes (mean = 20 minutes).  
193 Sessions fell short of the desired 30 minutes in duration, due to both clinical restraints (e.g.  
194 gymnasium bookings, staffing requirements) and participant preferences for shorter sessions.  
195 Total contact time between therapist and participants for the 59 attended sessions equalled 18  
196 hours and 21 minutes.

197

### 198 *3.3. Implementation*

199 Of the seven participants to complete the post-intervention feedback questionnaire, four had  
200 used video-calling software previously: Skype ( $n = 2$ ; 29%); Business Skype ( $n = 1$ ; 14%);  
201 iPhone Facetime ( $n = 1$ ; 14%); with three participants (43%) using it for the first time due to

202 this study. Six of seven participants (86%) reported it was ‘easy’ to set up Skype, with one  
203 (14%) reporting set up as ‘OK’.

204

205 Participants used differing devices to connect via Skype including laptop ( $n = 4$ ; 57%),  
206 smartphone ( $n = 2$ ; 29%) and tablet ( $n = 1$ ; 14%). Connections were made over Wi-Fi ( $n = 4$ ;  
207 57%), broadband ( $n = 2$ ; 29%) and fibre broadband ( $n = 1$ ; 14%), with four participants (57%)  
208 reporting connection issues. These issues were experienced on differing devices and types of  
209 connection (tablet/Wi-Fi,  $n = 1$  [14%]; laptop/broadband,  $n = 1$  [14%]; smartphone/Wi-Fi,  $n =$   
210 1 [14%]; laptop/fibre broadband,  $n = 1$  [14%]). Sound quality was rated ‘good’ by 3/7 (43%)  
211 participants and ‘OK’ by 4/7 (57%) participants. Video quality was rated ‘good’ by 4/7 (57%)  
212 participants and ‘OK’ by 3/7 (43%) participants.

213

214 A total of 22 technical issues were reported by staff administering the intervention, for 15/59  
215 (25%) sessions. As a proportion of the number of issues, these included connection issues ( $n =$   
216 8; 36%); delays/lags ( $n = 7$ ; 32%); as well as visual ( $n = 4$ ; 18%) and sound ( $n = 3$ ; 14%)  
217 problems. Technical issues resulted in three video-calls (5% of total) being cancelled.

218

### 219 *3.4. Participant Feedback*

220 Participants found using Skype for exercise useful, with ratings ranging from 7/10 – 10/10  
221 (mean = 9/10). Overall satisfaction ratings, with regards to taking part in this research study,  
222 included: ‘excellent’ ( $n = 2$ ; 29%), ‘very good’ ( $n = 3$ ; 43%) and ‘good’ ( $n = 2$ ; 29%). All  
223 participants (7/7; 100%) stated they would be happy to take part in future research studies.

224

225 Four participants provided qualitative feedback via the intervention feedback questionnaire.

226 These comments covered different topics, including their support for, and enjoyment of, the

227 exercise intervention:

228

229 [exercise at home] ...*saved me a lot of hassle, not having to travel up to the hospital for*

230 *exercise* (Participant 1)

231

232 *Really enjoyable & set me up for the day* (Participant 4)

233

234 *I found the Skype session useful* (Participant 7)

235

236 Participants also commented on the use of Skype as the modality of delivering the intervention,

237 with both positive and negative comments:

238

239 *Connection was sometimes poor and a slight delay - was sometimes difficult hearing my*

240 *physio* (Participant 1)

241

242 *Very easy to setup and use. The connection was very good at all times* (Participant 7)

243

244 Comments also highlighted how the disease interfered with the delivery of the intervention:

245

246 *Unfortunately, I was poorly for a couple of weeks so I didn't get to exercise as much as I*

247 *would have liked to* (Participant 1)

248

249 Finally, participants also provided suggestions for further enhancements of the study design,

250 with specific mention of timeline of events:

251

252 *Would be good to have a tailored timetable at the start detailing when each part is happening*  
253 *e.g. Week 1: Exercise session x2; Week 2: wear exercise watch; Week 3: Review in hospital*  
254 *etc. (Participant 9)*

255

### 256 3.5. Participant Outcomes

257 Participant characteristics are listed in Table 1, with subsequent changes in body size and lung  
258 function, PA and QoL included in Tables 1, 2 and 3 respectively. The study was not powered  
259 to detect changes in these outcomes and no changes were seen across all variables during the  
260 course of the study.

261

262 The majority of data was collected at each visit without issue. However, of the seven  
263 participants providing follow up data, one did not undertake body composition at 8-weeks, and  
264 three SaO<sub>2</sub> measures (one at 8-weeks, 2 at 12-weeks) were missed; all due to non-availability  
265 of equipment. Furthermore, for PA data, of the seven participants providing follow up data,  
266 seven (of 21; 33%) PA measures across the three time points (4, 8, 12 weeks) were missed.  
267 These seven missed measurements were due to one participant not wearing the accelerometer  
268 (i.e. non-compliance,  $n = 3$ ; 43%), and the remaining four due to equipment error ( $n = 2$ ; 29%),  
269 inpatient admission ( $n = 1$ ; 14%) and loss within the postal service when returning  
270 accelerometer to study team ( $n = 1$ ; 14%).

271

272

## 273 4. DISCUSSION

274 The purpose of this study was to assess the feasibility and acceptability of using video-calling  
275 technology to implement exercise programmes to engage patients with CF in exercise training.  
276 Results suggest this modality may be feasible in practice, as it was accepted by participants

277 and could therefore potentially be used in clinical practice to deliver exercise interventions.  
278 Many different aspects of feasibility can be assessed to evaluate new interventions, and this  
279 study focused on the demand, implementation, practicality and acceptability (21).

280

#### 281 *4.1. Demand and Implementation*

282 For assessment of demand and implementation, outcomes of interest include the actual use of  
283 the programme and the degree of execution – characterised by the number of participants to  
284 complete the study and number of sessions completed.

285

286 As with any exercise intervention, a loss of study participants is to be expected, and the  
287 withdrawal of two participants (22%) in the present study is comparable to previous training  
288 interventions in people with CF, both in terms of percentage of participants (4/18; 22% (22))  
289 and absolute numbers (13). Therefore, given the self-reported reasons of ‘time commitments’  
290 from participants as reasons for withdrawal, and comparable attrition rates to other studies, it  
291 can be concluded that use of Skype itself is not a contributory factor in withdrawing from this  
292 intervention – a reason for withdrawal that has been previously reported in people with chronic  
293 obstructive pulmonary disease (COPD) (23).

294

295 In addition to withdrawals, 32% of appointments were missed by remaining participants for  
296 various reasons, a lower rate than that seen when using Skype to deliver exercise for chronic  
297 knee pain (24). These reasons were related to lifestyle and environmental factors that could  
298 feasibly interfere with any intervention (e.g. work commitments) and were not related to the  
299 use of Skype or the internet itself. This provides further evidence that the use of a Skype is a  
300 feasible platform for use when remotely delivering an exercise intervention.

301

302       4.2. *Practicality*

303   In order to assess practicality, the ability of participants to carry out the intervention must be  
304   considered. Within this study, there were multiple technical issues associated with using Skype,  
305   such as connection issues and audio/visual problems. However, these issues were not mutually  
306   exclusive and multiple issues could (and did) occur per video-contact session, thus reducing  
307   the total number of affected sessions. The 25% of sessions that were affected is a lower rate to  
308   that previously reported for an online Yoga intervention for people with COPD and heart  
309   failure (25), although the issues are similar (e.g. visual lags).

310

311   Individual participants used varying platforms, and connection modalities, to operate Skype  
312   and yet all participants reported at least one technical issue. Therefore, no single connection  
313   mode or user platform can be associated with technical issues. Furthermore, as only 5% of calls  
314   were cancelled as a result of technical issues, this suggests that use of Skype as a delivery  
315   modality for exercise sessions is practically feasible. This is supported by previous use of  
316   telemedicine in CF in the United Kingdom (UK), whereby connection problems have delayed  
317   delivery of the intervention, but do not appear to have negatively affected the acceptability of  
318   remote monitoring (26). Given the increased government investment in internet infrastructure  
319   in the UK (27), it is likely such technical issues associated with video-calling will reduce in the  
320   future, further increasing the feasibility of this intervention modality.

321

322   In addition to patients, interventions must also be practically feasible for clinical staff. This  
323   current intervention required a total contact time of 18 hours and 21 minutes from the exercise  
324   therapist, although this does not include clinical time associated with setting up appointments  
325   or preparing programmes for delivery. However, the online nature of sessions does mean that  
326   staff can contact patients immediately one after another (as done multiple times in the present

327 study), reducing the time normally required between meeting patients in the same facility due  
328 to cross-infection risks. This can therefore be viewed as an efficient use of clinical time and  
329 increases the practical feasibility of using Skype as a modality for exercise delivery.

330

#### 331 *4.3. Acceptability*

332 Whilst the use of Skype does not appear to be a barrier to participation in an exercise training  
333 programme, participant support and enjoyment is fundamentally required for an intervention  
334 to be deemed acceptable. Without this participant support, any prospective development of an  
335 intervention is unlikely to succeed in the long-term.

336

337 Participant feedback was largely positive in this study, with all participants who completed this  
338 study being satisfied with the study and reporting Skype as a useful platform. Furthermore,  
339 given that three participants requested to continue training sessions via Skype following the  
340 intervention, this suggests acceptability of this modality. Qualitative comments were mixed;  
341 although negative comments were related to technical issues associated with connection (which  
342 could be overcome with advancements/upgrades in software/internet speeds), as opposed to  
343 the use of an online platform and the burden of the disease itself. Positive responses to the  
344 intervention are in agreement with previous studies to utilise Skype in CF (28), osteoarthritis  
345 (29) and breast cancer (30).

346

#### 347 *4.4. Anthropometrics, Pulmonary Function, PA and QoL*

348 As this study was not powered or designed to identify changes in function over time, analysis  
349 of data is limited to descriptive statistics only. However, the majority of measures were  
350 collected without issue, with the technical issues and loss within the postal system having been  
351 experienced by other studies previously (31). Furthermore, the purpose of the study was to

352 remotely *supervise* exercise, not to remotely *monitor* exercise responses and as such, the loss  
353 of data impacts only upon our understanding of habitual PA and does not impact upon clinical  
354 decisions that may be made on account of monitoring, as incorporated into other prospective  
355 monitoring interventions (32).

356

357 When examining the data obtained from the study, mean values for all anthropometric,  
358 pulmonary, PA and QoL factors appear to have remained stable, suggesting maintenance of  
359 function when engaging in an online exercise regimen over a 12-week period. The wide  
360 standard deviation associated with each variable is likely due to a) the range of disease severity  
361 within the recruited group (as shown by baseline FEV<sub>1</sub> ranging from 23 – 121% predicted [data  
362 not reported]), and b) admissions to hospital due to pulmonary exacerbations experienced by  
363 participants. Regardless, the lack of an overall decline in function aligns with previous studies  
364 in other clinical groups that have utilised Skype to remotely deliver exercise interventions, such  
365 as COPD (23), breast cancer (30) and chronic knee pain (24), all of which have found positive  
366 outcomes associated with online-delivered exercise.

367

368 As patients with CF are recommended to undertake PA as part of disease management (3), the  
369 challenge for clinical staff is how to implement this on a personalised level, and ensure  
370 compliance. Whilst the mean duration of exercise sessions in this study was 20 minutes, below  
371 the 30 minutes of recommended daily PA (3), it has been shown that accumulation of bouts of  
372 as little as 10 minutes of MVPA could yield long-term benefits in CF (33). Therefore, use of  
373 telehealth could prove to be an integral component of future care and possibly reduce the time  
374 required on behalf of clinical teams to engage patients in exercise and PA.

375

376 The findings of the present study have implications for clinical practice, by identifying issues  
377 associated with a platform that has the potential to overcome geographical barriers and reduce  
378 cross-infection risks.

379

#### 380 *4.5. Study Limitations*

381 The small samples size (due to the feasibility driven approach of this investigation) will limit  
382 the utility of findings to further groups of individuals with CF, although the findings can be  
383 used to statistically power future studies. Furthermore, the variances in the types of exercise  
384 undertaken by each participant has the potential to bias results. Whilst a uniform training  
385 regimen would alleviate such bias, it would remove the personalised approach to each training  
386 regimen that can improve acceptance and adherence. This therefore, provides a challenge for  
387 future researchers to accommodate this trade-off between uniform and personalised approaches  
388 to exercise prescription.

389

390 In conclusion, this feasibility study demonstrated that use of Skype as a telehealth platform can  
391 be successfully used to engage patients with CF in a personalised exercise regimen, and that  
392 the participants in this study responded positively to this approach. Future research is warranted  
393 to identify whether the utility of this delivery modality can effectively improve health and  
394 physical function in CF.

395

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400

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404

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**Table 1.** Changes in anthropometric and pulmonary variables over the course of the study period.

	Baseline (0 weeks) <i>n</i> = 7	Intervention End (8 weeks) <i>n</i> = 7	Follow Up (12 weeks) <i>n</i> = 7
Age (years)	30.0 (8.6)	30.2 (8.6)	30.3 (8.6)
Height (m)	1.64 (0.09)	1.64 (0.09)	1.64 (0.09)
Weight (kg)	61.9 (14.8)	62.2 (14.2)	62.8 (14.7)
BMI (kg·m <sup>-2</sup> )	22.8 (3.7)	23.0 (3.6)	23.1 (3.6)
Fat Mass (kg)	13.2 (6.3)	14.0 (6.5)	13.4 (6.7)
Fat Mass (%)	20.8 (9.2)	21.1 (8.0)	21.1 (9.7)
Fat Free Mass (kg)	48.7 (11.4)	50.8 (11.0)	49.4 (12.5)
Fat Free Mass (%)	79.2 (9.2)	78.9 (8.0)	78.9 (9.7)
Resting SaO <sub>2</sub> (%)	97 (1)	97 (2)	98 (1)
FEV <sub>1</sub> (L)	2.53 (1.47)	2.51 (1.55)	2.54 (1.43)
FEV <sub>1</sub> (% <sub>Predicted</sub> )	74 (31)	73 (34)	73 (32)
FVC (L) <sup>a</sup>	3.65 (1.68)	3.61 (1.71)	3.58 (1.49)
FVC (% <sub>Predicted</sub> ) <sup>a</sup>	93 (25)	91 (27)	90 (22)
Homozygous ΔF508		3	
Heterozygous ΔF508		4	
Other Alleles	E1371X, Q220X, 2789+5G>A, D1152H		

All values reported as mean (SD). BMI, body mass index; FEV<sub>1</sub>, forced expiratory volume in 1 second; FVC, forced vital capacity. Data presented for *n* = 7 to demonstrate the seven participants who completed the study. a: FVC only available for 6/7 participants due to positive screen of non-tuberculosis mycobacterium in one participant, whereby subsequent use of personal spirometer only provides FEV<sub>6</sub>, not FVC.

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**Table 2.** Changes in physical activity over the course of the study period.

	Baseline (0 weeks)	Mid-Intervention (4 weeks)	Intervention End (8 weeks)	Follow Up (12 weeks)
Activity Domain	<i>n</i> = 6 <sup>a</sup>	<i>n</i> = 4 <sup>b</sup>	<i>n</i> = 6 <sup>c</sup>	<i>n</i> = 4 <sup>d</sup>
Sedentary (mins·day <sup>-1</sup> )	528 (86)	565 (61)	470 (66)	513 (151)
Sedentary (%)	65 (8)	67 (13)	65 (12)	63 (20)
Light (mins·day <sup>-1</sup> )	96 (20)	85 (6)	86 (40)	98 (33)
Light (%)	12 (3)	10 (1)	14 (9)	13 (4)
Moderate (mins·day <sup>-1</sup> )	180 (72)	201 (129)	193 (104)	196 (148)
Moderate (%)	22 (7)	23 (13)	24 (10)	24 (16)
Vigorous (mins·day <sup>-1</sup> )	5 (5)	6 (8)	4 (4)	2 (3)
Vigorous (%)	1 (1)	1 (1)	1 (1)	0 (0)

All values are presented as means (SD). a: Baseline values for six participants, accounting for all individuals to complete study (*n* = 7), and loss of data due to non-wear of accelerometer (*n* = 1). b: 4-weeks only includes four participants due to withdrawal (*n* = 2), non-wear of accelerometer (*n* = 1), inpatient admission unrelated to interventions (*n* = 1), and loss of accelerometer within postal system (*n* = 1). c: 8-weeks only includes six participants due to withdrawal (*n* = 2) and non-wear of accelerometer (*n* = 1). d: 12-weeks only includes four participants due to withdrawal (*n* = 2), equipment error (*n* = 2), and non-wear of accelerometer (*n* = 1).

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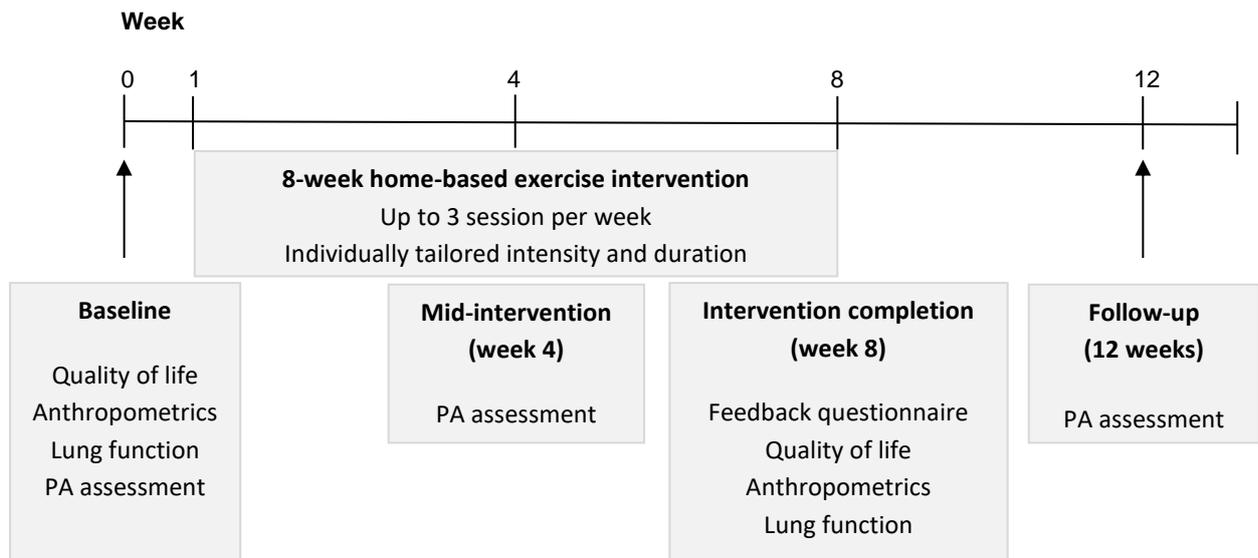
**Table 3.** Changes in quality of life (QoL) over the course of the study period.

	Baseline (0 weeks)	Intervention End (8 weeks)	Follow Up (12 weeks)
QoL Dimension	<i>n</i> = 6 <sup>a</sup>	<i>n</i> = 6 <sup>b</sup>	<i>n</i> = 7 <sup>c</sup>
Physical	72 (34)	58 (37)	72 (33)
Vitality	56 (25)	51 (21)	56 (24)
Emotion	71 (27)	71 (18)	79 (18)
Eating	80 (25)	83 (18)	88 (17)
Treatment Burden	56 (36)	37 (24)	49 (33)
Health Perception	70 (24)	37 (38)	52 (34)
Social	74 (16)	62 (19)	62 (29)
Body Image	69 (29)	69 (28)	73 (27)
Role	75 (27)	65 (38)	77 (28)
Weight	67 (42)	67 (30)	71 (36)
Respiratory	52 (33)	56 (23)	64 (27)
Digestive	85 (22)	91 (11)	87 (20)

All values are presented as means (SD). a: Baseline values for six participants, accounting for all individuals to complete study (*n* = 7), but failure of one participant to complete baseline QoL (*n* = 1). b: 8-weeks only includes six participants due to withdrawal from study (*n* = 2) and loss of QoL questionnaire within postal system (*n* = 1). c: 12-weeks only includes seven participants due to withdrawal from study (*n* = 2).

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552 **Figure 1.** Schematic representation of assessment and intervention time points.



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565 **SUPPLEMENTARY FILES**

566 Supplement 1. Study feedback questionnaire administered to participants, following 8-week  
567 intervention.

## SKYPE STUDY FEEDBACK QUESTIONNAIRE.

Thank you for taking part in this Research Study at the RD&E. We would be grateful if you would complete this questionnaire about your experience as a Research participant so that we can improve the service we provide.

The information you provide will be collected by the Research and Development team and will be treated in the strictest confidence. It will not affect any further treatment or participation in a Research Study.

Thank you.

<b><u>About Skype.</u></b>				
Did you use Skype or similar software before now?			<input type="checkbox"/> YES	<input type="checkbox"/> NO
If YES please state which software you used:				
How easy/difficult was it to set up Skype?			<input type="checkbox"/> EASY	<input type="checkbox"/> OK
Which (if any) issues did you encounter?				
What device are you using for Skype?		<input type="checkbox"/> DESKTOP	<input type="checkbox"/> LAPTOP	<input type="checkbox"/> TABLET
			<input type="checkbox"/> SMARTPHONE	
Have you had any connection issues?			<input type="checkbox"/> YES	<input type="checkbox"/> NO
What internet connection are you using?		<input type="checkbox"/> 3G	<input type="checkbox"/> 4G	<input type="checkbox"/> BROADBAND
		<input type="checkbox"/> FIBREBROADBAND		<input type="checkbox"/> WIFI
How was the sound quality?			<input type="checkbox"/> GOOD	<input type="checkbox"/> OK
			<input type="checkbox"/> BAD	
How was the video quality?			<input type="checkbox"/> GOOD	<input type="checkbox"/> OK
			<input type="checkbox"/> BAD	
Did you find using Skype for an exercise session useful?				
Not at all   1   2   3   4   5   6   7   8   9   10   very useful				
How could this format of appointment be improved?				
Overall comments/opinions:				

<b><u>About the Study.</u></b>		YES	PARTLY	NO					
Was the study information sheet easy to understand?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Did the Research Team answer questions about the study in a way that you could understand?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Did you know what was expected of you when you agreed to take part in the study?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Do you feel it is important to take part in Research?		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Would you be happy to take part in another Research Study?		<input type="checkbox"/>		<input type="checkbox"/>					
<b><u>General Satisfaction.</u></b>									
		POOR	FAIR	GOOD	VERY GOOD	EXCELLENT			
My overall satisfaction with taking part in this Research Study is:-		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
<b><u>Please add any further comments about your experience of taking part in this study:-</u></b>									
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<b><u>Please tell us your reasons for taking part in this study. Circle all the options which apply.</u></b>									
1) To help others	2) Own benefit	3) Felt obliged	4) Other – please specify: _____						
<b>ADDITIONAL INFORMATION – PLEASE CIRCLE</b>									
AGE GROUP	11-16	17-21	22-30	31-40	41-50	51-60	61-70	71-80	80+
<b>Thank you for your help.</b>									
<b>RESEARCH TRIAL INFORMATION TO BE COMPLETED BY STUDY TEAM</b>									
Study Title:						R&D Number:			