

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

**ON THE MOVE: OPTIMIZING PARTICIPATION IN GROUP EXERCISE
TO PREVENT WALKING DIFFICULTY IN AT-RISK OLDER ADULTS**

Principal Investigator:

Jennifer S. Brach, PhD, PT

Supported by:

PCORI

CE-1304-6301

**Version 1
October 6, 2015**

| | | |
|----|---|-------------|
| 17 | TABLE OF CONTENTS | |
| 18 | | <u>Page</u> |
| 19 | PRÉCIS..... | 5 |
| 20 | STUDY TEAM ROSTER | 6 |
| 21 | 1 Study objectives..... | 7 |
| 22 | 1.1 Primary Objective | 7 |
| 23 | 1.2 Secondary Objectives..... | 7 |
| 24 | 2 BACKGROUND AND RATIONALE | 7 |
| 25 | 3 STUDY DESIGN..... | 10 |
| 26 | 4 SELECTION AND ENROLLMENT OF PARTICIPANTS | 13 |
| 27 | 4.1 Inclusion Criteria | 13 |
| 28 | 4.2 Exclusion Criteria | 13 |
| 29 | 4.3 Study Enrollment Procedures | 14 |
| 30 | 5 STUDY INTERVENTIONS | 15 |
| 31 | 5.1 Overview..... | 15 |
| 32 | 5.2 On the Move | 15 |
| 33 | 5.3 Standard | 16 |
| 34 | 5.4 Monitoring of vital signs..... | 16 |
| 35 | 5.5 Program monitoring..... | 16 |
| 36 | 5.6 Adherence Assessment | 16 |
| 37 | 6 STUDY PROCEDURES | 16 |
| 38 | 6.1 Schedule of Evaluations..... | 17 |
| 39 | 6.2 Description of Evaluations..... | 18 |
| 40 | 6.2.1 Baseline Assessments | 18 |
| 41 | 6.2.2 Baseline 2 Assessments | 20 |
| 42 | 6.2.3 Post-Intervention Assessment..... | 21 |
| 43 | 7 SAFETY ASSESSMENTS | 21 |
| 44 | 7.1 Expected Adverse Experiences..... | 21 |
| 45 | 7.2 Minimizing Risk during Assessments and Interventions..... | 22 |

| | | | |
|----|-----------|---|-----------|
| 46 | 7.3 | Confidentiality..... | 22 |
| 47 | 7.4 | Participant Education about Potential Risks..... | 23 |
| 48 | 7.5 | Adverse Events and Serious Adverse Events..... | 23 |
| 49 | 7.5.1 | Classifying Adverse Events (AE)..... | 24 |
| 50 | 7.5.2 | Severity..... | 24 |
| 51 | 7.5.3 | Expectedness..... | 24 |
| 52 | 7.5.4 | Relatedness..... | 25 |
| 53 | 7.6 | Expected AEs..... | 25 |
| 54 | 7.7 | Reportable AEs (RAEs)..... | 25 |
| 55 | 7.8 | Reporting of Events..... | 26 |
| 56 | 8 | INTERVENTION DISCONTINUATION..... | 26 |
| 57 | 8.1 | Interruption to Exercise Participation..... | 26 |
| 58 | 8.2 | Intervention Discontinuation..... | 26 |
| 59 | 8.3 | Voluntary Participation..... | 27 |
| 60 | 9 | STATISTICAL CONSIDERATIONS..... | 27 |
| 61 | 9.1 | General Design Issues..... | 27 |
| 62 | 9.2 | Sample Size..... | 28 |
| 63 | 9.3 | Data Analyses..... | 30 |
| 64 | 9.3.1 | Overview..... | 30 |
| 65 | 9.3.2 | Main Analysis for Aims 1-3..... | 30 |
| 66 | 9.3.3 | Aim 4 exploratory Analysis..... | 31 |
| 67 | 9.3.4 | Additional Exploratory/Sensitivity and Compliance/Dropout Analyses..... | 32 |
| 68 | 10 | DATA COLLECTION AND QUALITY ASSURANCE..... | 32 |
| 69 | 10.1 | Data Collection Forms..... | 32 |
| 70 | 10.2 | Data Management..... | 33 |
| 71 | 10.3 | Quality Assurance..... | 33 |
| 72 | 10.3.1 | Intervention..... | 33 |
| 73 | 10.3.2 | Protocol Deviation Tracking..... | 33 |
| 74 | 10.3.3 | Subject Termination..... | 34 |
| 75 | 11 | PARTICIPANT RIGHTS AND CONFIDENTIALITY..... | 34 |
| 76 | 11.1 | Institutional Review Board (IRB) Review..... | 34 |
| 77 | 11.2 | Informed Consent Forms..... | 34 |
| 78 | 11.3 | Participant Confidentiality..... | 34 |

| | | | |
|----|-----------|--|-----------|
| 79 | 11.4 | Study Discontinuation..... | 35 |
| 80 | 12 | STUDY TIMELINE..... | 35 |
| 81 | 13 | PUBLICATION OF RESEARCH FINDINGS..... | 36 |
| 82 | 14 | REFERENCES..... | 37 |
| 83 | | | |
| 84 | | | |

85 **PRÉCIS**

86 Community-dwelling older adults fear loss of independence and nursing home placement more
87 than death. Walking difficulty often leads to loss of independence. Exercise is beneficial to
88 physical and mental health and may prevent walking difficulty and promote independence.
89 Recognizing the importance of exercise, senior housing facilities offer exercise programs to their
90 residents. The exercise programs are often group-based, seated range of motion exercises that do
91 not challenge the older adult; consequently participation rates and resident satisfaction are low.
92 If the goal is to improve walking to promote independence than the exercise program should
93 specifically target walking. Therefore, we developed a challenging, group exercise program
94 entitled “On the Move” which focuses on the fundamentals of walking. In this research study we
95 will determine if the On the Move program is better than a standard program at improving
96 walking and promoting independence and if the same benefits can be obtained if the On the
97 Move program is delivered by staff of the senior living facilities instead of an exercise leader.
98 To answer these questions, 560 community-dwelling older adults living in 28 different
99 Independent Living Facilities and Senior High Rises will be randomly assigned to either the 12
100 week On the Move group exercise program or the standard group exercise program delivered by
101 either an exercise leader or staff activity personnel. Participants’ walking and reported ability to
102 carry out everyday activities (functional ability) will be assessed before and after the 12 week
103 program. We will also assess participant safety and satisfaction with the exercise program and
104 instructor.

105
106 The findings from this research study will provide evidence for the value of the On the Move
107 group exercise program and will better inform patient choices regarding participation in exercise
108 programs. If successful in improving walking and promoting independence and acceptable to the
109 older adult, the On the Move program could be incorporated into exercise programming for older
110 adults in community centers, health clubs, and senior residences across the country.
111

112 **STUDY TEAM ROSTER**

113 **Principal Investigator:**

114 **Jennifer S. Brach, PhD, PT**

115 Bridgeside Point 1

116 100 Technology Drive

117 Pittsburgh, PA 15219-3130

118 Phone: 412-383-6533

119 Fax: 412-648-5970

120 jbrach@pitt.edu

121 Main responsibilities/Key roles: Oversees and is responsible for all aspects of the study

122

123 **Co-Investigators:**

124

| | |
|--|--|
| <p>Deborah Brodine, MHA, MBA UPMC Community Provider Services Forbes Tower Suite 10055 200 Lothrop St Pittsburgh, PA 15213 Phone: (412) 647-0548 brodineds@umpmc.edu Main responsibilities: Provider Stakeholder</p> | <p>Sandra Gilmore, RN, MS UPMC Community Provider Services 101 Orchard Drive Suite 104 Trafford, PA 15085 Phone: (412)380-8750 gilmoresl@upmc.edu Main responsibilities: Provider Stakeholder, community liaison. Identify community sites.</p> |
| <p>Neelesh Nadkarni, MD, PhD Division of Geriatric Medicine Kaufmann Building, Suite 500 Pittsburgh, PA Phone: (412) 692-2383 nkn3@pitt.edu Main responsibilities: Study physician</p> | <p>Subashan Perera, PhD Division of Geriatric Medicine Kaufmann Building, Suite 500 Pittsburgh, PA Phone: (412) 692-2365 Ksp9@pitt.edu Main responsibilities: Randomization, data management and study statistician</p> |
| <p>Jessie VanSwearingen, PhD, PT Bridgeside Point 1 100 Technology Drive Pittsburgh, PA 15219-3130 Phone: 412-383-6533 jessievs@pitt.edu Main responsibilities/Key roles: Quality control of the intervention</p> | <p>Edmund Ricci, PhD 207A Parran Hall Graduate School of Public Health University of Pittsburgh 130 DeSoto Street Pittsburgh, PA 15261 Phone: 412-624-6393 emricci@pitt.edu Main Responsibilities: Program evaluation</p> |

125

126

127 **1 STUDY OBJECTIVES**

128 **1.1 Primary Objective**

129 **Compare the effects of the *On the Move* group exercise program to a standard program on**
130 **self-reported function and disability and walking ability.** *The On the Move program will*
131 *produce greater gains in self-reported function and disability (Late Life Function and Disability*
132 *Index/LLFDI) and walking ability (6-minute walk test/6MWT and gait speed) when delivered by*
133 *an exercise leader.*

134 **1.2 Secondary Objectives**

135 **When delivered by staff activity personnel, assess the effectiveness of On the Move**
136 **compared to a standard program; and sustainability compared to delivery by exercise**
137 **leaders.** *On the Move delivered by staff activity personnel will produce gains in above outcomes*
138 *that are greater than the standard program; and comparable to when delivered by an exercise*
139 *leader.*

140 **Compare the acceptability and the risks of the On the Move and standard exercise**
141 **programs delivered by exercise leaders and staff activity personnel.** *On the Move will result*
142 *in greater satisfaction and higher attendance rates than the standard program. Attendance rates*
143 *and satisfaction will be similar for exercise leader and staff activity personnel led programs.*
144 *Adverse event (falls, soft tissue injuries, muscle soreness, etc.) rates during exercise will be*
145 *similar between the two groups and the two facilitators.*

146 **Explore potential baseline predictors of benefit and risks of participation in *On the Move***
147 **program to facilitate informed patient decision making.** *We will be able to identify*
148 *combinations of baseline physical, psychosocial and demographic factors associated with each*
149 *of the treatment response and adverse events outcomes.*

150

151 **2 BACKGROUND AND RATIONALE**

152 Disability is a common, costly problem in older adults. Walking difficulty in older adults
153 contributes to loss of independence, higher rates of morbidity and increased mortality.(1),(2-5)
154 Mobility loss is also a sentinel predictor of other disabilities that restrict independent living.(6)
155 Compared to older adults without self-reported walking difficulty, those who developed mild
156 walking difficulty over one year had higher healthcare costs (mean \$1,128 per person).
157 Extrapolated to the estimated 22% of older adults who develop walking difficulty annually, the
158 cost to society is an additional 3.6 billion dollars per year.(7) Therefore, preventing or delaying
159 the onset of walking difficulty might have a substantial impact on older adults' independence and
160 their healthcare costs.

161
162 Exercise intervention studies have neglected to include disability outcomes. Difficulty walking is
163 associated with reduced activity and participation and a loss of independence.(8),(9, 10) Exercise

164 interventions for older adults have focused on improving walking as a means to reduce or delay
165 physical disability.(11, 12) These exercise interventions have included strength, balance and
166 endurance activities in order to reduce impairments and improve physiologic capacity for
167 walking. These studies have resulted in only modest gains in walking ability (i.e. an approximate
168 5% increase in speed) with only one study reporting disability outcomes.(11, 13-21) Definitive
169 evidence that exercise that improves walking also reduces disability is lacking; therefore the
170 need for the ongoing Lifestyle Interventions and Independence for Elders (LIFE) study.

171
172 Exercise interventions fail to include an important component of exercise to improve walking,
173 the timing and coordination of movement. National recommendations and interventions to
174 prevent walking difficulty, such as the Lifestyle Interventions and Independence for Elders
175 (LIFE) study have overlooked an important component of exercise that is critical for walking,
176 the timing and coordination of movement.(20, 22) The ongoing Lifestyle Interventions and
177 Independence for Elders (LIFE) study examines a standard walking endurance, strength, static
178 balance and flexibility intervention on the prevention of disability in community-dwelling older
179 adults. The LIFE pilot study, using the same intervention, demonstrated significant but only
180 modest effects.(20) We have preliminary data to suggest that a novel exercise program that
181 includes timing and coordination exercise is superior to a standard strength and endurance
182 program for improving walking in older adults.(23)

183
184 Timing and coordination training improve walking in older adults. We conducted two pilot
185 studies, involving contrasting subject groups, to examine the impact of a timing and coordination
186 exercise program on walking. The first study (RESTORE) included older adults with slow (gait
187 speed < 1.0 m/s) and variable gait and has been published.(23) The second study (PRIME) has
188 just recently been completed. It included older adults with near normal gait speed (gait speed >
189 1.0 m/s) but with difficulty with aspects of the timing and coordination of walking (i.e. Figure of
190 8 test time > 8.0 s- see choice of outcomes section below for details of this measure). Participant
191 retention for the 12 week post-tests was over 95%.

192
193 In the RESTORE study, 50 subjects (mean age 77.2±5.5 years, 65% women) were randomly
194 assigned to either a standard exercise program (endurance, strength and typical static balance
195 training) or a timing and coordination program, for one hour, 2 times per week for 12 weeks,
196 with baseline and 12 week follow up assessments. Of the 50 who entered, 47 (94%) completed
197 the study. Both groups increased gait speed (timing and coordination by 0.21 m/s and standard
198 by 0.14 m/s). The timing and coordination group reduced the energy cost of walking
199 $0.10 \pm 0.03 \text{ mL/kg/m}$ more than the standard group ($p=0.0002$), had a 9.8 ± 3.5 point greater gain in
200 reported walking confidence (i.e. Gait Efficacy Scale) than the standard group ($p=0.008$), had a
201 1.5 ± 0.6 point greater reduction in gait abnormalities (i.e. GARS) than the standard group
202 ($p=0.02$), and had a 3.5 ± 1.7 ($p=0.04$) point greater gain than the standard group in basic lower
203 extremity function (LLFDI) and a 2.6 ± 1.7 ($p=0.12$) point greater gain than the standard group in
204 advanced LE function (LLFDI).(23)

205
206 In the PRIME study, 38 subjects (mean age 78.5±5.6 years, 65% women) were randomly
207 assigned to either a standard endurance and strength exercise program or a timing and
208 coordination plus strengthening program, 2 times per week for 12 weeks, with assessments at
209 baseline and immediately following the 12 week intervention. Preliminary analyses indicate that

210 the timing and coordination group had greater improvements in gait speed, figure of 8 walk, and
211 challenging gait tasks than the standard group. Both groups had improvements in the 6MWT
212 ($p < 0.05$); however, the timing and coordination group had marginally greater improvements
213 ($p = 0.14$). Only the timing and coordination group demonstrated improvement in self-reported
214 disability and neither group decreased perceived walking difficulty (LLFDI – total function).
215 However, this group had very high initial LLFDI function scores; reflecting low levels of
216 baseline perceived walking difficulty, so may have been vulnerable to ceiling effects. Since our
217 proposed sample will be more impaired, we anticipate that there is more room for change and
218 that treatment group differences or declines of perceived walking difficulty will be detectable.

219
220 Our preliminary data demonstrate the benefit of timing and coordination training and support the
221 concept that timing and coordination training provides something distinct from standard training,
222 with potential effects on self-reported function, disability and mobility. Note that these pilot
223 studies examined the effects of the timing coordination program delivered on a one on one basis.
224 In the current proposal we will be testing the timing and coordination training delivered as a
225 group program (i.e. On the Move group exercise program).

226
227 Exercise programs offered in senior housing are inadequate. Recognizing the importance of
228 exercise for promoting physical and mental health many senior housing facilities offer exercise
229 programs for the older adults. Though available, participation rates and participant satisfaction
230 are low. Older adults feel the seated group exercise programs that are offered, are not
231 challenging or beneficial so they stop participation. Providers, such as UPMC Senior
232 Communities, are looking for viable alternatives. Older adults are interested in exercise
233 interventions that will improve their mobility and help maintain their independence (focus group
234 information). Exercise programs currently offered in senior living settings are inadequate
235 because they 1) are often conducted in seated position and do not challenge the older adult and 2)
236 exclude an important component of exercise that is critical to walking, the timing and
237 coordination of movement. There is a need for a more challenging, evidence-based exercise
238 program that is designed to improve walking and promote independence in older adults.

239
240 We developed a challenging, evidence-based group exercise program, On the Move, to improve
241 walking in older adults. Though effective, an individualized, physical therapist led exercise
242 program (described above as timing and coordination training) is not a cost effective model for
243 the prevention of walking difficulty. A group exercise program is a cost efficient alternative
244 which would likely promote adherence through socialization. Therefore, in collaboration with
245 UPMC Community Provider Services, we developed a novel timing and coordination group-
246 based exercise program entitled “On the Move”. The On the Move program differs from current
247 group exercise programs in that 1) it contains timing and coordination exercises based on the
248 biomechanics and motor control of walking (i.e. specificity of training), 2) the majority of the
249 program consists of standing and walking exercises which challenge the older adult, and 3) it
250 was developed with input from older adults.

251
252 UPMC Community Provider Services is interested in the sustainability of the exercise program.
253 A main priority of our stakeholder, UPMC Community Provider Services, is the sustainability of
254 the exercise program. Often scientists conduct research within their facilities and when the
255 research is over, the scientists move on to another project and the program does not continue.

256 Recognizing this as an issue, we incorporated a sustainability component into our Aging Institute
257 pilot described above. During the 12 week exercise program, the exercise leader is training the
258 activity staff personnel to conduct the program. The activity staff personnel is currently assisting
259 with the 12 week program. After 6 weeks of exercise classes we surveyed the activity staff
260 personnel to determine her level of confidence in conducting the program. The activity staff
261 responded that she was very confident that she could identify participants who were doing the
262 exercises correctly and/or incorrectly and she was confident that she could lead the exercise
263 program and progress the exercises. The activity staff personnel stated that a “cheat sheet” of
264 listed exercises would be very useful when leading the exercise class. At the conclusion of the
265 first 12 week exercise leader program, the staff activity personnel will start a new 12 week
266 program with residents who were placed on the wait list.

267

268 Summary

269 The evidence-based On the Move program was developed based on our past research and with
270 input from older adults. In our initial pilot study, we demonstrate that the program is feasible and
271 acceptable to the older adult and that activity staff personnel have confidence in their ability to
272 lead the program. In our current pilot we demonstrate our ability to engage management from
273 other community sites and the ability to recruit from different populations. The next key step is
274 to examine the benefits and risks of the On the Move program in a larger, more diverse sample
275 of older adults and to assess the sustainability of the program. Specifically, we are interested in
276 determining if the challenging group-based program improves mobility and prevents functional
277 decline and disability without any increased risk to the older adult and if the activity staff
278 personnel can lead the On the Move exercise program obtaining similar results to the exercise
279 leader delivered program.

280

281 **3 STUDY DESIGN**

282 To address our research questions, we will conduct a cluster randomized single-blind two arm
283 intervention trial to compare the effects on function, disability and mobility of a standard group
284 exercise program and a novel *On the Move* group exercise program in 560 community-dwelling
285 older adults who reside in 8 independent living facilities and 20 senior housing sites. Group
286 exercise classes are twice weekly for 12 weeks and will be delivered by exercise leaders and
287 activity staff personnel. Function, disability and mobility are assessed at baseline and post
288 intervention (**Figure 1**).

289

290

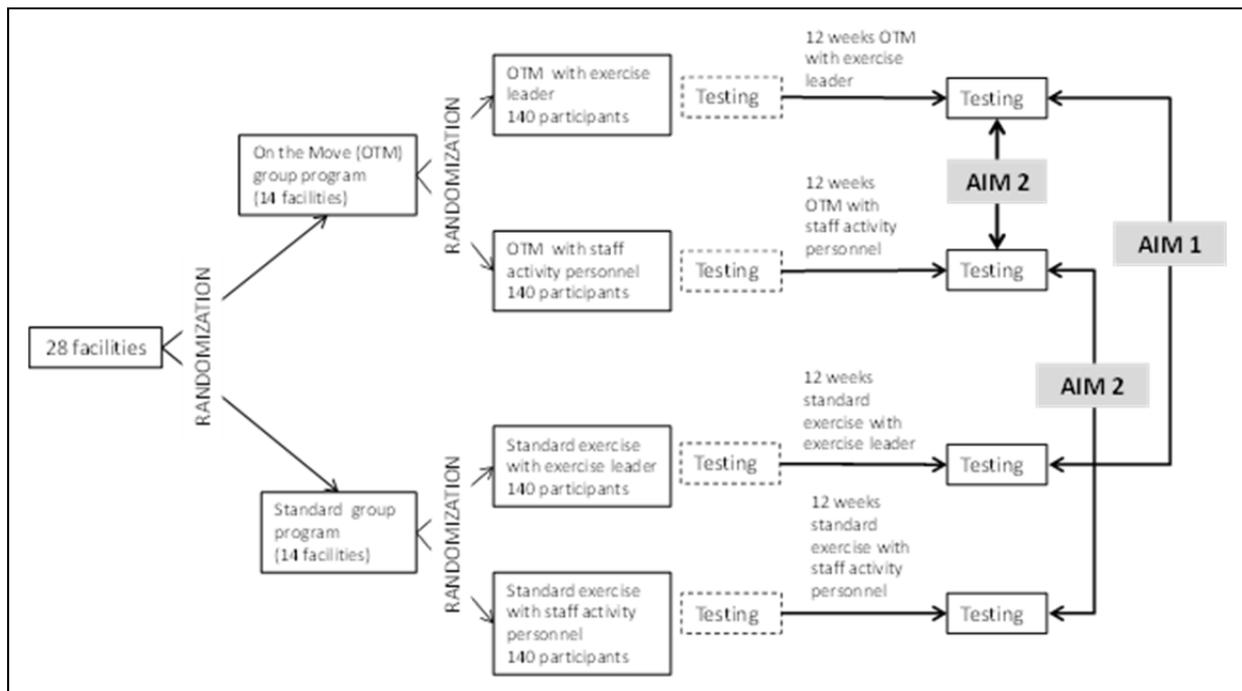
291

292

293

294

295



298

Choice of comparators

299

There are two main comparisons being examined, 1) the type of exercise program (i.e. *On the Move* versus a standard group exercise program) and 2) the delivery mode (i.e. exercise leaders versus staff activity personnel).

300

301

302

Exercise program comparison (Aim 1). The novel challenging *On the Move* exercise program will be compared to a standard group exercise program. Both exercise programs (*On the Move* and standard) will be group-based and led by a person. Our older adult participants have stressed the importance of having the exercise program led by a person instead of viewing a videotape. They feel the person is more enjoyable and they like the idea of the instructor providing feedback about their performance throughout the exercise class. Both programs will be delivered by trained exercise leaders or trained staff activity personnel (sustainability component). The frequency and duration of the programs are identical (50 minutes, 2 times a week for 12 weeks). From our past research we have determined that a frequency of 2 times per week for 12 weeks is acceptable to the older adult participants and is an adequate dose to obtain meaningful outcomes.(23) The main difference between the standard and the *On the Move* group exercise programs is the program content which is described below.

303

304

305

306

307

308

309

310

311

312

313

314

315

The *On the Move* exercise program is based on principles of motor learning that enhance “skill” or smooth and automatic movement control.(24-29) The program contains a warm-up (5 minutes), stepping patterns (15 minutes), walking patterns (15 minutes), strengthening exercises (10 minutes), and cool-down exercises (5 minutes). The warm-up and cool down contain gentle range of motion exercises and stretches for the lower extremities and trunk. The stepping and walking patterns are goal-oriented progressively more difficult patterns which promote the

316

317

318

319

320

321 timing and coordination of stepping, integrated with the phases of the gait cycle.(25, 26, 28, 29)
322 Conceptually, the exercise is intended to achieve its effects by shifting the center of pressure
323 posteriolateral then forward, encouraging hip extension prior to stepping, loading the trailing
324 limb, coordinating activation of the abductors of the soon to be swing leg with adductors of the
325 stance limb, and shifting the center of pressure in medial stance to unload the stepping limb.(30-
326 32) Progression is based on first separately increasing the speed, amplitude or accuracy of
327 performance prior to undertaking a more complex task.(33) For example, the progression of
328 stepping patterns is, 1) self-paced step forward and across, 2) increase stepping speed, 3)
329 alternate side of stepping, 4) alternate forward with backward stepping. In the group class,
330 exercises can be individualized by having some older adults use upper extremity support while
331 others do not hold on during the exercises. Also, some subjects will step in all one direction
332 while others will do the more challenging alternating left and right steps. Walking patterns
333 incorporate patterns of muscle coordination and interlimb timing into walking. Walking patterns
334 progress by altering speed, amplitude (e.g. narrowing oval width), or accuracy of performance
335 (e.g. without straying from the desired path), and then to complex walking patterns involving
336 walking past others and with upper extremity object manipulation tasks, such as carrying or
337 bouncing a ball.(29) Walking and stepping patterns (i.e. timing and coordination training) were
338 used in both of our pilot studies.(23) The strengthening exercises are conducted in sitting and
339 standing and target the lower extremity muscles. The majority of the program will be conducted
340 in standing (40 minutes) with only a small portion conducted in sitting (10 minutes). We have
341 conducted two pilot exercise classes with older adults with varying levels of ability. We were
342 able to successfully individualize the group program in that participants reported feeling both
343 challenged and safe. Please see the appendix for example exercises and progressions.

344
345 The standard group exercise program is based on exercise programs that are currently being
346 conducted at the facilities (i.e. standard of care). The operationally defined program contains a
347 warm-up (5 minutes), upper and lower extremity strength and flexibility exercises (30 minutes),
348 static balance exercises (10 minutes) and a cool-down (5 minutes). The majority of the program
349 will be conducted in sitting (40 minutes) with only a small portion (10 minutes) conducted in
350 standing. The active control group (i.e. standard exercise program) will aid in adherence and
351 retention in that subjects who volunteer to participate in the study will be looking for exercise
352 options.

353
354 **Sustainability of the program: exercise leader and staff activity personnel comparison (Aim**
355 **2).** The sustainability of the program will be evaluated by assessing the effectiveness of *On the*
356 *Move* compared to a standard program when delivered by staff activity personnel and by
357 comparing outcomes obtained by the *On the Move* program delivered by exercise leaders and
358 staff activity personnel (**Figure 1**). Exercise leaders are individuals with training and experience
359 in administering exercise programs, such as exercise physiologists, physical therapists, physical
360 therapy assistants, etc. Staff activity personnel are employees of the Independent Living
361 Facilities and Senior High Rises that are involved in providing services to the residents. They
362 could be activity directors, social workers, outreach coordinators, care coordinators, etc. These
363 individuals are not specifically trained to deliver exercise interventions as part of their job. We
364 will work with Holly Rolt, Missy Sovak and Sandra Gilmore to identify staff activity personnel
365 at each of the sites who would be involved in this research study. All exercise leaders and
366 identified staff activity personnel will be trained in the delivery of the exercise program prior to

367 leading any exercises classes. The staff activity personnel will participate in a one hour training
368 sessions in which the rationale and the general format of the program will be explained. During
369 these training sessions the activity staff personnel will participate in a sample exercise class. In
370 addition to the 2 training sessions, the activity staff personnel will be able to observe the 12 week
371 exercise session delivered by the exercise leader at their facility. They will be given the
372 opportunity to observe all 24 sessions if they would like. In addition to training the exercise
373 leaders and activity staff personnel, we will provide printed materials explaining the exercise
374 program that we developed in our pilot work (see appendix). A study investigator (Dr. Brach or
375 Dr. VanSwearingen) will meet with the staff activity personnel or email them periodically (i.e.
376 during weeks 1, 3, 6, and 10 of the 12 week exercise program) to observe the intervention,
377 monitor treatment fidelity, and to answer any questions.
378

379 **4 SELECTION AND ENROLLMENT OF PARTICIPANTS**

380 We will recruit participants from the UPMC Independent Living Facilities (ILFs) and the Senior
381 Housing sites. There are eight different ILFs with over 700 residents. UPMC is affiliated with
382 32 different Senior Housing sites that house over 2,000 residents. We anticipate enrolling
383 subjects from all 8 ILFs and from 20 of the Senior Housing sites for a total of 28 sites. We plan
384 to enroll 20 subjects from each site or 160 (20%) from the ILFs and 400 (21%) from the Senior
385 Housing Sites.

386 **4.1 Inclusion Criteria**

387 Participants must meet all of the following inclusion criteria to participate in the study.

- 388 1) 65 years of age or older
- 389 2) Resident of a UPMC ILF or Senior Housing site
- 390 3) Ambulate independently for household distances with or with a straight cane,
- 391 4) Usual gait speed greater than or equal to 0.60 m/s

392

393 **4.2 Exclusion Criteria**

394 Potential participants who meet any of the following exclusion criteria at baseline will be
395 excluded from study participation.

396

- 397 1) Non English speaking,
- 398 2) Impaired cognition, defined as inability to follow 2 step commands or understand the
399 informed consent process,
- 400 3) Plans to leave the area for an extended period of time over the next 4 months,
- 401 4) Progressive neuromuscular disorder such as Parkinson's or Multiple Sclerosis,
- 402 5) Any acute illness or medical condition that is not stable,
- 403 6) Inappropriate response to the 6 minute walk test (i.e. exercise heart rate \geq 120 bpm, exercise
404 SBP \geq 220 or a drop in SBP $>$ 10 mmHg, or DBP \geq 110 mm Hg).

405 4.3 Study Enrollment Procedures

406 We will hold information sessions at each of the sites. The study PI (Dr. Brach) will visit each
407 site and describe the study to the residents. Subjects who are interested in hearing more will be
408 asked to place their name and phone number on a sign-up sheet. Research staff will then contact
409 the subject to explain the study and conduct the initial phone screen if the subject is interested.

410
411 Subject eligibility will be determined from a phone screen and an in-person clinical screen.
412 Researchers will contact potential participants by phone to determine their eligibility. After
413 obtaining verbal consent, a structured screening questionnaire (see attached) will be administered
414 to determine the presence and absence of the inclusion/exclusion criteria. Individuals who meet
415 the criteria will be scheduled for an in-person screening visit that will take place at the ILF or
416 senior housing site.

417
418 At the in-person screening visit, the first task will be to obtain informed consent for participation
419 in the study. Once informed consent is obtained, the screening exam will take place. The
420 screening exam will be conducted by trained research personnel (physical therapists, exercise
421 physiologists, physical therapy assistants, or physical therapy students) who have experience
422 working with older adults and conducting such screening measures. ACSM Guidelines regarding
423 exercise participation will be available to all staff during testing. At all screening sessions at least
424 1 physical therapist will be available as a resource for the other research staff conducting
425 screening procedures.

426
427 The purpose of the physical examination is to identify potential exclusion issues that are not
428 identified by self-report. The exam includes a review of systems, current medications, vital signs,
429 lower extremity range of motion and strength testing, and visual screening. A standard
430 demographics questionnaire will be used to determine age, gender, race, marital status and work
431 history in order to adequately describe the research participants. As a screening for exercise
432 participation, all subjects will complete a six minute walk test (additional detail under
433 experimental procedures). Participants will be asked to walk as far as they can in six minutes
434 (without jogging or running) in a hallway. Participants are permitted to stop and rest during this
435 test, if needed, and the number and duration of rest breaks are recorded. Blood pressure, heart
436 rate and level of fatigue (using the rate of perceived exertion (RPE) scale) are recorded before
437 and after the test. Based on the ACSM guidelines, subjects who have an inappropriate exercise
438 response (i.e. exercise heart rate ≥ 120 bpm, exercise SBP ≥ 220 or a drop in SBP > 10
439 mmHg, or DBP ≥ 110 mm Hg) will be referred to their primary care physician for clearance
440 before they can be enrolled in the study.(34) Subjects who have an appropriate exercise response
441 and are eligible based on the other screening criteria will then complete the outcome measures of
442 function, disability and walking ability described below. All subjects will sign a “Liability
443 Waiver Release for Participation in an Exercise Program” prior to starting the exercise program.

444
445

446 5 STUDY INTERVENTIONS

447 5.1 Overview

448 The exercise interventions will be delivered in 2 phases. The first phase or 12 week class will be
449 delivered by the exercise leader. The second phase or 12 week class will begin once the first
450 phase is completed and will be delivered by staff activity personnel. Participants who are
451 randomized to the second phase class (i.e. delivered by staff activity personnel) will repeat the
452 baseline testing prior starting the exercise class.

453
454 The facilities will be randomized (described above) to receive either the "On the Move" or a
455 standard group exercise program. Both exercise programs (On the Move and standard) will be
456 group-based and led by a person. Both programs will be delivered by trained exercise leaders or
457 trained staff activity personnel (sustainability component). The frequency and duration of the
458 programs are identical (50 minutes, 2 times a week for 12 weeks). From our past research we
459 have determined that a frequency of 2 times per week for 12 weeks is acceptable to the older
460 adult participants and is an adequate dose to obtain meaningful outcomes.(23) The main
461 difference between the standard and the On the Move group exercise programs is the program
462 content which is described below.

464 5.2 On the Move

465 The On the Move exercise program is based on principles of motor learning that enhance "skill"
466 or smooth and automatic movement control.(24-29) The program contains a warm-up (5
467 minutes), stepping patterns (15 minutes), walking patterns (15 minutes), strengthening exercises
468 (10 minutes), and cool-down exercises (5 minutes). The warm-up and cool down contain gentle
469 range of motion exercises and stretches for the lower extremities and trunk. The stepping and
470 walking patterns are goal-oriented progressively more difficult patterns which promote the
471 timing and coordination of stepping, integrated with the phases of the gait cycle.(25, 26, 28, 29)
472 Conceptually, the exercise is intended to achieve its effects by shifting the center of pressure
473 posteriolateral then forward, encouraging hip extension prior to stepping, loading the trailing
474 limb, coordinating activation of the abductors of the soon to be swing leg with adductors of the
475 stance limb, and shifting the center of pressure in medial stance to unload the stepping limb.(30-
476 32) Progression is based on first separately increasing the speed, amplitude or accuracy of
477 performance prior to undertaking a more complex task.(33) For example, the progression of
478 stepping patterns is, 1) self-paced step forward and across, 2) increase stepping speed, 3)
479 alternate side of stepping, 4) alternate forward with backward stepping. In the group class,
480 exercises can be individualized by having some older adults use upper extremity support while
481 others do not hold on during the exercises. Also, some subjects will step in all one direction
482 while others will do the more challenging alternating left and right steps. Walking patterns
483 incorporate patterns of muscle coordination and interlimb timing into walking. Walking patterns
484 progress by altering speed, amplitude (e.g. narrowing oval width), or accuracy of performance
485 (e.g. without straying from the desired path), and then to complex walking patterns involving
486 walking past others and with upper extremity object manipulation tasks, such as carrying or
487 bouncing a ball.33 Walking and stepping patterns (i.e. timing and coordination training) were
488 used in both of our pilot studies.5 the strengthening exercises are conducted in sitting and

489 standing and target the lower extremity muscles. The majority of the program will be conducted
490 in standing (40 minutes) with only a small portion conducted in sitting (10 minutes). We have
491 conducted two pilot exercise classes with older adults with varying levels of ability. We were
492 able to successfully individualize the group program in that participants reported feeling both
493 challenged and safe. Please see the appendix for example exercises and progressions.
494

495 5.3 Standard

496 The standard group exercise program is based on exercise programs that are currently being
497 conducted at the facilities (i.e. standard of care). The operationally defined program contains a
498 warm-up (5 minutes), upper and lower extremity strength and flexibility exercises (20 minutes),
499 cardiovascular exercises (20 minutes) and a cool-down (5 minutes). The majority of the program
500 will be conducted in sitting (>40 minutes) with only a small portion (<10 minutes) conducted in
501 standing. The active control group (i.e. standard exercise program) will aid in adherence and
502 retention in that subjects who volunteer to participate in the study will be looking for exercise
503 options.
504

505 5.4 Monitoring of vital signs

506 Vital signs will be monitored before and after the exercise class as needed. Vitals signs will be
507 monitored more at the beginning of the program, and at any time the participant reports or
508 displays signs and symptoms (i.e. shortness of breath, lightheadedness, racing heart, etc). We
509 will once again follow the ACSM guidelines for stopping of exercise.
510

511 5.5 Program monitoring

512 Periodically (approximately 1-2 times) throughout the exercise program we will be videotaping
513 the exercise sessions. These videos will be used primarily to monitor the quality and consistency
514 of the exercise program and to further develop the training manual for the exercise instructors.
515 The videos may be used to train future exercise instructors.
516

517 5.6 Adherence Assessment

518 A roster of participants will be developed for each group exercise class. At the beginning of each
519 class, attendance will be recorded by the exercise leader or staff activity personnel. Reasons for
520 missed classes will be recorded when available. Attendance rate ($[\text{number of sessions attended}$
521 $\text{by the participant}/\text{total number of classes offered, i.e 24}] \times 100\%$) will be calculated for each
522 participant and will be the main indicator of adherence.
523

524 6 STUDY PROCEDURES

525

526 6.1 Schedule of Evaluations

| Measure | Clinic Screen | Baseline 1 Pre-intervention | Baseline 2 Pre-intervention Activity staff group | 12 week Post- intervention |
|---|---------------|--------------------------------|--|----------------------------------|
| Demographics Questionnaire | X | | | |
| Physical exam screen (BP, strength, 2 step command) | X | | | |
| 6 MWT | X | | X | X |
| Screening gait speed | X | | | |
| Comorbidities Index | | X | | |
| Fall history | | X | X | X |
| Anthropometric Measurements | | X | | |
| Gait Measures | | | | |
| Gait speed – Zeno Walkway | | X | X | X |
| Complex walk (Shumway-Cook) | | X | X | X |
| SPPB | | X | X | X |
| Figure 8 | | X | X | X |
| GES | | X | X | X |
| Physical Function | | | | |
| LLFDI | | X | X | X |
| Global items | | X | X | X |
| Potential confounders | | | | |
| PHQ-9 | | X | X | X |
| Digit Symbol Substitution Test | | X | X | X |
| Program Evaluation | | | | |
| Satisfaction survey | | | | X |

527
528
529

530 **6.2 Description of Evaluations**

531 6.2.1 Baseline Assessments

532
533 If after the clinic screen the participant is eligible (i.e. meets all inclusion/exclusion criteria) they
534 will undergo baseline testing. All baseline testing will be performed by research staff trained in
535 the testing procedures. All testing will be completed at the ILFs and Senior Housing Sites.

536
537 Our main outcomes, function, disability, and walking ability are highly associated with
538 independence and are extremely important to the older adult. Our primary measure of function
539 and disability is the Late Life Function and Disability Instrument (LLFDI) and our main
540 measures of walking ability are Six Minute Walk Test (6MWT) and gait speed. We will also
541 examine confidence in walking (Gait Efficacy Scale), walking under challenging conditions
542 (challenging gait tasks and figure of 8 walk), gait variability and the Short Physical Performance
543 Battery (SPPB) as additional measures of walking ability. We will also collect a measure of
544 cognition (Digit Symbol Substitution Test) and mood (PHQ-9).

545
546 6.2.1.1 Function and Disability

547 Late Life Function and Disability Instrument (LLFDI).(35, 36) Our primary function and
548 disability outcome will be the LLFDI. The LLFDI is a pair of self-report measures targeted for
549 assessing physical function and disability in older adults with acute or chronic problems, and
550 designed to be more sensitive to change than similar measures. The two components of the
551 LLFDI correspond to the activity (LLFDI – function) and participation (LLFDI – disability)
552 components of the World health Organization’s International Classification of Function,
553 Disability and Health model. The LLFDI function component has 32 items in three dimensions,
554 basic lower extremity (BLE), advance lower extremity (ALE) and upper extremity (UE) and the
555 LLFDI disability component has 16 items representing two dimensions, frequency of
556 performance and limitation in performance of life tasks. We’ve selected the LLFDI because 1) it
557 measures both function and disability which are critical components of independence, 2) it
558 includes a wide variety of life tasks in various social areas thus extending beyond the traditional
559 focus of just activities of daily living, 3) the scale was designed with sufficient breadth of items
560 and increments of rating in order to minimize ceiling and floor effects and maximize the scale’s
561 ability to detect change over time, and 4) it is a continuous outcome which gives us greater
562 power than a dichotomous outcome to detect change over time. We will focus our analyses on
563 the LLFDI function and disability dimension scores (i.e. BLE function, ALE function, UE
564 function, disability frequency and disability limitation). We will also examine the disability
565 domain scores (social role, personal role, instrumental role and management role) since they may
566 provide insight into the impact of the disability on frequency of performance and perceived
567 limitations.(36) The LLFDI function and disability scales have established known groups
568 validity and the test-retest reliability is moderate to high for the disability component (ICCs
569 range from 0.68 to 0.82) and extremely high for the function component (ICCs range from 0.91-
570 0.98 for the dimensions). Scores range from 0-100; higher scores represent less difficulty and
571 less disability.

572
573

574 6.2.1.2 Walking Ability

575 Six-Minute Walk Test (6MWT). One of the main walking ability outcomes is the Six-Minute Walk Test
576 (6MWT) of distance walked (meters) in six minutes, including time for rest as needed.(37) We have
577 selected the 6MWT because it is 1) a performance-based measure of walking ability and walking ability is
578 an important component of independence, 2) an indicator of community ambulation (i.e. the ability to
579 walk 300m in 6 minutes),(38, 39) 3) a continuous outcome which gives us greater power than a
580 dichotomous outcome to detect change over time,(40) and 4) a widely used measure of mobility that is
581 included in the NIH PROMIS project to establish measures of clinical assessment. The 6MWT has
582 established psychometric properties, test-retest reliability (Pearson $r=.95$) in older adults,(41, 42)
583 construct validity for graded exercise test and functional classification.(43) The Six-Minute walk test will
584 be completed as part of the clinic screen (described earlier) and also used as an outcome measure.
585 Participants will only complete the 6MWT once at baseline. Participants will be asked to walk as far as
586 they can in six minutes (without jogging or running) in a hallway. Participants are permitted to stop and
587 rest during this test, if needed, and the number and duration of rest breaks are recorded. Blood pressure,
588 heart rate and level of fatigue (using the rate of perceived exertion (RPE) scale) are recorded before and
589 after the test. Based on the ACSM guidelines, subjects who have an inappropriate exercise response (i.e.
590 exercise heart rate ≥ 120 bpm, exercise SBP ≥ 220 or a drop in SBP > 10 mmHg, or DBP ≥ 110 mm
591 Hg) will be referred to their primary care physician for clearance before they can be enrolled in the
592 study.(34) Greater distance covered during six minutes is better.

593
594 Gait Speed. The second main walking ability outcome is gait speed. We have selected gait speed because
595 it is a strong indicator/predictor of morbidity and mortality in the older adult.(2, 3, 5) Gait speed is
596 assessed in usual walking with an instrumented walkway. After explanation, the participant completes 2
597 practice walks to become accustomed to walking on the walkway. The subject then completes 4 passes at
598 their usual, self-selected walking speed. Gait speed will be averaged over the 4 passes. The test-retest
599 reliability of gait speed measured using instrumented walkways by ICC is 0.98.(44) A faster speed is
600 better.

601
602

603 6.2.1.3 Additional Mobility Measures

604 Gait Efficacy Scale. In order to determine if changes in walking ability are associated with
605 changes in confidence in walking, confidence will be assessed using the Gait Efficacy Scale.(45-
606 47) The items include a range of gait activities such as walking over different surfaces, up and
607 down curbs, and negotiating stairs. Each item has a 10 point Likert scale scoring option, with the
608 total score for the 10 items, ranging from 0-100. A higher score represents greater confidence.

609
610 Figure of 8 Walk.(48) The Figure of 8 Walk was designed to measure motor skill in walking.
611 The test involves walking a figure of eight pattern about two markers placed 5 feet apart.
612 Performance is scored based on the time to complete the figure 8 walk and the number of steps.
613 Faster and fewer steps are better.

614
615 Challenging Gait Tasks. Challenging gait tasks are used to examine an individual's ability to
616 adapt their gait to different environmental conditions.(49)53 Subjects will complete two, 12
617 meter trials of each challenging condition, obstacle, curved path, and narrow path.(49) The time

618 to complete each task, averaged over two trials, is the summary indicator of gait during
619 challenging tasks. In a sample of 40 community-dwelling older adults, the 1-week test re-test
620 reliability of the timed measures of challenging gait ranged from ICC = 0.70 to 0.94. The
621 marginal additional time for completing each challenging task compared to usual gait is the main
622 indicator and lower marginal cost is better.

623
624 Gait Variability. Gait variability, defined as fluctuations in gait characteristics from one step to
625 the next,(50) is an important indicator of impaired mobility in older adults.(9) Gait variability is
626 quantified using established measures of temporal and spatial gait characteristics including
627 stance time, step length, and step width. Variability will be calculated as the standard deviation
628 of the set of steps recorded over 4 passes on the instrumented walkway (described above).
629 Approximately 32 steps will be collected from 4 passes on the mat which will be more than
630 adequate to achieve a stable measure of gait variability. Our prior work has shown that 20 steps
631 are sufficient to achieve a reliability of 0.75 and 30 are sufficient for 0.80.(51) In general, lower
632 variability is better although there are exceptions.(9, 52)

633
634 Short Physical Performance Battery (SPPB). The SPPB of lower extremity function was
635 designed and used in the Epidemiologic Studies of the Elderly (EPESE) to assess lower-
636 extremity function of individuals 65 years of age and older. It combined measures of gait speed,
637 balance, and timed chair rise to develop the SPPB for lower-extremity function. The three
638 components are: gait speed over 4-meters, standing balance and chair stands are timed and these
639 times are converted to scores from 0-4 (0=unable, 4=fastest time) for each component. Total
640 scores on the Battery range from 0-12, ranges defined for relative risks of disability.(4)

641
642

643 6.2.1.4 Cognition and Mood

644 Digit Symbol Substitution Test.(53)A measure of processing speed, the Digit Symbol
645 Substitution test will be used to gather information about both motor and cognitive processing
646 speed. The DSST is a paper and pencil task from the WAIS III that provides normed measures of
647 both motor and cognitive processing speed. The DSST has been widely used in studies of
648 physical and cognitive performance of older adults.

649
650 Patient Health Questionnaire (PHQ-9).(54) The PHQ-9 is the 9 item depression scale of the
651 Patient Health Questionnaire. It asks participants to describe how they have been feeling over the
652 past 2 weeks. It has been used successfully in older adults.

653

654 6.2.2 Baseline 2 Assessments

655 Individuals who are randomized to the second exercise session taught by the staff activity
656 personnel we complete a second baseline assessment prior to initiating the exercise class. This
657 will be approximately 12 weeks after the initial baseline assessment. Baseline 2 Assessment will
658 be identical to Baseline testing.

659
660

661 6.2.3 Post-Intervention Assessment

662 At the completion of the 12 week exercise program, all participants will undergo a post-
663 intervention assessment. The assessment will include all measures from the baseline assessment
664 (LLFDI, 6MWT, gait speed, Gait Efficacy Scale, walking under challenging conditions
665 (challenging gait tasks and figure of 8 walk), gait variability, SPPB, DSST, PHQ-9. Post-
666 intervention testing will be completed at the sites (ILFs and senior housing sites) by research
667 personnel masked to the intervention group and trained in the testing procedures.
668

669 In addition, we will also assess participant satisfaction. Participant satisfaction will be assessed
670 using in-depth interviews and a satisfaction survey. In-depth phone interviews will be used to
671 assess satisfaction in a subsample of participants (approximately 20%). We will randomly select
672 a diverse sample of older adults representing the different intervention arms (On the Move,
673 Standard, exercise leader, activity staff personnel) and the different sites (ILF and senior
674 housing). We selected in-depth interviews instead of focus groups because we are more likely to
675 draw people out, they are less intimidated, and more likely to be truthful. The interview will be
676 developed by The Evaluation Institute under the direction of Dr. Edmund Ricci (Co-Investigator)
677 and with input from the other investigators and stakeholders (Community Advisory Board). The
678 interview will include a mixture of closed and open-ended questions. Sample topics to be
679 included in the interviews include perceived benefits and risks, satisfaction with the program,
680 facilities, and instructor, and amount of individualized instruction. The interview will be pilot
681 tested and modified accordingly prior to administration in the study. Pilot testing will ensure that
682 the questions are understandable to our target population and that we are obtaining the
683 information and feedback that we hope to obtain.
684

685 Satisfaction will also be assessed by surveys in all participants at the conclusion of the exercise
686 program. The satisfaction survey includes five items measured on a Likert scale and three yes/no
687 questions. The Likert items will assess degree of satisfaction with various components of the
688 exercise program (i.e. the exercises, instructor, music, space, and the overall program). We will
689 also use a series of yes/no questions to determine if the program has meet the participants'
690 expectations, if they feel they have benefited from the program, and if they would recommend
691 the program to others.
692
693

694 **7 SAFETY ASSESSMENTS**

695 **7.1 Expected Adverse Experiences**

- 696 1. Major risks such as a cardiac event or a fall are expected to be rare – expected to occur in
697 less than 1% of people (less than 1 out of 100 people).(55) Gardner et al, 2000,(55)
698 reviewed controlled clinical trials of exercise interventions for older adults at-risk for
699 falling. No cardiac events or falls were reported in the 12 clinical trials reviewed. The
700 at-risk older adults in the studies reviewed have slightly poorer physical performance
701 than the older persons we expect to recruit for our study. In our recent MOBILE study, a
702 1 year cohort study of 120 older adults participating in 3 clinic visits over a 1 year period
703 there were no cardiac events or falls reported. In all conditions of testing in which the

704 participant is standing and/or walking (eg conditions with a potential risk for falling), the
705 participant will be directly supervised by the trained tester. The trained tester is present
706 for all testing sessions. We expect this level of supervision reduces the risk of falling to
707 an even greater degree.

708 2. Less severe risks of participation such as such as muscle soreness, fatigue, or minor
709 sprains or strains with each assessment, are expected to be infrequent – expected to occur
710 in 1-10% of people (1-10 out of 100 people). Gardner et al, 2000,(55) reviewed
711 controlled clinical trials of exercise interventions for older adults at-risk for falling,
712 finding reports of such side effects of the intervention reported in only 4 of the 12 studies
713 reviewed. The side effects were not a reason for dropout from the study and were
714 described as soreness or musculoskeletal symptoms, but no injuries.

715 3. There is a rare risk that confidentiality could be breached. All of the research records
716 will be kept in a locked file cabinet and/or password protected files. All of the
717 investigators and staff that assist with the management of the files are trained in the
718 privacy and confidentiality regulations that govern research.

719

720 7.2 **Minimizing Risk during Assessments and Interventions.**

721 All assessments approved in this study are considered to be a part of everyday clinical practice.
722 We have minimized risks we believe by applying usual safeguards for the assessment of gait.
723 Assessment side effects, such as muscle soreness, fatigue, or minor sprains or strains with each
724 assessment, will be recorded by the physical therapist and monitored by Dr. Brach, the Principal
725 Investigators in consultation with the physician investigator, Dr. Nadkarni. Based upon the
726 existing literature and our own clinical experience, we anticipate the frequency of these side
727 effects to be extremely low.(55)

728 We will maximize the safety of our subjects with the following procedures.

- 729 1. Individuals with absolute contraindications to testing will be excluded based on the
730 inclusion/exclusion criteria.
- 731 2. Testing will be carefully monitored by trained testers and will be adjusted according to
732 the American College of Sports Medicine Guidelines for Exercise Testing and
733 Prescription.(34)
- 734 3. In all conditions of testing in which the participant is standing and/or walking (eg
735 conditions with a potential risk for falling), the participant will be directly supervised by
736 the trained tester.

737

738 7.3 **Confidentiality.**

739 Participant's confidentiality will be protected in the data collection process. All personnel
740 involved with the research have read and signed a Confidentiality statement, and approval is
741 being obtained from the University of Pittsburgh Biomedical Institutional Review Board.
742 Consent forms and data collection forms that identify the participant by name will be stored in a
743 locked cabinet. All computers are password protected. If the data are used in scholarly
744 presentations or journal articles, the investigators will protect the anonymity of individual

745 participants and will report only aggregate data (eg group means) where appropriate. The
746 Principal Investigator will review data confidentiality processes monthly or as indicated with the
747 project staff. The Investigators are all certified in Research Practice Fundamentals, Human
748 Subjects Research Module.

749

750 **7.4 Participant Education about Potential Risks**

751 Potential risks associated with study-related activities and interventions will be explained to each
752 participant by trained study personnel during the informed consent process. Each participant will
753 be instructed to report the occurrence of an AE to appropriate study staff at scheduled data
754 collection times, to PTs administering the intervention, or spontaneously at any other time.
755 Participants also will be encouraged to report concerns about the safety of participating in the
756 study to any research staff.

757

758 **7.5 Adverse Events and Serious Adverse Events**

759 If an adverse event occurs during testing or intervention, staff or activity personnel will assess
760 the situation and provide immediate assistance to the participant if necessary. If a medical
761 emergency should occur, staff will immediately contact 911. They will describe the incident to
762 the 911 operator and provide their location. They will also contact the facility director to make
763 them aware of the situation. In each testing/exercise space, we will post a copy of the emergency
764 plan which will include the number to call (911) and the address of the facility. All staff will be
765 informed of the emergency procedures prior to starting the interventions and they will be
766 reviewed every 6 months. Once the emergency situation is under control, the staff will contact
767 the study PI to notify them of the situation. The PI will report unexpected or adverse events in
768 accordance with the University of Pittsburgh IRB guidelines. As a group the PI and Co-Is
769 review the adverse events to determine if they are expected vs unexpected and serious vs not
770 serious. All events are reported to the irb who will also review the events. The study
771 coordinator (Ms. Betts), study biostatistician (Dr. Subashan Perera) and study physician (Dr.
772 Neelesh Nadkarni) who are unblinded will track the events to determine if there are an unequal
773 number of events between the groups.

774 A clinical complication form will be completed any time an incident (accident, injury, illness,
775 problems with medication, etc.) occurs or a subject reports an episode. Complications will be
776 categorized as study related, possibly study related, or not study related. Any complications that
777 are categorized as either study related or possibly study related will be reported to the IRB per
778 protocol if the event is an unexpected event, and/or is of serious or moderate to severe in nature
779 as defined by the IRB. A separate clinical complication form will be completed for each incident
780 that may occur in each subject. The form will be kept in the subject's research record.

781

782 7.5.1 Classifying Adverse Events (AE)

783 An AE is any unfavorable or unintended medical occurrence in a human study participant that
784 has taken place during the course of a research project, including any abnormal sign, symptom,
785 or disease, whether or not related to participation in the research.

786
787 For the purposes of this study, any event that meets the criteria for a severe adverse event (SAE),
788 is unexpected, or results in injury to the participant while he/she is under the supervision of study
789 related personnel will be classified as a reportable adverse event (RAE). Adequate review,
790 assessment, and monitoring of RAEs require they be classified as to severity, expectedness, and
791 potential relatedness to the study intervention.

792

793 7.5.2 Severity

794 The following guidelines will be used to determine level of severity:

795

796 Mild: Awareness of signs and symptoms, but easily tolerated and causing no loss of time from
797 normal activities. No specific medical attention is required.

798

799 Moderate: Discomfort enough to cause a low level of inconvenience or concern to the participant
800 and may interfere with daily activities. Symptoms may require minimal, local or noninvasive
801 medical intervention.

802

803 Severe: Events interrupt the participant's normal daily activities and are usually incapacitating.
804 Significant symptoms may require hospitalization or invasive medical intervention.

805

806 Life-threatening/Disabling: Events that may involve acute, life-threatening metabolic or
807 cardiovascular complications (such as circulatory failure, hemorrhage, sepsis) or life –
808 threatening physiological consequences. Intensive care or emergent invasive procedure is
809 required.

810

811 Death: Causing death.

812

813 Severity is not synonymous with seriousness. A severe headache is not necessarily an RAE.
814 However, mild chest pain may result in a day's hospitalization and thus would be classified as a
815 RAE.

816

817 7.5.3 Expectedness

818 AEs will be assigned as to whether they were expected or unexpected based on current
819 knowledge. Categories are defined as follows:

820

821 Expected: An AE that is anticipated on the basis of prior experience with the intervention under
822 investigation; an event that can be attributed to the underlying condition of the participant being
823 studied; or an event that can be attributed to the patient population being studied (see section---
824 Expected AEs). Expected AEs are captured in a standardized way by study personnel.

825

826 Unexpected: An AE that was not anticipated on the basis of prior experience with the underlying
827 intervention under investigation; an event that can be attributed to the underlying condition of the
828 participant being studied; or to the patient population being studied or an expected event whose
829 frequency or severity exceeds what is anticipated. Unexpected events are reportable.
830

831 7.5.4 Relatedness

832 The PI in consultation with the Co-Investigators and an independent safety monitor will
833 determine the degree to which RAEs are related to study procedures using the criteria below.
834

835 Definitely related: The adverse event is clearly related to the investigational procedure – i.e., an
836 event that follows a reasonable temporal sequence from administration of the study intervention,
837 follows a known or expected pattern of response to the study intervention, that is confirmed by
838 improvement on stopping and reappearance of the event on repeated exposure, and that could not
839 be reasonably explained by the known characteristics of the participant’s clinical state.
840

841 Possibly related: An adverse event that follows a reasonable temporal sequence from
842 administration of the study intervention of that follows a known or expected pattern of response
843 to the study intervention, but that could readily have been produced by a number of other factors.
844

845 Unrelated: The adverse event is clearly not related to the investigational procedure (i.e. another
846 cause of the event is most plausible; and/or a clinically plausible temporal sequence is
847 inconsistent with the onset of the event and the study intervention and/or a causal relationship is
848 considered biologically implausible).
849

850 7.6 Expected AEs

851 Expected adverse events (AEs) will be captured through interviews at 12, 24 and 36 weeks,
852 based on the Health Status Update questionnaire. The following are expected adverse events that
853 have been listed in the informed consent form:

- 854 • Muscle soreness
- 855 • Fatigue
- 856 • Chest pain
- 857 • Breathing problems
- 858 • Cardiac event
- 859 • Fall (with or without injury)
- 860

861 7.7 Reportable AEs (RAEs)

862 Reportable AEs are events that have potential implications for participant safety and that require
863 individual reporting. RAEs will be defined as events that fall into at least one of the following
864 categories:

- 865 1. Serious adverse event (SAEs) - SAEs will be defined as any adverse event that results in
866 death, is life threatening, or places the participant at immediate risk of death from the
867 event as it occurred, requires or prolongs hospitalization, causes persistent or significant

868 disability or incapacity, results in congenital abnormalities or birth defects, or is another
869 condition which investigators judge to represent significant hazards.

870 2. Unexpected AEs - An unexpected AE is defined as medical events that occur during
871 study participation, but do not commonly occur in the study population and which are not
872 listed in the informed consent document or study protocol.

873 3. AEs related or possibly related to the research intervention – defined as any AE which in
874 the opinion of the principal investigator, the incident, experience or outcome more likely
875 than not was caused by the procedures involved in the research.
876

877 Events that cannot be clearly defined as “reportable” will be discussed with the study physician
878 and the PI to determine if they should be reported. All reportable events will be captured on an
879 Adverse Event form which will be filed in the participant binder and then reported using the
880 following guidelines.

881

882 7.8 Reporting of Events

883 The study PI has primary responsibility for the safety of participants as it relates to the study
884 protocol. The study coordinator will be responsible for reviewing adverse events and assuring
885 accurate and timely reporting of the adverse events. The co-investigators (including study
886 physician) will review, evaluate and classify adverse events and provide follow-up for events
887 until they are resolved. The PI will be responsible for reporting study-defined AEs and SAEs to
888 the University of Pittsburgh institutional review board (IRB) according to their timeline and
889 format.

890

891 8 INTERVENTION DISCONTINUATION

892 8.1 Interruption to Exercise Participation

893 Attendance will be taken at all exercise session and will be documented on the attendance sheet.
894 Participants who miss three consecutive classes will be contacted by phone to determine the
895 reason for the absences. Participants who miss three or more consecutive classes due to illness
896 or injury will be required to obtain medical clearance from their physician prior to returning to
897 the exercise class. Participants who miss three consecutive classes for other reasons (vacation, ill
898 spouse, caregiving responsibilities, transportation etc.) will be encouraged to attend as many
899 classes as possible.

900

901 8.2 Intervention Discontinuation

902

903 At any time, the study team may recommend discontinuation of any component of the
904 intervention or intervention group of the study for any of the following reasons:

- 905 1. Compelling evidence from this or any other study of an adverse effect of the study
906 intervention(s) that is sufficient to override the potential benefit of the interventions to the
907 target population
908 2. Compelling evidence from this or any other study of a significant beneficial effect of the
909 study intervention(s), such that it is continued denial to other study group(s) would be
910 unethical
911 3. A very low probability of addressing the study goals within a feasible timeframe.
912

913 The research team may decide at any time to remove a participant from the research study if the
914 team feels the participant is unsafe to continue. Participation in the research study will be
915 discontinued if a participant's walking ability worsens; for example, if a subject who has
916 osteoarthritis of the knees exhibits a significant increase in pain that negatively affects their
917 walking ability. Participants can be removed from the study if they have unstable vital signs as a
918 response to exercise. A participant can also be removed from the study if any new medical
919 condition, injury or illness is discovered during the course of treatment that would make the
920 participant unsafe to continue.
921
922

923 8.3 Voluntary Participation

924 The participants' participation in this research study is completely voluntary. The participant
925 may withdraw, at any time, their consent for participation in this research study. Any
926 identifiable research information recorded for, or resulting from, their participation in this
927 research study prior to the date that they formally withdrew their consent may continue to be
928 used and disclosed by the investigators. To formally withdraw consent for participation in this
929 research study the participant should provide a written and dated notice of this decision to the
930 principal investigator of this research study. If the participant withdraws from the intervention,
931 study staff will ask permission to continue to follow the participant for follow-up assessment. If
932 participation is discontinued for medical reasons and the participant is unable to complete the
933 performance-based testing, all attempts will be made to obtain the self-reported outcomes.
934

935

936 9 STATISTICAL CONSIDERATIONS

937 9.1 General Design Issues

938 A randomized trial is needed to control for confounding factors that affect the outcome. There
939 are no ethical issues regarding a randomized trial since both groups will be receiving an active
940 exercise intervention delivered by trained personnel. We carefully considered the advantages and
941 disadvantages of randomizing at the level of the facility and the resident. Given the amount of
942 interaction that occurs between subjects within a facility, it is imperative that we conduct a
943 cluster randomized trial, and randomize by facility to exercise programs. If we randomize at the
944 resident, participants would discuss details of their intervention and cause cross-contamination
945 between the intervention arms. Unlike a traditional trial in which participants are randomized as
946 they are being recruited, a cluster randomized trial also affords the additional benefit of

947 examining the facility characteristics such as type (independent living/senior high rise) and size,
948 and ensuring a balance in those characteristics is achieved by design rather than chance. Once the
949 facilities are randomized to exercise program, we will then randomized within facility for
950 delivery mode (i.e. subjects will be randomized to either an exercise leader or staff activity
951 person led exercise program). Randomization for delivery mode will occur after baseline testing.
952 We will use a commercially available high quality pseudo-random deviate generator such as that
953 available in SAS® (SAS Institute, Inc., Cary, North Carolina) known to be free of serial
954 correlations(56) to randomize facilities to the two arms in a 1:1 ratio, stratified by facility type
955 and size. In addition, the proposed design reaps the advantages of a paired comparison for the
956 sustainability hypothesis (Aim 2) as both exercise leaders and staff activity personnel will be
957 delivering On the Move in the same set of facilities.

958
959
960 The main outcomes are self-reported function and disability (Late Life Function and Disability
961 Index/LLFDI) and walking ability (6-minute walk test/6MWT and gait speed). We will also
962 examine satisfaction, attendance rates and adverse event (falls, soft tissue injuries, muscle
963 soreness, etc) rates.

964 9.2 Sample Size

965 We base our sample size justification on prior data from our RESTORE and PRIME pilot studies
966 (see Part A. Background and Significance above), two-tailed tests conducted at the $\alpha=0.05$ level,
967 a conservative attrition rate of 10% between baseline and follow-up assessments, practical
968 consideration of a class size of 10 participants for group exercise, computational techniques that
969 match our study design and proposed analytical approach as much as possible within the
970 constraints of already published methodologies and commercially available sample size and
971 power software (PASS 2002®, Number Cruncher Statistical Systems, Inc., Kayesville, Utah), and
972 ability to detect differences that correspond to published meaningful change criteria(57) or
973 moderate Cohen's effect sizes of $d=0.5$.(58)

974 The numbers needed to enroll in order to detect statistical significance of intervention effect
975 when delivered by an exercise leader (Aim 1) and staff activity personnel (Aim 2), are presented
976 in **Table 3**. We take into account the clustering of participants by facility by assuming an
977 intracluster correlation of 0.1 and a resulting design effect of 1.90 to appropriately inflate the
978 sample size accordingly.(59) In summary, a total of 560 participants with 140 in each arm will
979 allow us to detect statistical significance in intervention effects in all main outcomes with at least
980 80% statistical power.

981

982 **Table 3. Number needed to enroll for detecting effects of intervention incorporating**
 983 **clustered design (x1.90), attrition (10%), and rounded up to class size of 10.**

| Outcome | Prior Information | | | Estimated Sample Size | |
|----------------------------|----------------------------------|---------------------------------|---|--|---------------------------------|
| | Baseline Standard Deviation (SD) | SD in Baseline-Follow up Change | Meaningful Difference Targeted (Source) | Completers Needed Per Arm assuming No Clustering | Number Needed to Enroll Per Arm |
| LLFDI Overall Function | 6.15 | 4.86 | 3.08 ($d=0.5$) | 41 | 90 |
| LLFDI Disability Frequency | 6.35 | 4.76 | 3.18 ($d=0.5$) | 37 | 80 |
| Gait Speed (m/s) | 0.13 | 0.20 | 0.10 ⁶⁵ | 64 | 140 |
| 6MWD (m) | 62.0 | 42.8 | 50 ⁶⁵ | 13 | 30 |

984
 985 The numbers needed to enroll in order to detect statistical significance of difference in gains
 986 attributable to *On the Move* when delivered by exercise leaders and staff activity personnel
 987 (sustainability hypothesis in Aim 2) are in **Table 4**. We use 95% statistical power (rather than
 988 the customary 80%) to reduce the likelihood of a type II error, thereby minimizing the
 989 probability of a finding in favor of sustainability being due to lack of statistical power rather than
 990 equivalence. We take into account the clustering of participants by facility assuming an
 991 intracluster correlation of 0.1, the advantages reaped by the pairing nature of clusters, and the
 992 resulting design effect of 0.90 to appropriately adjust the sample size.(60, 61) In summary, the
 993 sample size requirements for assessing the intervention effects above are also adequate for
 994 assessing the sustainability hypothesis with at least 95% statistical power.

995 **Table 4. Number needed to enroll for establishing sustainability of *On the Move*,**
 996 **incorporating clustered design (x0.90), attrition (10%), and rounded up to class size of 10.**

| Outcome | Prior Information | | | Estimated Sample Size | |
|----------------------------|----------------------------------|---------------------------------|---|--|---------------------------------|
| | Baseline Standard Deviation (SD) | SD in Baseline-Follow up Change | Meaningful Difference Targeted (Source) | Completers Needed Per Arm assuming No Clustering | Number Needed to Enroll Per Arm |
| LLFDI Overall Function | 6.15 | 4.86 | 3.08 ($d=0.5$) | 66 | 70 |
| LLFDI Disability Frequency | 6.35 | 4.76 | 3.18 ($d=0.5$) | 60 | 60 |
| Gait Speed (m/s) | 0.13 | 0.20 | 0.10 ⁶⁵ | 105 | 110 |
| 6MWD (m) | 62.0 | 42.8 | 50 ⁶⁵ | 21 | 30 |

997

998 9.3 Data Analyses

999 9.3.1 Overview

1000 All statistical analyses will be performed or overseen by Dr. Perera using SAS[®] version 9 (SAS
1001 Institute, Inc., Cary, North Carolina) and Salford Predictive Miner[®] (Salford Systems, Inc., San
1002 Diego, California) based on the **intention-to-treat** philosophy. We will begin by summarizing
1003 data by arm and time point as well as pre- to post-intervention change using appropriate
1004 descriptive statistics for continuous (mean, standard deviation, median, range) and categorical
1005 (frequencies, percentages) to elicit information about general data quality and their distributional
1006 characteristics. Next, we will perform the modeling and inferential analyses to address the main
1007 hypotheses. First, the baseline participant characteristics will be compared between the two arms
1008 (see Avoidance of Bias below). Although no significant differences are expected, any significant
1009 differences will be noted and accounted for as covariates in the main analyses. Second, main
1010 analyses to address Aims 1-3 will be performed as outlined below. If residuals reveal violations
1011 of linear models assumptions, we will Box-Cox transform(62) the response variables. The two-
1012 step protected test approach will be used to control the experimentwise type I error rate from
1013 multiple outcomes, and multiple imputation(63, 64) will be used to account for any missing data
1014 in the main analysis. Third, we will perform the exploratory analyses to address Aim 4, using a
1015 data mining philosophy. Finally, we will perform a set of exploratory analyses to potentially
1016 extend our findings and generate new hypotheses, as well as a set of sensitivity analyses to assess
1017 the robustness of our findings.

1018 9.3.2 Main Analysis for Aims 1-3

1019 First, we will perform a multivariate Hotelling *t*-test to simultaneously compare the baseline to
1020 follow-up change in the three primary outcomes between the arms to protect the type I error rate
1021 from multiplicity. If significant, subsequent analyses will be performed without further
1022 multiplicity adjustment. If not, subsequent comparisons will be performed with a conservative
1023 Bonferroni correction at the $\alpha=0.05/4=0.0125$ level. This protected test approach has been
1024 recommended in the statistical literature(65) and used in other exercise intervention trials with
1025 multiple outcomes.(66)

1026 Second, we will fit a series of linear mixed models(67) using the SAS[®] MIXED procedure with
1027 baseline to follow-up change in each of the continuous outcomes (LLFDI function/disability,
1028 walking ability, other measures of mobility performance) as the dependent variable; intervention
1029 arm (standard/*On the Move*), delivery mode (by exercise leader/staff activity personnel) and their
1030 interaction as fixed effects of interest; baseline value of outcome and any other measures found
1031 to be different between arms or deemed important as additional fixed effects covariates; and a
1032 facility random effect to account for greater similarity of participants from the same facility
1033 compared to different facilities and resulting non-independence of observations within facility
1034 (ie. clustering). We will construct appropriate means contrasts to estimate difference in gains in
1035 the two interventions when delivered by exercise leaders (Aim 1); difference in gains in the two
1036 interventions when delivered by staff exercise personnel (Aim 2 effectiveness hypothesis); and
1037 difference in gains attributable to *On the Move* intervention when delivered by exercise leaders
1038 and staff activity personnel. Statistical significance of the estimates will serve as formal tests
1039 hypotheses.

1040 Third, we will fit a series of generalized estimating equations (GEE) models(68) using the SAS[®]
1041 GENMOD procedure with each of the dichotomous adverse events, adherence (21+ sessions or
1042 ≥90%) and satisfaction outcomes as the dependent variable; a binomial distribution for the
1043 outcome and a logit canonical link function; intervention arm, delivery model and their
1044 interaction as effects of interest; baseline value of outcome and any other measures found to be
1045 different between arms or deemed important as additional fixed effects covariates; and an
1046 exchangeable working correlation structure to account for clustering due to facility. We will
1047 appropriately construct contrasts to test hypotheses of differential proportions with adverse
1048 events based on intervention and delivery mode (Aim 3).

1049 9.3.3 Aim 4 exploratory Analysis

1050 We will perform the exploratory analyses to identify combinations of baseline predictors of
1051 treatment response and risks of participating in *On the Move* program. We do not anticipate
1052 differences in outcomes of On the Move program based on delivery mode (Aim 2), and thus
1053 propose to combine *On the Move* groups led by exercise leaders and staff activity personnel in
1054 the present analysis to maximize sample size and amount of information available for this
1055 analysis (140+140=280). In the unlikely event of differences due to delivery mode, we will
1056 stratify the Aim 4 analysis by delivery mode.
1057

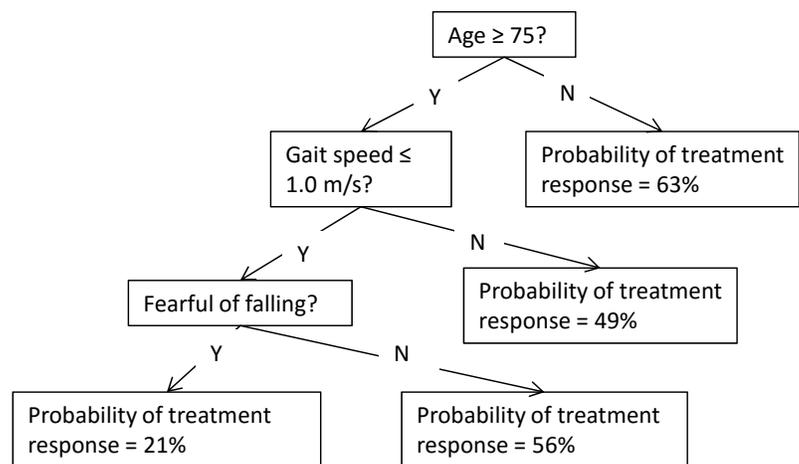
1058 Adverse events and markers of response to treatment in walking ability have readily available
1059 dichotomous operational definitions based on simply presence/absence of an event or evidenced
1060 based criteria for having achieved meaningful change in gait speed (0.1+ m/s) and 6MWT
1061 (50m).(57) For such dichotomous markers of benefit and harm, we will fit a series of logistic
1062 regression models using the SAS[®] LOGISTIC procedure and classification tree models(69, 70)
1063 using Salford Predictive Miner[®] software with each measure of whether there was a benefit/harm
1064 from *On the Move* as the dichotomous response variable; and baseline physical, psychosocial and
1065 demographic characteristics as predictors. Logistic regression models are more efficient when
1066 associations are linear, and hard-to-discover higher order interactions and non-linearity and/or
1067 multicollinearities among predictors do not exist, while classification tree models are more
1068 efficient when they do exist. In terms of practically applying prediction criteria, results from
1069 logistic regression models require substituting values of predictors to a regression equation while
1070 classification tree model produces a flowchart that can be used as is in a clinical setting when a
1071 new individual is presented with known predictors. Thus we will use both methods to obtain
1072 areas under the receiver operator characteristic curve (AUROCC) to quantify predictive
1073 accuracy, and use the results from the method with a greater AUROCC. If the AUROCCs are not
1074 substantially different, we will favor the classification tree results due to ease of interpretation
1075 and utility in the clinical setting (see **Figure 2** for a hypothetical template for summarization of
1076 results). For logistic regression modeling, we will include all available baseline information
1077 simultaneously in the model as predictors, and use the backward elimination stepwise procedure
1078 to guard against model over-fitting to obtain a parsimonious model with a small number of most
1079 relevant predictors to facilitate interpretation, communication and clinical utility of the model.
1080 For the classification tree models, we will use all predictors available and use a minimum
1081 misclassification-complexity cost tree to achieve the same objectives. We will use the method of
1082 DeLong(71) to obtain the statistical significance of the improvement in predictive accuracy, as
1083 measured by AUROCC.

1084 Our LLFDI function and disability outcomes do not have the same level of evidence based for
 1085 creating intuitively appealing dichotomous measures of treatment response. Thus we will
 1086 consider pre- to post-intervention change as a continuous variable, and perform analogous
 1087 analysis to that for dichotomous outcomes but with appropriate statistical models. Specifically,
 1088 we will fit standard multiple linear regression models using the SAS[®] REG procedure and
 1089 regression tree models(69, 70) using Salford Predictive Miner[®]; and use proportion of explained
 1090 variance (R^2) to quantify predictive accuracy.

1091 9.3.4 Additional
 1092 Exploratory/Sensitivity
 1093 and
 1094 Compliance/Dropout
 1095 Analyses

Figure 2. Hypothetical template for summarization of Aim 4 results.

Figure 1. Predictors of treatment response using age, gait speed, and fear of falling. Area under ROC curve=0.797



1096 We will perform additional
 1097 analyses to extend our
 1098 findings, generate new
 1099 hypotheses, assess robustness
 1100 and potentially refine
 1101 conclusions. They will
 1102 include using an alternative
 1103 threshold besides 90% to
 1104 operationally define high level
 1105 of adherence/compliance
 1106 calculating proportion missing
 1107 each session to describe the
 1108 pattern of
 1109 adherence/compliance over
 1110 time; assessing intervention effects using as-treated instead of intention-to-treat philosophy; and
 1111 alternative operational definitions of treatment response such as combinations of walking ability,
 1112 function and/or disability, and reaching a published threshold such as 0.4(0.8) m/s in gait speed
 1113 for limited(full) community ambulation.(72)

1114

1115 **10 DATA COLLECTION AND QUALITY ASSURANCE**

1116 **10.1 Data Collection Forms**

1117 Data collection will consist of paper forms. Data collected on paper forms will be entered into
 1118 the electronic database by the research staff.

1119

1120 Screening and baseline data collection, which will occur prior to randomization, will be
 1121 conducted by research staff trained in the outcomes and may include the study coordinator if
 1122 necessary. Outcome assessments post-intervention will only be conducted by research staff
 1123 trained in the outcomes and who are blinded to the intervention group assignment.

1124

1125 Participants' confidentiality will be protected in the data collection process. All study personnel
1126 are certified in Research Practice Fundamentals, Human Subjects Research Module. Consent
1127 forms and paper data collection forms will be stored in locked file cabinets. All computers are
1128 password protected. Only authorized team members will have access to personal information
1129 needed for tracking and informed consent.

1130

1131 10.2 Data Management

1132 An electronic tracking system will monitor enrollment, track follow-up rates and the data entry
1133 process, providing up-to-date status reports. All completed data collection forms will be entered
1134 into a secure relational database located in a local network, and stored in a secure location. To
1135 improve accuracy, the data entry screens are identical in appearance to the paper forms. The data
1136 entry system includes automatic and routine data quality checks for out-of-range and extreme
1137 values, and automatic enforcement of skip patterns. In addition, functionality will be built in to
1138 the data entry system to facilitate double data entry and comparison of two versions so that
1139 discrepancies can be resolved against the authoritative paper forms. All screened subjects will be
1140 assigned unique subject identifiers that will appear on all data collection forms and files and
1141 serve as an index in database tables. The database will have access restricted to only those study
1142 personnel who need it and the level of access (read/write) will depend on the specific role. All
1143 files will be backed-up daily and archived weekly, including storage of back-up copies in an off-
1144 site location.

1145

1146 10.3 Quality Assurance

1147 10.3.1 Intervention

1148 Program monitoring: Periodically throughout the exercise program we will be videotaping the
1149 exercise sessions. These videos will be used primarily to monitor the quality and consistency of
1150 the exercise program and to further develop the training manual for the exercise instructors. The
1151 videos may be used to train future exercise instructors.

1152

1153 At each session, the exercise leaders and activity staff personnel will complete the exercise class
1154 log (see 9.3 above). Dr. VanSwearingen will review the exercise logs monthly to make sure the
1155 interventionists are following the protocol and progressing the exercise class appropriately. If
1156 deficiencies are noted, we will review the program with the interventionist and discuss potential
1157 modifications to the administration of the program.

1158

1159 10.3.2 Protocol Deviation Tracking

1160 Protocol deviations may occur in the randomization process, exercise intervention protocols, the
1161 timing or completion of testing sessions, and in the completion of data forms. A Protocol
1162 Deviation Form has been developed for the study and will be completed, dated, and signed for
1163 each protocol deviation that may occur for each subject. This form will be kept in a folder for

1164 protocol deviations. The protocol deviation will also be noted in the progress section of the
1165 subject's research record.

1166

1167 10.3.3 Subject Termination

1168 If subject participation in the study is terminated for any reason (death, self-withdrawal, lost-to-
1169 follow-up, or change in health) a Study Termination form will be completed by the trial
1170 coordinator and placed in the subject's research record.

1171

1172 **11 PARTICIPANT RIGHTS AND CONFIDENTIALITY**

1173 11.1 Institutional Review Board (IRB) Review

1174 The study protocol, the informed consent document and any subsequent modifications will be
1175 reviewed and approved by the University of Pittsburgh IRB.

1176 11.2 Informed Consent Forms

1177 All potential participants will be adults (65 years of age or older) who are capable of providing
1178 direct consent for their participation in the study. Written informed consent will be obtained at
1179 the clinic screening visit prior to performing any of the clinic screening procedures. One of the
1180 study investigators will explain the study and the participant will be given a copy of the consent
1181 form to read. The consent form will describe the purpose of the study, the procedures to be
1182 followed, and the risks and benefits of participation. The investigator will answer any questions
1183 that the participant may have about the study. Finally, the participant will be asked to sign and
1184 date the consent form. The participant will be given a copy of the consent form for their records.

1185 11.3 Participant Confidentiality

1186 Research assessments and interventions are conducted in the community/activities room. This
1187 space includes several small tables in different portions of the room that can be used to privately
1188 conduct questionnaires and simple physical examination measures. Many of the walking
1189 assessments are done in the open area. Participants may be screened individually, which further
1190 protects their privacy. Participants are informed via the consent process that the treatment
1191 programs are conducted in groups. Although not completely private, this level of exposure to
1192 others during exercise is similar to what one might experience at a physical therapy appointment
1193 or during an exercise class at a public gym.

1194
1195 Participant's confidentiality will be protected in the data collection process. All personnel
1196 involved with the research have read and signed a Confidentiality statement. All study related
1197 data will be maintained in secure locked hard copy files and password protected computer files.
1198 To facilitate referring to our older adult subjects by name throughout all testing sessions and to
1199 minimize errors that could occur while multiple testers collect data on multiple participants in the
1200 same research space at the same time, data sets will not be de-identified. Subjects' names and
1201 emergency contact information will be maintained in both the hard copy and computer files, and
1202 subjects will be made aware of this during the informed consent process.

1203
 1204 If data are used in scholarly presentations or journal articles, the investigators will protect the
 1205 anonymity of individual participants and will report only aggregate data (eg group means) where
 1206 appropriate. The Principal Investigator will review data confidentiality process monthly or as
 1207 indicated with the research staff. The Investigators are all certified in Research Practice
 1208 Fundamentals, Human Subjects Research Module.
 1209

1210 **11.4 Study Discontinuation**

1211 The study may be discontinued at any time by the IRB, the NIA, the OHRP, or other government
 1212 agencies as part of their duties to ensure that research participants are protected.

1213 **12 STUDY TIMELINE**

1214 In this three year project we will conduct a single-blind cluster randomized intervention trial.
 1215 The trial will be conducted in 28 facilities (ILFs and Senior High Rises) and will include 560
 1216 community-dwelling older adults. We will train 28 staff activity personnel and will conduct 56,
 1217 12 week group exercise sessions. The table below contains the timeline for all research activities.

Table - Project Timeline.

| Research Activity | Year 1 | | | | Year 2 | | | | Year 3 | | | |
|---|--------|---|---|---|--------|---|---|---|--------|---|---|---|
| Hire and train research staff | X | X | | | | | | | | | | |
| Develop manual of operations | X | X | | | | | | | | | | |
| Assemble Advisory Board | X | | | | | | | | | | | |
| Train staff activity personnel | | | X | X | X | X | X | X | | | | |
| Finalize data collection forms | X | X | | | | | | | | | | |
| Construct database | | X | X | | | | | | | | | |
| Recruitment | | | X | X | X | X | X | X | | | | |
| Baseline testing | | | X | X | X | X | X | X | | | | |
| Conduct exercise programs | | | | X | X | X | X | X | | | | |
| Post testing | | | | X | X | X | X | X | X | | | |
| In-depth satisfaction interviews | | | | X | X | X | X | X | X | | | |
| In-depth interviews of Community Advisory Board | | | | | X | X | | | | | | |
| Data entry | | | | X | X | X | X | X | X | X | | |
| Analysis | | | | | | | | | | X | X | |
| Review and interpret results | | | | | | | | | | X | X | X |
| Dissemination | | | | | | | | | | | | X |

| | | | | | | | | | | | | |
|--------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Meetings | | | | | | | | | | | | |
| Advisory Board meetings | X | | X | | X | | X | | X | | X | |
| Research staff | X | X | X | X | X | X | X | X | X | X | X | X |
| Data Safety Monitoring Meeting | | X | | | | X | | | | X | | |

1218

1219

1220 **Year 1**

1221 In the first 6 months of funding, we will hire and train research staff, develop the manual of
 1222 operations, assemble to Advisory Board, finalize the data collection forms, and construct the
 1223 database. In the second 6 months of Year 1 we will initiate recruitment and baseline testing of
 1224 research subjects. The group exercise programs will begin in a minimum of 4 facilities in
 1225 months 10-12 of Year 1. The deliverables for Year 1 are outlined in the milestone schedule.

1226

1227 **Year 2**

1228 At the beginning of Year 2 we will conduct the in-depth interviews of the Community Advisory
 1229 Board members. The majority of the group exercises classes will be conducted in Year 2. We
 1230 will continue to train the staff activity personnel (months 1-9 Year 2) as we include additional
 1231 facilities in the research study. Our goal is that every quarter we would introduce the exercise
 1232 program to 6 facilities and train the staff activity personnel to conduct the exercise program. In
 1233 Year 2 we will recruit subjects to participate, baseline test the subjects, conduct the 12 week
 1234 exercise program, and conduct the post testing. By the end of year 2, we will have trained 24
 1235 staff activity personnel to conduct the exercise program and completed forty-eight 12 week
 1236 exercise sessions within 24 facilities. The deliverables for Year 2 are outlined in the milestone
 1237 schedule.

1238

1239 **Year 3**

1240 In Year three we will complete the exercise group sessions and complete all post testing. The
 1241 majority of Year 3 will be dedicated to data entry, data analysis, review and interpretation of
 1242 results and dissemination of research findings. See the milestone schedule for Year 3
 1243 deliverables.

1244

1245 **13 PUBLICATION OF RESEARCH FINDINGS**

1246 Publications will be operationally defined as manuscripts for publications; abstracts for platform
 1247 or poster presentation at scientific meetings and other professional meetings; slides for
 1248 presentation at scientific and other meetings; doctoral dissertations; and master’s theses.

1249

1250 The goal of the publication policy is to encourage and facilitate publication of study results. The
 1251 purposes of this policy are to ensure the following:

- 1252 • On the Move publications will be of the highest scientific quality
- 1253 • On the Move will be described in a consistent manner across publications
- 1254 • Measures are reported in consistent ways across publications
- 1255 • Proper acknowledgements are included
- 1256 • Appropriate authorship credit is determined prior to submission of manuscripts for
- 1257 publication consideration.
- 1258

1259 Publications from On the Move will be overseen by the PI and Co-Investigators.

1260

1261 14 REFERENCES

- 1262 1. Guralnik J, Ferrucci L, Simonsick E, Salive M, Wallace R. Lower extremity function in
1263 persons over the age of 70 years as a predictor of subsequent disability. *New Engl J Med.*
1264 1995;332:556-61.
- 1265 2. Cesari M, Kritchevsky S, Bauer D, Visser M, Rubin S, Harris T, et al. Prognostic value
1266 of usual gait speed in well-functioning older people--results from the Health, Aging and
1267 Body Composition Study. *J Am Geriatr Soc.* 2005;53:1675-80.
- 1268 3. Guralnik J, Ferrucci L, Pieper C, Leveille S, Markides K, Ostir G, et al. Lower extremity
1269 function and subsequent disability: consistency across studies, predictive models, and
1270 value of gait speed alone compared with the short physical performance battery. *J*
1271 *Gerontol Med Sci.* 2000;55A:M221-M31.
- 1272 4. Guralnik J, Simonsick E, Ferrucci L, Glynn R, Berkman L, Blazer D, et al. A short
1273 physical performance battery assessing lower extremity function: Association with self-
1274 reported disability and prediction of mortality and nursing home admission. *J Gerontol.*
1275 1994;49:M85-M94.
- 1276 5. Studenski S, Perera S, Patel K, Rosano C, Faulkner K, Inzitari M, et al. Gait speed and
1277 survival in older adults. *JAMA.* 2011;305(1):50-8.
- 1278 6. Fried L, Bandeen-Roche K, Chaves P, Johnson B. Preclinical Mobility Disability Predicts
1279 Incident Mobility Disability in Older Women. *Journal of Gerontology.*
1280 2000;55A(1):M43-M52.
- 1281 7. Hoffman J, Ciol M, Huynh M, Chan L. Estimating transitions probabilities in mobility
1282 and total costs for Medicare beneficiaries. *Arch Phys Med Rehabil.* 2010;91:1849-55.
- 1283 8. Guralnik J, Ferrucci L, Balfour J, Volpato S, Di I, A. Progressive versus catastrophic loss
1284 of the abilit to walk: Implications for the prevention of mobility loss. *J Am Geriatr Soc.*
1285 2001;49:1463-70.
- 1286 9. Brach J, Studenski S, Perera S, VanSwearingen J, Newman A. Gait variability and the
1287 risk of incident mobility disability. *J Gerontol Med Sci.* 2007;62A:983-8.
- 1288 10. Hausdorff J, Rios D, Edelberg H. Gait variability and fall risk in community-living older
1289 adults: a 1-year prospective study. *Arch Phys Med Rehabil.* 2001;82:1050-6.
- 1290 11. Judge J, Underwood M, Gennosa T. Exercise to improve gait velocity in older adults.
1291 *Arch Phys Med Rehabil.* 1993;74:400-6.
- 1292 12. Mian O, Thom J, Ardigo L, Morse C, Narici M, Minetti A. Effect of a 12-month physical
1293 conditioning programme on the metabolic cost of walking in healthy older adults. *Eur J*
1294 *Appl Physiol.* 2007;100:499-505.
- 1295 13. Brown M, Holloszy J. Effects of a low intensity exercise program on selected physical
1296 performance characteristics of 60- to 71-year olds. *Aging (Milano).* 1991;3:129-39.

1297 14. Manini T, Marko M, VanArnam T, Cook S, Fernhall B, Burke J, et al. Efficacy of
1298 resistance and task-specific exercise in older adults who modify tasks of everyday life. *J*
1299 *Gerontol Med Sci.* 2007;62A:616-23.

1300 15. Wolf S, O'Grady M, Easley K, Guo Y, Kressig R, Kutner M. The influence of intense Tai
1301 Chi training on physical performance and hemodynamic outcomes in transitionally frail,
1302 older adults. *J Gerontol Med Sci.* 2006;61A:184-9.

1303 16. Helbostad J, Sletvold O, Moe-Nilssen R. Home training with and without additional
1304 group training in physically frail older people living at home: effect on health-related
1305 quality of life and ambulation. *Clinical Rehabilitation.* 2004;18:498-508.

1306 17. Buchner D, Cress M, de L, BJ, Esselman P, Margherita A, Price R, et al. A comparison
1307 of the effects of three types of endurance training on balance and other fall risk factors in
1308 older adults. *Aging Clin Exp Res.* 1997;9:112-9.

1309 18. Buchner D, Cress M, de L, BJ, Esselman P, Margherita A, Price R, et al. The effects of
1310 strength and endurance training on gait, balance, fall risk, and health services use in
1311 community-living older adults. *Journal of Gerontology: Medical Sciences.*
1312 1997;52A(4):M218-M24.

1313 19. Bean J, Herman S, Kiely D, Frey I, Leveille S, Fielding R, et al. Increased velocity
1314 exercise specific to task training: a pilot study exploring effects on leg power, balance,
1315 and mobility in community dwelling older women. *J Am Geriatr Soc.* 2004;52(5):799-
1316 804.

1317 20. LIFE S, Investigators. Effects of a physical activity intervention on measures of physical
1318 performance: results of the Lifestyle Interventions and independence for elders pilot
1319 (LIFE-P) study. *J Gerontol Med Sci.* 2006;61A:1157-65.

1320 21. Liu C, Latham N. Progressive resistance strength training for improving physical
1321 function in older adults. *Cochrane Database of Systematic Reviews.* 2009(3).

1322 22. Nelson M, Rejeski W, Blair S, Duncan P, Judge J, King A, et al. Physical activity and
1323 public health in older adults: recommendation from the American College of Sports
1324 Medicine and the American Heart Association. *Med Sci Sports.* 2007;39(8):1435-45.

1325 23. VanSwearingen J, Perera S, Brach J, Cham R, Rosano C, Studenski S. A randomized trial
1326 of two forms of therapeutic activity to improve walking: effect on the energy cost of
1327 walking. *J Gerontol A Biol Sci Med Sc.* 2009;64A:1190-8.

1328 24. Nelson W. Physical principles for economies of skilled movements. *Biol Cybernetics.*
1329 1983;46:135-47.

1330 25. Daly J, Ruff R. Construction of efficacious gait and upper limb functional interventions
1331 based on brain plasticity evidence and model-based measures for stroke patients. *The*
1332 *Scientific World Journal.* 2007;7:2031-45.

1333 26. Lay B, Sparrow W, Hughes K, O'Dwyer N. Practice effects on coordination and control,
1334 metabolic energy expenditure, and muscle activation. *Human Movement Science.*
1335 2002;21:807-30.

1336 27. Newman M, Dawes H, van d, Berg, M, Wade D, Burrridge J, Izadi H. Can aerobic
1337 treadmill training reduce the effort of walking and fatigue in people with multiple
1338 sclerosis: a pilot study. *Multiple Sclerosis.* 2007;13:113-9.

1339 28. Brooks V. *The Neural Basis of Motor Control.* New York: Oxford University Press;
1340 1986.

- 1341 29. Gentile A. Skill acquisition: action, movement, and neuromotor processes. In: JH C, RB
1342 S, J G, AM G, JM H, eds. *Movement Sciences*. 1 ed. Rockville: Aspen Publishers;
1343 1987:93-154.
- 1344 30. Polcyn A, Lipsitz L, Kerrigan C, Collins J. Age-related changes in the initiation of gait:
1345 degradation of central mechanisms for momentum generation. *Arch Phys Med Rehabil*.
1346 1998;79:1582-9.
- 1347 31. Capaday C. The special nature of human walking and its neural control. *Trends in*
1348 *Neurosciences*. 2002;25(7):370-6.
- 1349 32. Alexander R. Walking made simple. *Science*. 2005;308:58-9.
- 1350 33. Schmidt R. Organizing and Scheduling Practice. In: RA S, ed. *Motor Learning and*
1351 *Practice: From Principles to Practice*. Champaign, IL: Human Kinetics Books; 1991:199-
1352 225.
- 1353 34. ACSM's Guidelines for Exercise Testing and Prescription. 5th ed. Baltimore, MD:
1354 Williams & Wilkins; 1995.
- 1355 35. Haley S, Jette A, Coster W, Kooyoomijian J, Levenson S, Heeren T, et al. Late life
1356 function and disability instrument:II. Development and evaluation of the function
1357 component. *J Gerontol*. 2002;57A:M217-M22.
- 1358 36. Jette A, Haley S, Coster W, Kooyoomijian J, Levenson S, Heeren T, et al. Late life
1359 function and disability instrument: I. Development and evaluation of the disability
1360 component. *J Gerontol*. 2002;57A:M209-M16.
- 1361 37. Butland R, Pang J, Gross E, Woodcock A, Geddes D. Two-, six-, and 12-minute walking
1362 tests in reespiratory disease. *BMJ*. 1982;284:1607-8.
- 1363 38. Lerner-Frankiel M, Vargas S, Brown M, Krusel L, Schoneberger W. Functional
1364 community ambulation: what are your criteria? *Clinical Management*. 1986;6((2)):12-5.
- 1365 39. Robinett C, Vondran M. Functional ambulation velocity and distance requirements in
1366 rural and urban communities. *Phys Ther*. 1988;68(9):1371-3.
- 1367 40. Solway S, Brooks D, Lacasse Y, Tomas S. A qualitative, systematic overview of the
1368 measurement properties of the functional walk tests used in the cardiorespiratory
1369 domain. *Chest*. 2001;119:256-70.
- 1370 41. Harada N, Chiu V, Damron-Rodriguez J, Fowler E, Siu A, Reuben D. Screening for
1371 balance and mobility impairment in elderly individuals living in residential care facilities.
1372 *Physical Therapy*. 1995;75(6):462-9.
- 1373 42. Harada N, Chiu V, Stewart A. Mobility-related function in older adults: assessment with
1374 a 6-minute walk test. *Arch Phys Med Rehabil*. 1999;80:837-41.
- 1375 43. Guyatt G, Sullivan M, Thompson P. The 6-minute walk: a new measure of exercise
1376 capacity in patients with chronic heart failure. *Can Med Assoc*. 1985;132:919-23.
- 1377 44. Brach J, Perera S, Studenski S, Newman A. Reliability and validity of measures of gait
1378 variability in community-dwelling older adults. *Arch Phys Med Rehabil*. 2008;89:2293-6.
- 1379 45. McAuley E, Mihalko S, Rosengren K. Self-efficacy and balance correlates of fear of
1380 falling in the elderly. *J Aging Phys Activity*. 1997;5:329-40.
- 1381 46. Rosengren K, McAuley E, Mihalko S. Gait adjustments in older adults: Activity and
1382 efficacy influences. *Psychology and Aging*. 1998;13:375-80.
- 1383 47. Newell A, VanSwearingen J, Hile E, Brach J. The modified gait efficacy scale:
1384 establishing the psychometric properties in older adults. *Phys Ther*. 2012;92:318-28.
- 1385 48. Hess R, Brach J, Piva S, VanSwearingen J. Walking skill can be assessed in older adults:
1386 Validity of figure-of-8 walk test. *Phys Ther*. 2010;90:89-99.

- 1387 49. Brach J, Perera S, VanSwearingen J, Hile E, Wert D, Studenski S. Challenging gait
1388 conditions predict 1-year decline in gait speed in older adults with apparently normal gait.
1389 Phys Ther. 2011;91:1857-64.
- 1390 50. Gabell A, Nayak U. The effect of age and variability in gait. Journal of Gerontology.
1391 1984;39(6):662-6.
- 1392 51. Perera S, Brach J, Talkowski J, Wert d, Studenski S. Measuring stride time variability:
1393 estimating test-retest reliability and required walk length using bootstrapping. Program &
1394 Abstracts of the ISPGR 18th International Conference. 2007:55-6.
- 1395 52. Brach J, Berlin J, VanSwearingen J, Newman A, Studenski S. Too much or too little step
1396 width variability is associated with a fall history in older persons who walk at or near
1397 normal gait speed. J Neuroengineering Rehabil. 2005;2(21).
- 1398 53. Madden DJ, Whiting WL, Cabeza R, Huettel SA. Age-related preservation of top-down
1399 attentional guidance during visual search. Psychol Aging. 2004;19(2):304-9.
- 1400 54. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity
1401 measure. J Gen Intern Med. 2001;16(9):606-13.
- 1402 55. Gardner M, Robertson C, Campbell A. Exercise in preventing falls and fall related
1403 injuries in older people: a review of randomized controlled trials. Br J Sports Med.
1404 2000;34:7-17.
- 1405 56. Meinert C. Clinical Trials. New York: Oxford University Press; 1986.
- 1406 57. Perera S, Mody S, Woodman R, Studenski S. Meaningful change and responsiveness in
1407 common physical performance measures in older adults. J Am Geriatr Soc. 2006;54:743-
1408 9.
- 1409 58. Cohen J. Statistical Power Analysis for the Behavioral Sciences. New York: Academic
1410 Press; 1977.
- 1411 59. Eldridge S, Ashby D, Kerry S. Sample size for cluster randomized trials: effects of
1412 coefficient of variation of cluster size and analysis method. International Journal of
1413 Epidemiology. 2006;35:1292-300.
- 1414 60. Vierron E, Giraudeau B. Sample size calculation for multicenter randomized trial: taking
1415 the center effect into account. Contemp Clin Trials. 2007;28(4):451-8.
- 1416 61. Vierron E, Giraudeau B. Design effect in multicenter studies: gain or loss of power?
1417 BMC Medical Research Methodology. 2009;9:39.
- 1418 62. Box G, Cox D. An analysis of transformations. Journal of the Royal Statistical Society-
1419 Series B. 1964;26:211-43.
- 1420 63. Rubin D. Multiple Imputation for Nonresponse in Surveys: John Wiley and Sons; 1987.
- 1421 64. Rubin D. Multiple imputation after 18+ years. Statistics in Medicine. 1991;14:1913-25.
- 1422 65. Johnson D. Applied Multivariate Statistics. Belmont, CA: Duxbury Press; 1998.
- 1423 66. Duncan P, Studenski S, Richards L, Gollub S, Lai S, Reker D, et al. Randomized clinical
1424 trial of therapeutic exercise in subacute stroke. Stroke. 2003;34(9):2173-80.
- 1425 67. Milliken G, Johnson D. Analysis of Messy Data Volume 1: Designed Experiments. New
1426 York: Van Nostrand Reinhold; 1992.
- 1427 68. Diggle P, Liang K, Zeger S. Analysis of Longitudinal Data. Oxford: Clarendon Press;
1428 1994.
- 1429 69. Breiman L, Friedman J, Stone C, Olshen R. Classification and Regression Trees: CRC
1430 Press; 1984.

- 1431 70. Strobl C, Malley J, Tutz G. An introduction to recursive partitioning: rationale,
1432 application, and characteristics of classification and regression trees, bagging, and
1433 random forests. *Psychological Methods*. 2009;14(4):323-48.
- 1434 71. DeLong E, DeLong D, Clarke-Pearson D. Comparing the areas under two or more
1435 correlated receiver operating characteristic curves: a nonparametric approach. *Biometrics*.
1436 1988;44:837-45.
- 1437 72. Schmid A, Duncan P, Studenski S, Lai S, Richards L, Perera S, et al. Improvements in
1438 speed-based gait classifications are meaningful. *Stroke*. 2007;38(7):2096-100.

1439

1440

1441

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

**ON THE MOVE: OPTIMIZING PARTICIPATION IN GROUP EXERCISE
TO PREVENT WALKING DIFFICULTY IN AT-RISK OLDER ADULTS**

Principal Investigator:

Jennifer S. Brach, PhD, PT

Supported by:

PCORI

CE-1304-6301

**Version 2.0
October 29, 2015**

17 Summary of Modifications to Protocol Version 1.0 for Version 2.0
 18

| Version (date) | Section | Brief Summary of Modification |
|--------------------------|--|---|
| Version 2.0 (12/03/2015) | Précis | We have updated the précis with a focus on Aim 1 and have specified the sample size by Aim. The sample size for Aim 1 is the same (n=280). We will continue enrolling subjects into Aim 2 until the sample size is met for Aim 1. We anticipate enrolling approximately 120 subjects in Aim 2. |
| Version 2.0 (12/03/2015) | Section 1.2 Secondary Objectives | Modified Aims 2 and 3 to make them more exploratory aims given our recent experience in the study and the barriers we have encountered with identifying and training facility staff to run the program. |
| Version 2.0 (12/03/2015) | Section 3 Study Design | <ul style="list-style-type: none"> • Added text to emphasize that comparisons of delivery mode (exercise leaders vs staff activity personnel) depend on the identification of staff activity personnel. • Clarified that exercise leaders will determine if the staff activity personnel are trained to safely run the program. • Clarified that if staff activity personnel is unable to lead the class, the second session will be led by an exercise leader. • Removed names of specific individuals and replaced with a general description of the person responsible for the task. • Updated #facilities from 28 to 34 and sample size in the staff activity personnel arms from 140 per group to 60 per group in the study figure. |
| Version 2.0 (12/03/2015) | Section 4 Selection and Enrollment of Participants | <ul style="list-style-type: none"> • Increased the number of sites • Clarified that enrollment will continue until the sample size is met for Aim 1 (i.e. n=280) |
| Version 2.0 (12/03/2015) | Section 6.2.2 Baseline 2 Assessments | Clarified that if staff activity personnel is unable to lead the class, the second |

| | | |
|-----------------------------|--|--|
| | | session will be led by an exercise leader. |
| Version 2.0 (12/03/2015) | Section 8.2 Intervention Discontinuation | Added that the research team may discontinue training of staff activity personnel or classes led by staff activity personnel if they believe the staff activity personnel is unsafe to lead the class. |
| Version 2.0 (12/03/2015) | Section 9.1 General Design Issues | Updated to reflect the exploratory nature of Aim 2 |
| Version 2.0 (12/03/2015) | Section 9.2 Sample Size | <ul style="list-style-type: none"> • Made changes to indicate that sample size is focused on Aim 1. • Aim 2 is now exploratory – and does not have a fixed sample size. We estimate that we will enroll approximately 120 participants into Aim 2 and have indicated the power for each outcome given the fixed sample size. |
| Version 2.0 (12/03/2015) | Section 9.3 Data Analysis | Updated analyses to reflect changes to the aims. Have separated the analysis into 2 main sections to reflect the change in Aim 2 to a more exploratory aim. |
| Version 2.0 (12/03/2015) | Section 12 Study Timeline | Updated timeline to reflect that recruitment will continue until March 2016 which will also extend baseline testing, intervention, and post-testing |

19
20

| | | |
|----|---|-------------|
| 21 | | |
| 22 | TABLE OF CONTENTS | |
| 23 | | <u>Page</u> |
| 24 | PRÉCIS | 7 |
| 25 | STUDY TEAM ROSTER | 8 |
| 26 | 1 Study objectives | 9 |
| 27 | 1.1 Primary Objective | 9 |
| 28 | 1.2 Secondary Objectives..... | 9 |
| 29 | 2 BACKGROUND AND RATIONALE | 9 |
| 30 | 3 STUDY DESIGN | 12 |
| 31 | 4 SELECTION AND ENROLLMENT OF PARTICIPANTS | 15 |
| 32 | 4.1 Inclusion Criteria | 15 |
| 33 | 4.2 Exclusion Criteria | 16 |
| 34 | 4.3 Study Enrollment Procedures | 16 |
| 35 | 5 STUDY INTERVENTIONS | 17 |
| 36 | 5.1 Overview..... | 17 |
| 37 | 5.2 On the Move | 17 |
| 38 | 5.3 Standard | 18 |
| 39 | 5.4 Monitoring of vital signs..... | 18 |
| 40 | 5.5 Program monitoring..... | 18 |
| 41 | 5.6 Adherence Assessment | 18 |
| 42 | 6 STUDY PROCEDURES | 19 |
| 43 | 6.1 Schedule of Evaluations..... | 20 |
| 44 | 6.2 Description of Evaluations..... | 21 |
| 45 | 6.2.1 Baseline Assessments | 21 |
| 46 | 6.2.2 Baseline 2 Assessments | 23 |
| 47 | 6.2.3 Post-Intervention Assessment..... | 24 |
| 48 | 7 SAFETY ASSESSMENTS | 24 |
| 49 | 7.1 Expected Adverse Experiences..... | 24 |

| | | | |
|----|-----------|---|-----------|
| 50 | 7.2 | Minimizing Risk during Assessments and Interventions..... | 25 |
| 51 | 7.3 | Confidentiality. | 25 |
| 52 | 7.4 | Participant Education about Potential Risks..... | 26 |
| 53 | 7.5 | Adverse Events and Serious Adverse Events..... | 26 |
| 54 | 7.5.1 | Classifying Adverse Events (AE)..... | 27 |
| 55 | 7.5.2 | Severity..... | 27 |
| 56 | 7.5.3 | Expectedness..... | 27 |
| 57 | 7.5.4 | Relatedness..... | 28 |
| 58 | 7.6 | Expected AEs..... | 28 |
| 59 | 7.7 | Reportable AEs (RAEs)..... | 28 |
| 60 | 7.8 | Reporting of Events..... | 29 |
| 61 | 8 | INTERVENTION DISCONTINUATION..... | 29 |
| 62 | 8.1 | Interruption to Exercise Participation..... | 29 |
| 63 | 8.2 | Intervention Discontinuation..... | 29 |
| 64 | 8.3 | Voluntary Participation..... | 30 |
| 65 | 9 | STATISTICAL CONSIDERATIONS..... | 31 |
| 66 | 9.1 | General Design Issues..... | 31 |
| 67 | 9.2 | Sample Size..... | 31 |
| 68 | 9.3 | Data Analyses..... | 34 |
| 69 | 9.3.1 | Overview..... | 34 |
| 70 | 9.3.2 | Main Analysis for Aims 1and 3a..... | 34 |
| 71 | 9.3.3 | Aims 2, 3(b) and 4 exploratory Analyses..... | 35 |
| 72 | 9.3.4 | Additional Exploratory/Sensitivity and Compliance/Dropout Analyses..... | 37 |
| 73 | 10 | DATA COLLECTION AND QUALITY ASSURANCE..... | 37 |
| 74 | 10.1 | Data Collection Forms..... | 37 |
| 75 | 10.2 | Data Management..... | 38 |
| 76 | 10.3 | Quality Assurance..... | 38 |
| 77 | 10.3.1 | Intervention..... | 38 |
| 78 | 10.3.2 | Protocol Deviation Tracking..... | 38 |
| 79 | 10.3.3 | Subject Termination..... | 39 |
| 80 | 11 | PARTICIPANT RIGHTS AND CONFIDENTIALITY..... | 39 |
| 81 | 11.1 | Institutional Review Board (IRB) Review..... | 39 |
| 82 | 11.2 | Informed Consent Forms..... | 39 |

| | | | |
|----|-----------|--|-----------|
| 83 | 11.3 | Participant Confidentiality | 39 |
| 84 | 11.4 | Study Discontinuation..... | 40 |
| 85 | 12 | STUDY TIMELINE..... | 40 |
| 86 | 13 | PUBLICATION OF RESEARCH FINDINGS..... | 41 |
| 87 | 14 | REFERENCES..... | 42 |
| 88 | | | |
| 89 | | | |

90 **PRÉCIS**

91 Community-dwelling older adults fear loss of independence and nursing home placement more
92 than death. Walking difficulty often leads to loss of independence. Exercise is beneficial to
93 physical and mental health and may prevent walking difficulty and promote independence.
94 Recognizing the importance of exercise, senior housing facilities offer exercise programs to their
95 residents. The exercise programs are often group-based, seated range of motion exercises that do
96 not challenge the older adult; consequently participation rates and resident satisfaction are low.
97 If the goal is to improve walking to promote independence than the exercise program should
98 specifically target walking. Therefore, we developed a challenging, group exercise program
99 entitled “On the Move” which focuses on the fundamentals of walking. In this research study we
100 will determine if the On the Move program is better than a standard program at improving
101 walking and promoting independence and if the same benefits can be obtained if the On the
102 Move program is delivered by staff of the senior living facilities instead of an exercise leader.
103 To answer these questions, community-dwelling older adults living in different Independent
104 Living Facilities and Senior High Rises and attending senior centers will be randomly assigned
105 to either the 12 week On the Move group exercise program or the standard group exercise
106 program delivered by either an exercise leader or staff activity personnel. We will enroll 280
107 community-dwelling older adults into the exercise leader arm (Aim 1). We will enroll older
108 adults into the staff activity personnel arm until the sample size is met for Aim 1. Given the
109 number of barriers to identifying, training and maintaining the staff activity personnel
110 (experienced after the study began) we will likely be unable to enroll 280 older adults into this
111 arm. We will document barriers to identifying and training staff activity personnel. Participants’
112 walking and reported ability to carry out everyday activities (functional ability) will be assessed
113 before and after the 12 week program. We will also assess participant safety and satisfaction
114 with the exercise program and instructor.

115
116 The findings from this research study will provide evidence for the value of the On the Move
117 group exercise program and will better inform patient choices regarding participation in exercise
118 programs. If successful in improving walking and promoting independence and acceptable to the
119 older adult, the On the Move program could be incorporated into exercise programming for older
120 adults in community centers, health clubs, and senior residences across the country.
121

122 **STUDY TEAM ROSTER**

123 **Principal Investigator:**

124 **Jennifer S. Brach, PhD, PT**

125 Bridgeside Point 1

126 100 Technology Drive

127 Pittsburgh, PA 15219-3130

128 Phone: 412-383-6533

129 Fax: 412-648-5970

130 jbrach@pitt.edu

131 Main responsibilities/Key roles: Oversees and is responsible for all aspects of the study

132

133 **Co-Investigators:**

134

| | |
|--|--|
| <p>Deborah Brodine, MHA, MBA UPMC Community Provider Services Forbes Tower Suite 10055 200 Lothrop St Pittsburgh, PA 15213 Phone: (412) 647-0548 brodineds@umpmc.edu Main responsibilities: Provider Stakeholder</p> | <p>Sandra Gilmore, RN, MS UPMC Community Provider Services 101 Orchard Drive Suite 104 Trafford, PA 15085 Phone: (412)380-8750 gilmoresl@upmc.edu Main responsibilities: Provider Stakeholder, community liaison. Identify community sites.</p> |
| <p>Neelesh Nadkarni, MD, PhD Division of Geriatric Medicine Kaufmann Building, Suite 500 Pittsburgh, PA Phone: (412) 692-2383 nkn3@pitt.edu Main responsibilities: Study physician</p> | <p>Subashan Perera, PhD Division of Geriatric Medicine Kaufmann Building, Suite 500 Pittsburgh, PA Phone: (412) 692-2365 Ksp9@pitt.edu Main responsibilities: Randomization, data management and study statistician</p> |
| <p>Jessie VanSwearingen, PhD, PT Bridgeside Point 1 100 Technology Drive Pittsburgh, PA 15219-3130 Phone: 412-383-6533 jessievs@pitt.edu Main responsibilities/Key roles: Quality control of the intervention</p> | <p>Edmund Ricci, PhD 207A Parran Hall Graduate School of Public Health University of Pittsburgh 130 DeSoto Street Pittsburgh, PA 15261 Phone: 412-624-6393 emricci@pitt.edu Main Responsibilities: Program evaluation</p> |

135

136

137 **1 STUDY OBJECTIVES**

138 **1.1 Primary Objective**

139 **Aim 1: Compare the effects of the *On the Move* group exercise program to a standard**
140 **program on self-reported function and disability and walking ability.** *The On the Move*
141 *program will produce greater gains in self-reported function and disability (Late Life Function*
142 *and Disability Index/LLFDI) and walking ability (6-minute walk test/6MWT and gait speed)*
143 *when delivered by an exercise leader.*

144 **1.2 Secondary Objectives**

145 **Aim 2: When feasible to be delivered by staff activity personnel, explore the effectiveness of**
146 **On the Move compared to a standard program; and sustainability compared to delivery by**
147 **exercise leaders (when feasible). Explore barriers to identifying and training staff activity**
148 **personnel.** *On the Move delivered by staff activity personnel (when feasible) will produce gains*
149 *in above outcomes that are greater than the standard program; and comparable to when*
150 *delivered by an exercise leader.*

151 **Aim 3: Explore the acceptability and the risks of the On the Move and standard exercise**
152 **programs delivered by (a) exercise leaders and (b) staff activity personnel (when feasible).**
153 *On the Move will result in greater satisfaction and higher attendance rates than the standard*
154 *program. Attendance rates and satisfaction will be similar for exercise leader and staff activity*
155 *personnel led programs when feasible to recruit staff personnel. Adverse event (falls, soft tissue*
156 *injuries, muscle soreness, etc.) rates during exercise will be similar between the two groups and*
157 *the two facilitators when feasible to recruit staff personnel.*

158 **Aim 4: Explore potential baseline predictors of benefit and risks of participation in *On the***
159 ***Move* program to facilitate informed patient decision making.** *We will be able to identify*
160 *combinations of baseline physical, psychosocial and demographic factors associated with each*
161 *of the treatment response and adverse events outcomes.*

162

163 **2 BACKGROUND AND RATIONALE**

164 Disability is a common, costly problem in older adults. Walking difficulty in older adults
165 contributes to loss of independence, higher rates of morbidity and increased mortality.(1),(2-5)
166 Mobility loss is also a sentinel predictor of other disabilities that restrict independent living.(6)
167 Compared to older adults without self-reported walking difficulty, those who developed mild
168 walking difficulty over one year had higher healthcare costs (mean \$1,128 per person).
169 Extrapolated to the estimated 22% of older adults who develop walking difficulty annually, the
170 cost to society is an additional 3.6 billion dollars per year.(7) Therefore, preventing or delaying
171 the onset of walking difficulty might have a substantial impact on older adults' independence and
172 their healthcare costs.
173

174 Exercise intervention studies have neglected to include disability outcomes. Difficulty walking is
175 associated with reduced activity and participation and a loss of independence.(8),(9, 10) Exercise
176 interventions for older adults have focused on improving walking as a means to reduce or delay
177 physical disability.(11, 12) These exercise interventions have included strength, balance and
178 endurance activities in order to reduce impairments and improve physiologic capacity for
179 walking. These studies have resulted in only modest gains in walking ability (i.e. an approximate
180 5% increase in speed) with only one study reporting disability outcomes.(11, 13-21) Definitive
181 evidence that exercise that improves walking also reduces disability is lacking; therefore the
182 need for the ongoing Lifestyle Interventions and Independence for Elders (LIFE) study.

183
184 Exercise interventions fail to include an important component of exercise to improve walking,
185 the timing and coordination of movement. National recommendations and interventions to
186 prevent walking difficulty, such as the Lifestyle Interventions and Independence for Elders
187 (LIFE) study have overlooked an important component of exercise that is critical for walking,
188 the timing and coordination of movement.(20, 22) The ongoing Lifestyle Interventions and
189 Independence for Elders (LIFE) study examines a standard walking endurance, strength, static
190 balance and flexibility intervention on the prevention of disability in community-dwelling older
191 adults. The LIFE pilot study, using the same intervention, demonstrated significant but only
192 modest effects.(20) We have preliminary data to suggest that a novel exercise program that
193 includes timing and coordination exercise is superior to a standard strength and endurance
194 program for improving walking in older adults.(23)

195
196 Timing and coordination training improve walking in older adults. We conducted two pilot
197 studies, involving contrasting subject groups, to examine the impact of a timing and coordination
198 exercise program on walking. The first study (RESTORE) included older adults with slow (gait
199 speed < 1.0 m/s) and variable gait and has been published.(23) The second study (PRIME) has
200 just recently been completed. It included older adults with near normal gait speed (gait speed >
201 1.0 m/s) but with difficulty with aspects of the timing and coordination of walking (i.e. Figure of
202 8 test time > 8.0 s- see choice of outcomes section below for details of this measure). Participant
203 retention for the 12 week post-tests was over 95%.

204
205 In the RESTORE study, 50 subjects (mean age 77.2±5.5 years, 65% women) were randomly
206 assigned to either a standard exercise program (endurance, strength and typical static balance
207 training) or a timing and coordination program, for one hour, 2 times per week for 12 weeks,
208 with baseline and 12 week follow up assessments. Of the 50 who entered, 47 (94%) completed
209 the study. Both groups increased gait speed (timing and coordination by 0.21 m/s and standard
210 by 0.14 m/s). The timing and coordination group reduced the energy cost of walking
211 0.10±0.03mL/kg/m more than the standard group (p=0.0002), had a 9.8±3.5 point greater gain in
212 reported walking confidence (i.e. Gait Efficacy Scale) than the standard group (p=0.008), had a
213 1.5±0.6 point greater reduction in gait abnormalities (i.e. GARSM) than the standard group
214 (p=0.02), and had a 3.5±1.7 (p=0.04) point greater gain than the standard group in basic lower
215 extremity function (LLFDI) and a 2.6±1.7 (p=0.12) point greater gain than the standard group in
216 advanced LE function (LLFDI).(23)

217
218 In the PRIME study, 38 subjects (mean age 78.5±5.6 years, 65% women) were randomly
219 assigned to either a standard endurance and strength exercise program or a timing and

220 coordination plus strengthening program, 2 times per week for 12 weeks, with assessments at
221 baseline and immediately following the 12 week intervention. Preliminary analyses indicate that
222 the timing and coordination group had greater improvements in gait speed, figure of 8 walk, and
223 challenging gait tasks than the standard group. Both groups had improvements in the 6MWT
224 ($p<0.05$); however, the timing and coordination group had marginally greater improvements
225 ($p=0.14$). Only the timing and coordination group demonstrated improvement in self-reported
226 disability and neither group decreased perceived walking difficulty (LLFDI – total function).
227 However, this group had very high initial LLFDI function scores; reflecting low levels of
228 baseline perceived walking difficulty, so may have been vulnerable to ceiling effects. Since our
229 proposed sample will be more impaired, we anticipate that there is more room for change and
230 that treatment group differences or declines of perceived walking difficulty will be detectable.

231
232 Our preliminary data demonstrate the benefit of timing and coordination training and support the
233 concept that timing and coordination training provides something distinct from standard training,
234 with potential effects on self-reported function, disability and mobility. Note that these pilot
235 studies examined the effects of the timing coordination program delivered on a one on one basis.
236 In the current proposal we will be testing the timing and coordination training delivered as a
237 group program (i.e. On the Move group exercise program).

238
239 Exercise programs offered in senior housing are inadequate. Recognizing the importance of
240 exercise for promoting physical and mental health many senior housing facilities offer exercise
241 programs for the older adults. Though available, participation rates and participant satisfaction
242 are low. Older adults feel the seated group exercise programs that are offered, are not
243 challenging or beneficial so they stop participation. Providers, such as UPMC Senior
244 Communities, are looking for viable alternatives. Older adults are interested in exercise
245 interventions that will improve their mobility and help maintain their independence (focus group
246 information). Exercise programs currently offered in senior living settings are inadequate
247 because they 1) are often conducted in seated position and do not challenge the older adult and 2)
248 exclude an important component of exercise that is critical to walking, the timing and
249 coordination of movement. There is a need for a more challenging, evidence-based exercise
250 program that is designed to improve walking and promote independence in older adults.

251
252 We developed a challenging, evidence-based group exercise program, On the Move, to improve
253 walking in older adults. Though effective, an individualized, physical therapist led exercise
254 program (described above as timing and coordination training) is not a cost effective model for
255 the prevention of walking difficulty. A group exercise program is a cost efficient alternative
256 which would likely promote adherence through socialization. Therefore, in collaboration with
257 UPMC Community Provider Services, we developed a novel timing and coordination group-
258 based exercise program entitled “On the Move”. The On the Move program differs from current
259 group exercise programs in that 1) it contains timing and coordination exercises based on the
260 biomechanics and motor control of walking (i.e. specificity of training), 2) the majority of the
261 program consists of standing and walking exercises which challenge the older adult, and 3) it
262 was developed with input from older adults.

263
264 UPMC Community Provider Services is interested in the sustainability of the exercise program.
265 A main priority of our stakeholder, UPMC Community Provider Services, is the sustainability of

266 the exercise program. Often scientists conduct research within their facilities and when the
267 research is over, the scientists move on to another project and the program does not continue.
268 Recognizing this as an issue, we incorporated a sustainability component into our Aging Institute
269 pilot described above. During the 12 week exercise program, the exercise leader is training the
270 activity staff personnel to conduct the program. The activity staff personnel is currently assisting
271 with the 12 week program. After 6 weeks of exercise classes we surveyed the activity staff
272 personnel to determine her level of confidence in conducting the program. The activity staff
273 responded that she was very confident that she could identify participants who were doing the
274 exercises correctly and/or incorrectly and she was confident that she could lead the exercise
275 program and progress the exercises. The activity staff personnel stated that a “cheat sheet” of
276 listed exercises would be very useful when leading the exercise class. At the conclusion of the
277 first 12 week exercise leader program, the staff activity personnel will start a new 12 week
278 program with residents who were placed on the wait list.
279

280 Summary

281 The evidence-based On the Move program was developed based on our past research and with
282 input from older adults. In our initial pilot study, we demonstrate that the program is feasible and
283 acceptable to the older adult and that activity staff personnel have confidence in their ability to
284 lead the program. In our current pilot we demonstrate our ability to engage management from
285 other community sites and the ability to recruit from different populations. The next key step is
286 to examine the benefits and risks of the On the Move program in a larger, more diverse sample
287 of older adults and to assess the sustainability of the program. Specifically, we are interested in
288 determining if the challenging group-based program improves mobility and prevents functional
289 decline and disability without any increased risk to the older adult and if the activity staff
290 personnel can lead the On the Move exercise program obtaining similar results to the exercise
291 leader delivered program.
292

293 **3 STUDY DESIGN**

294 To address our research questions, we will conduct a cluster randomized single-blind two arm
295 intervention trial to compare the effects on function, disability and mobility of a standard group
296 exercise program and a novel *On the Move* group exercise program in 400 community-dwelling
297 older adults who reside in independent living facilities and senior housing sites or who attend
298 senior community centers. Group exercise classes are twice weekly for 12 weeks and will be
299 delivered by exercise leaders and activity staff personnel. Function, disability and mobility are
300 assessed at baseline and post intervention (**Figure 1**).
301

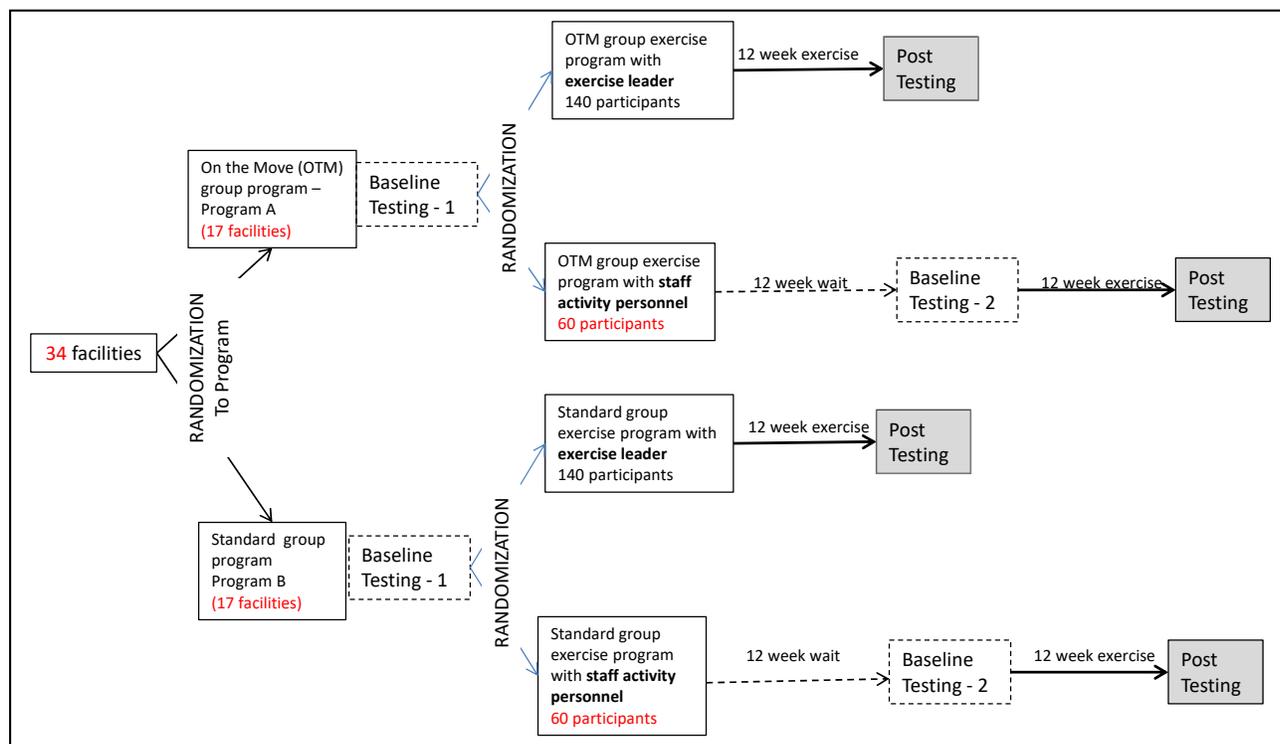
302

303

304

305

306



307 Figure 1.

308

309 Choice of comparators

310 There are two main comparisons being examined, 1) the type of exercise program (i.e. *On the*
 311 *Move* versus a standard group exercise program) and 2) the delivery mode (i.e. exercise leaders
 312 versus staff activity personnel), when a suitable staff activity person is available.

313 **Exercise program comparison (Aim 1).** The novel challenging *On the Move* exercise program
 314 will be compared to a standard group exercise program. Both exercise programs (*On the Move*
 315 and standard) will be group-based and led by a person. Our older adult participants have stressed
 316 the importance of having the exercise program led by a person instead of viewing a videotape.
 317 They feel the person is more enjoyable and they like the idea of the instructor providing feedback
 318 about their performance throughout the exercise class. Both programs will be delivered by
 319 trained exercise leaders or trained staff activity personnel (sustainability component; only when
 320 such a person is available). When a suitable staff activity person is not available, the program
 321 will be delivered by one of our exercise leaders. Class size will be set at a maximum of 10
 322 participants. If there are more than 10 participants at any site, multiple classes will be scheduled.
 323 The frequency and duration of the programs are identical (50 minutes, 2 times a week for 12
 324 weeks). From our past research we have determined that a frequency of 2 times per week for 12
 325 weeks is acceptable to the older adult participants and is an adequate dose to obtain meaningful
 326 outcomes.(23) The main difference between the standard and the *On the Move* group exercise
 327 programs is the program content which is described below.

328

329 The On the Move exercise program is based on principles of motor learning that enhance “skill”
330 or smooth and automatic movement control.(24-29) The program contains a warm-up (5
331 minutes), stepping patterns (15 minutes), walking patterns (15 minutes), strengthening exercises
332 (10 minutes), and cool-down exercises (5 minutes). The warm-up and cool down contain gentle
333 range of motion exercises and stretches for the lower extremities and trunk. The stepping and
334 walking patterns are goal-oriented progressively more difficult patterns which promote the
335 timing and coordination of stepping, integrated with the phases of the gait cycle.(25, 26, 28, 29)
336 Conceptually, the exercise is intended to achieve its effects by shifting the center of pressure
337 posteriolateral then forward, encouraging hip extension prior to stepping, loading the trailing
338 limb, coordinating activation of the abductors of the soon to be swing leg with adductors of the
339 stance limb, and shifting the center of pressure in medial stance to unload the stepping limb.(30-
340 32) Progression is based on first separately increasing the speed, amplitude or accuracy of
341 performance prior to undertaking a more complex task.(33) For example, the progression of
342 stepping patterns is, 1) self-paced step forward and across, 2) increase stepping speed, 3)
343 alternate side of stepping, 4) alternate forward with backward stepping. In the group class,
344 exercises can be individualized by having some older adults use upper extremity support while
345 others do not hold on during the exercises. Also, some subjects will step in all one direction
346 while others will do the more challenging alternating left and right steps. Walking patterns
347 incorporate patterns of muscle coordination and interlimb timing into walking. Walking patterns
348 progress by altering speed, amplitude (e.g. narrowing oval width), or accuracy of performance
349 (e.g. without straying from the desired path), and then to complex walking patterns involving
350 walking past others and with upper extremity object manipulation tasks, such as carrying or
351 bouncing a ball.(29) Walking and stepping patterns (i.e. timing and coordination training) were
352 used in both of our pilot studies.(23) The strengthening exercises are conducted in sitting and
353 standing and target the lower extremity muscles. The majority of the program will be conducted
354 in standing (40 minutes) with only a small portion conducted in sitting (10 minutes). We have
355 conducted two pilot exercise classes with older adults with varying levels of ability. We were
356 able to successfully individualize the group program in that participants reported feeling both
357 challenged and safe. Please see the appendix for example exercises and progressions.

358
359 The standard group exercise program is based on exercise programs that are currently being
360 conducted at the facilities (i.e. standard of care). The operationally defined program contains a
361 warm-up (5 minutes), upper and lower extremity strength and flexibility exercises (30 minutes),
362 static balance exercises (10 minutes) and a cool-down (5 minutes). The majority of the program
363 will be conducted in sitting (40 minutes) with only a small portion (10 minutes) conducted in
364 standing. The active control group (i.e. standard exercise program) will aid in adherence and
365 retention in that subjects who volunteer to participate in the study will be looking for exercise
366 options.

367
368 **Sustainability of the program: exercise leader and staff activity personnel comparison (Aim**
369 **2).** The sustainability of the program will be evaluated by assessing the effectiveness of *On the*
370 *Move* compared to a standard program when delivered by staff activity personnel and by
371 comparing outcomes obtained by the *On the Move* program delivered by exercise leaders and
372 staff activity personnel (**Figure 1**). Exercise leaders are individuals with training and experience
373 in administering exercise programs, such as exercise physiologists, physical therapists, physical
374 therapy assistants, etc. Staff activity personnel are employees of the Independent Living

375 Facilities and Senior High Rises that are involved in providing services to the residents. They
376 could be activity directors, social workers, outreach coordinators, care coordinators, etc. These
377 individuals are not specifically trained to deliver exercise interventions as part of their job. We
378 will work with our community stakeholders and the building managers to identify staff activity
379 personnel at each of the sites who would be involved in this research study. All exercise leaders
380 and identified staff activity personnel will be trained in the delivery of the exercise program prior
381 to leading any exercises classes. The staff activity personnel will participate in a one hour
382 training sessions in which the rationale and the general format of the program will be explained.
383 During these training sessions the activity staff personnel will participate in a sample exercise
384 class. In addition to the 2 training sessions, the activity staff personnel will be able to observe
385 the 12 week exercise session delivered by the exercise leader at their facility. They will be given
386 the opportunity to observe all 24 sessions if they would like. In addition to training the exercise
387 leaders and activity staff personnel, we will provide printed materials explaining the exercise
388 program that we developed in our pilot work (see appendix). After training, the exercise leader
389 will determine if the staff activity personnel is ready to lead the exercise class. The exercise
390 leader will consider the following when determining if the individual is ready to lead the class: 1)
391 attendance at training sessions, 2) attendance at exercise sessions, 3) interactions with research
392 participants, and 4) understanding of the exercise program including all safety considerations. A
393 study investigator (Dr. Brach or Dr. VanSwearingen or one of the exercise leaders) will meet
394 with the staff activity personnel or email them periodically (i.e. during weeks 1, 3, 6, and 10 of
395 the 12 week exercise program) to observe the intervention, monitor treatment fidelity, and to
396 answer any questions. If the study team believes the staff activity person is not ready to lead a
397 class safely and per protocol at a particular site, their class will also be led by an exercise leader.
398
399

400 **4 SELECTION AND ENROLLMENT OF PARTICIPANTS**

401 We will recruit participants from the UPMC Independent Living Facilities (ILFs), other
402 Independent Living Facilities, Senior Housing sites, and Community Centers. Within UPMC
403 there are eight different ILFs with over 700 residents. UPMC is affiliated with 32 different
404 Senior Housing sites that house over 2,000 residents. We anticipate enrolling subjects from 10
405 ILFs and from approximately 24 of the Senior Housing sites for a total of approximately 34 sites.
406 However, the number of participants per site will vary and we will continue adding sites and
407 enrolling participants until the planned sample size is met for the primary Aim (i.e. n=280).
408

409 **4.1 Inclusion Criteria**

410 Participants must meet all of the following inclusion criteria to participate in the study.

- 411 1) 65 years of age or older
- 412 2) Resident of a UPMC ILF or Senior Housing site
- 413 3) Ambulate independently for household distances with or with a straight cane,
- 414 4) Usual gait speed greater than or equal to 0.60 m/s
- 415

416 **4.2 Exclusion Criteria**

417 Potential participants who meet any of the following exclusion criteria at baseline will be
418 excluded from study participation.

- 419
- 420 1) Non English speaking,
 - 421 2) Impaired cognition, defined as inability to follow 2 step commands or understand the
422 informed consent process,
 - 423 3) Plans to leave the area for an extended period of time over the next 4 months,
 - 424 4) Progressive neuromuscular disorder such as Parkinson’s or Multiple Sclerosis,
 - 425 5) Any acute illness or medical condition that is not stable,
 - 426 6) Inappropriate response to the 6 minute walk test (i.e. exercise heart rate \geq 120 bpm, exercise
427 SBP \geq 220 or a drop in SBP $>$ 10 mmHg, or DBP \geq 110 mm Hg).

428 **4.3 Study Enrollment Procedures**

429 We will hold information sessions at each of the sites. The study PI (Dr. Brach) will visit each
430 site and describe the study to the residents. Subjects who are interested in hearing more will be
431 asked to place their name and phone number on a sign-up sheet. Research staff will then contact
432 the subject to explain the study and conduct the initial phone screen if the subject is interested.

433

434 Subject eligibility will be determined from a phone screen and an in-person clinical screen.
435 Researchers will contact potential participants by phone to determine their eligibility. After
436 obtaining verbal consent, a structured screening questionnaire (see attached) will be administered
437 to determine the presence and absence of the inclusion/exclusion criteria. Individuals who meet
438 the criteria will be scheduled for an in-person screening visit that will take place at the ILF or
439 senior housing site.

440

441 At the in-person screening visit, the first task will be to obtain informed consent for participation
442 in the study. Once informed consent is obtained, the screening exam will take place. The
443 screening exam will be conducted by trained research personnel (physical therapists, exercise
444 physiologists, physical therapy assistants, or physical therapy students) who have experience
445 working with older adults and conducting such screening measures. ACSM Guidelines regarding
446 exercise participation will be available to all staff during testing. At all screening sessions at least
447 1 physical therapist will be available as a resource for the other research staff conducting
448 screening procedures.

449

450 The purpose of the physical examination is to identify potential exclusion issues that are not
451 identified by self-report. The exam includes a review of systems, current medications, vital signs,
452 lower extremity range of motion and strength testing, and visual screening. A standard
453 demographics questionnaire will be used to determine age, gender, race, marital status and work
454 history in order to adequately describe the research participants. As a screening for exercise
455 participation, all subjects will complete a six minute walk test (additional detail under
456 experimental procedures). Participants will be asked to walk as far as they can in six minutes
457 (without jogging or running) in a hallway. Participants are permitted to stop and rest during this
458 test, if needed, and the number and duration of rest breaks are recorded. Blood pressure, heart
459 rate and level of fatigue (using the rate of perceived exertion (RPE) scale) are recorded before

460 and after the test. Based on the ACSM guidelines, subjects who have an inappropriate exercise
461 response (i.e. exercise heart rate ≥ 120 bpm, exercise SBP ≥ 220 or a drop in SBP > 10
462 mmHg, or DBP ≥ 110 mm Hg) will be referred to their primary care physician for clearance
463 before they can be enrolled in the study.(34) Subjects who have an appropriate exercise response
464 and are eligible based on the other screening criteria will then complete the outcome measures of
465 function, disability and walking ability described below. All subjects will sign a “Liability
466 Waiver Release for Participation in an Exercise Program” prior to starting the exercise program.
467
468

469 **5 STUDY INTERVENTIONS**

470 **5.1 Overview**

471 The exercise interventions will be delivered in 2 phases. The first phase or 12 week class will be
472 delivered by the exercise leader. The second phase or 12 week class will begin once the first
473 phase is completed and will be delivered by staff activity personnel. Participants who are
474 randomized to the second phase class (i.e. delivered by staff activity personnel) will repeat the
475 baseline testing prior starting the exercise class.
476

477 The facilities will be randomized (described above) to receive either the "On the Move" or a
478 standard group exercise program. Both exercise programs (On the Move and standard) will be
479 group-based and led by a person. Both programs will be delivered by trained exercise leaders or
480 trained staff activity personnel (sustainability component). The frequency and duration of the
481 programs are identical (50 minutes, 2 times a week for 12 weeks). From our past research we
482 have determined that a frequency of 2 times per week for 12 weeks is acceptable to the older
483 adult participants and is an adequate dose to obtain meaningful outcomes.(23) The main
484 difference between the standard and the On the Move group exercise programs is the program
485 content which is described below.
486

487 **5.2 On the Move**

488 The On the Move exercise program is based on principles of motor learning that enhance “skill”
489 or smooth and automatic movement control.(24-29) The program contains a warm-up (5
490 minutes), stepping patterns (15 minutes), walking patterns (15 minutes), strengthening exercises
491 (10 minutes), and cool-down exercises (5 minutes). The warm-up and cool down contain gentle
492 range of motion exercises and stretches for the lower extremities and trunk. The stepping and
493 walking patterns are goal-oriented progressively more difficult patterns which promote the
494 timing and coordination of stepping, integrated with the phases of the gait cycle.(25, 26, 28, 29)
495 Conceptually, the exercise is intended to achieve its effects by shifting the center of pressure
496 posteriolateral then forward, encouraging hip extension prior to stepping, loading the trailing
497 limb, coordinating activation of the abductors of the soon to be swing leg with adductors of the
498 stance limb, and shifting the center of pressure in medial stance to unload the stepping limb.(30-
499 32) Progression is based on first separately increasing the speed, amplitude or accuracy of
500 performance prior to undertaking a more complex task.(33) For example, the progression of
501 stepping patterns is, 1) self-paced step forward and across, 2) increase stepping speed, 3)
502 alternate side of stepping, 4) alternate forward with backward stepping. In the group class,

503 exercises can be individualized by having some older adults use upper extremity support while
504 others do not hold on during the exercises. Also, some subjects will step in all one direction
505 while others will do the more challenging alternating left and right steps. Walking patterns
506 incorporate patterns of muscle coordination and interlimb timing into walking. Walking patterns
507 progress by altering speed, amplitude (e.g. narrowing oval width), or accuracy of performance
508 (e.g. without straying from the desired path), and then to complex walking patterns involving
509 walking past others and with upper extremity object manipulation tasks, such as carrying or
510 bouncing a ball.³³ Walking and stepping patterns (i.e. timing and coordination training) were
511 used in both of our pilot studies.⁵ the strengthening exercises are conducted in sitting and
512 standing and target the lower extremity muscles. The majority of the program will be conducted
513 in standing (40 minutes) with only a small portion conducted in sitting (10 minutes). We have
514 conducted two pilot exercise classes with older adults with varying levels of ability. We were
515 able to successfully individualize the group program in that participants reported feeling both
516 challenged and safe. Please see the appendix for example exercises and progressions.
517

518 5.3 Standard

519 The standard group exercise program is based on exercise programs that are currently being
520 conducted at the facilities (i.e. standard of care). The operationally defined program contains a
521 warm-up (5 minutes), upper and lower extremity strength and flexibility exercises (20 minutes),
522 cardiovascular exercises (20 minutes) and a cool-down (5 minutes). The majority of the program
523 will be conducted in sitting (>40 minutes) with only a small portion (<10 minutes) conducted in
524 standing. The active control group (i.e. standard exercise program) will aid in adherence and
525 retention in that subjects who volunteer to participate in the study will be looking for exercise
526 options.
527

528 5.4 Monitoring of vital signs

529 Vital signs will be monitored before and after the exercise class as needed. Vitals signs will be
530 monitored more at the beginning of the program, and at any time the participant reports or
531 displays signs and symptoms (i.e. shortness of breath, lightheadedness, racing heart, etc). We
532 will once again follow the ACSM guidelines for stopping of exercise.
533

534 5.5 Program monitoring

535 Periodically (approximately 1-2 times) throughout the exercise program we will be videotaping
536 the exercise sessions. These videos will be used primarily to monitor the quality and consistency
537 of the exercise program and to further develop the training manual for the exercise instructors.
538 The videos may be used to train future exercise instructors.
539

540 5.6 Adherence Assessment

541 A roster of participants will be developed for each group exercise class. At the beginning of each
542 class, attendance will be recorded by the exercise leader or staff activity personnel. Reasons for
543 missed classes will be recorded when available. Attendance rate ($\frac{\text{number of sessions attended}}$

544 by the participant/total number of classes offered, i.e 24] X100%) will be calculated for each
545 participant and will be the main indicator of adherence.

546

547 **6 STUDY PROCEDURES**

548

549 6.1 Schedule of Evaluations

| Measure | Clinic Screen | Baseline 1 Pre-intervention | Baseline 2 Pre-intervention Activity staff group | 12 week Post- intervention |
|---|---------------|--------------------------------|--|----------------------------------|
| Demographics Questionnaire | X | | | |
| Physical exam screen (BP, strength, 2 step command) | X | | | |
| 6 MWT | X | | X | X |
| Screening gait speed | X | | | |
| Comorbidities Index | | X | | |
| Fall history | | X | X | X |
| Anthropometric Measurements | | X | | |
| Gait Measures | | | | |
| Gait speed – Zeno Walkway | | X | X | X |
| Complex walk (Shumway-Cook) | | X | X | X |
| SPPB | | X | X | X |
| Figure 8 | | X | X | X |
| GES | | X | X | X |
| Physical Function | | | | |
| LLFDI | | X | X | X |
| Global items | | X | X | X |
| Potential confounders | | | | |
| PHQ-9 | | X | X | X |
| Digit Symbol Substitution Test | | X | X | X |
| Program Evaluation | | | | |
| Satisfaction survey | | | | X |

550
551
552

553 **6.2 Description of Evaluations**

554 6.2.1 Baseline Assessments

555
556 If after the clinic screen the participant is eligible (i.e. meets all inclusion/exclusion criteria) they
557 will undergo baseline testing. All baseline testing will be performed by research staff trained in
558 the testing procedures. All testing will be completed at the ILFs and Senior Housing Sites.

559
560 Our main outcomes, function, disability, and walking ability are highly associated with
561 independence and are extremely important to the older adult. Our primary measure of function
562 and disability is the Late Life Function and Disability Instrument (LLFDI) and our main
563 measures of walking ability are Six Minute Walk Test (6MWT) and gait speed. We will also
564 examine confidence in walking (Gait Efficacy Scale), walking under challenging conditions
565 (challenging gait tasks and figure of 8 walk), gait variability and the Short Physical Performance
566 Battery (SPPB) as additional measures of walking ability. We will also collect a measure of
567 cognition (Digit Symbol Substitution Test) and mood (PHQ-9).

568
569 6.2.1.1 Function and Disability

570 Late Life Function and Disability Instrument (LLFDI).(35, 36) Our primary function and
571 disability outcome will be the LLFDI. The LLFDI is a pair of self-report measures targeted for
572 assessing physical function and disability in older adults with acute or chronic problems, and
573 designed to be more sensitive to change than similar measures. The two components of the
574 LLFDI correspond to the activity (LLFDI – function) and participation (LLFDI – disability)
575 components of the World health Organization’s International Classification of Function,
576 Disability and Health model. The LLFDI function component has 32 items in three dimensions,
577 basic lower extremity (BLE), advance lower extremity (ALE) and upper extremity (UE) and the
578 LLFDI disability component has 16 items representing two dimensions, frequency of
579 performance and limitation in performance of life tasks. We’ve selected the LLFDI because 1) it
580 measures both function and disability which are critical components of independence, 2) it
581 includes a wide variety of life tasks in various social areas thus extending beyond the traditional
582 focus of just activities of daily living, 3) the scale was designed with sufficient breadth of items
583 and increments of rating in order to minimize ceiling and floor effects and maximize the scale’s
584 ability to detect change over time, and 4) it is a continuous outcome which gives us greater
585 power than a dichotomous outcome to detect change over time. We will focus our analyses on
586 the LLFDI function and disability dimension scores (i.e. BLE function, ALE function, UE
587 function, disability frequency and disability limitation). We will also examine the disability
588 domain scores (social role, personal role, instrumental role and management role) since they may
589 provide insight into the impact of the disability on frequency of performance and perceived
590 limitations.(36) The LLFDI function and disability scales have established known groups
591 validity and the test-retest reliability is moderate to high for the disability component (ICCs
592 range from 0.68 to 0.82) and extremely high for the function component (ICCs range from 0.91-
593 0.98 for the dimensions). Scores range from 0-100; higher scores represent less difficulty and
594 less disability.

595
596

597 6.2.1.2 Walking Ability

598 Six-Minute Walk Test (6MWT). One of the main walking ability outcomes is the Six-Minute
599 Walk Test (6MWT) of distance walked (meters) in six minutes, including time for rest as
600 needed.(37) We have selected the 6MWT because it is 1) a performance-based measure of
601 walking ability and walking ability is an important component of independence, 2) an indicator
602 of community ambulation (i.e. the ability to walk 300m in 6 minutes),(38, 39) 3) a continuous
603 outcome which gives us greater power than a dichotomous outcome to detect change over
604 time,(40) and 4) a widely used measure of mobility that is included in the NIH PROMIS project
605 to establish measures of clinical assessment. The 6MWT has established psychometric
606 properties, test-retest reliability (Pearson $r=.95$) in older adults,(41, 42) construct validity for
607 graded exercise test and functional classification.(43) The Six-Minute walk test will be
608 completed as part of the clinic screen (described earlier) and also used as an outcome measure.
609 Participants will only complete the 6MWT once at baseline. Participants will be asked to walk as
610 far as they can in six minutes (without jogging or running) in a hallway. Participants are
611 permitted to stop and rest during this test, if needed, and the number and duration of rest breaks
612 are recorded. Blood pressure, heart rate and level of fatigue (using the rate of perceived exertion
613 (RPE) scale) are recorded before and after the test. Based on the ACSM guidelines, subjects who
614 have an inappropriate exercise response (i.e. exercise heart rate ≥ 120 bpm, exercise SBP \geq
615 220 or a drop in SBP > 10 mmHg, or DBP ≥ 110 mm Hg) will be referred to their primary care
616 physician for clearance before they can be enrolled in the study.(34) Greater distance covered
617 during six minutes is better.

618
619 Gait Speed. The second main walking ability outcome is gait speed. We have selected gait speed
620 because it is a strong indicator/predictor of morbidity and mortality in the older adult.(2, 3, 5)
621 Gait speed is assessed in usual walking with an instrumented walkway. After explanation, the
622 participant completes 2 practice walks to become accustomed to walking on the walkway. The
623 subject then completes 4 passes at their usual, self-selected walking speed. Gait speed will be
624 averaged over the 4 passes. The test-retest reliability of gait speed measured using instrumented
625 walkways by ICC is 0.98.(44) A faster speed is better.

626
627

628 6.2.1.3 Additional Mobility Measures

629 Gait Efficacy Scale. In order to determine if changes in walking ability are associated with
630 changes in confidence in walking, confidence will be assessed using the Gait Efficacy Scale.(45-
631 47) The items include a range of gait activities such as walking over different surfaces, up and
632 down curbs, and negotiating stairs. Each item has a 10 point Likert scale scoring option, with the
633 total score for the 10 items, ranging from 0-100. A higher score represents greater confidence.

634
635 Figure of 8 Walk.(48) The Figure of 8 Walk was designed to measure motor skill in walking.
636 The test involves walking a figure of eight pattern about two markers placed 5 feet apart.
637 Performance is scored based on the time to complete the figure 8 walk and the number of steps.
638 Faster and fewer steps are better.

639
640 Challenging Gait Tasks. Challenging gait tasks are used to examine an individual's ability to
641 adapt their gait to different environmental conditions.(49)53 Subjects will complete two, 12

642 meter trials of each challenging condition, obstacle, curved path, and narrow path.(49) The time
643 to complete each task, averaged over two trials, is the summary indicator of gait during
644 challenging tasks. In a sample of 40 community-dwelling older adults, the 1-week test re-test
645 reliability of the timed measures of challenging gait ranged from ICC = 0.70 to 0.94. The
646 marginal additional time for completing each challenging task compared to usual gait is the main
647 indicator and lower marginal cost is better.

648
649 Gait Variability. Gait variability, defined as fluctuations in gait characteristics from one step to
650 the next,(50) is an important indicator of impaired mobility in older adults.(9) Gait variability is
651 quantified using established measures of temporal and spatial gait characteristics including
652 stance time, step length, and step width. Variability will be calculated as the standard deviation
653 of the set of steps recorded over 4 passes on the instrumented walkway (described above).
654 Approximately 32 steps will be collected from 4 passes on the mat which will be more than
655 adequate to achieve a stable measure of gait variability. Our prior work has shown that 20 steps
656 are sufficient to achieve a reliability of 0.75 and 30 are sufficient for 0.80.(51) In general, lower
657 variability is better although there are exceptions.(9, 52)

658
659 Short Physical Performance Battery (SPPB). The SPPB of lower extremity function was
660 designed and used in the Epidemiologic Studies of the Elderly (EPESE) to assess lower-
661 extremity function of individuals 65 years of age and older. It combined measures of gait speed,
662 balance, and timed chair rise to develop the SPPB for lower-extremity function. The three
663 components are: gait speed over 4-meters, standing balance and chair stands are timed and these
664 times are converted to scores from 0-4 (0=unable, 4=fastest time) for each component. Total
665 scores on the Battery range from 0-12, ranges defined for relative risks of disability.(4)

666
667

668 6.2.1.4 Cognition and Mood

669 Digit Symbol Substitution Test.(53)A measure of processing speed, the Digit Symbol
670 Substitution test will be used to gather information about both motor and cognitive processing
671 speed. The DSST is a paper and pencil task from the WAIS III that provides normed measures of
672 both motor and cognitive processing speed. The DSST has been widely used in studies of
673 physical and cognitive performance of older adults.

674
675 Patient Health Questionnaire (PHQ-9).(54) The PHQ-9 is the 9 item depression scale of the
676 Patient Health Questionnaire. It asks participants to describe how they have been feeling over the
677 past 2 weeks. It has been used successfully in older adults.

679 6.2.2 Baseline 2 Assessments

680 Individuals who are randomized to the second exercise session taught by the staff activity
681 personnel (or by the exercise leader if staff person not ready to lead it) will complete a second
682 baseline assessment prior to initiating the exercise class. This will be approximately 12 weeks
683 after the initial baseline assessment. Baseline 2 Assessment will be identical to Baseline testing.

684
685

686 6.2.3 Post-Intervention Assessment

687 At the completion of the 12 week exercise program, all participants will undergo a post-
688 intervention assessment. The assessment will include all measures from the baseline assessment
689 (LLFDI, 6MWT, gait speed, Gait Efficacy Scale, walking under challenging conditions
690 (challenging gait tasks and figure of 8 walk), gait variability, SPPB, DSST, PHQ-9. Post-
691 intervention testing will be completed at the sites (ILFs and senior housing sites) by research
692 personnel masked to the intervention group and trained in the testing procedures.

693
694 In addition, we will also assess participant satisfaction. Participant satisfaction will be assessed
695 using in-depth interviews and a satisfaction survey. In-depth phone interviews will be used to
696 assess satisfaction in a subsample of participants (approximately 20%). We will randomly select
697 a diverse sample of older adults representing the different intervention arms (On the Move,
698 Standard, exercise leader, activity staff personnel) and the different sites (ILF and senior
699 housing). We selected in-depth interviews instead of focus groups because we are more likely to
700 draw people out, they are less intimidated, and more likely to be truthful. The interview will be
701 developed by The Evaluation Institute under the direction of Dr. Edmund Ricci (Co-Investigator)
702 and with input from the other investigators and stakeholders (Community Advisory Board). The
703 interview will include a mixture of closed and open-ended questions. Sample topics to be
704 included in the interviews include perceived benefits and risks, satisfaction with the program,
705 facilities, and instructor, and amount of individualized instruction. The interview will be pilot
706 tested and modified accordingly prior to administration in the study. Pilot testing will ensure that
707 the questions are understandable to our target population and that we are obtaining the
708 information and feedback that we hope to obtain.

709
710 Satisfaction will also be assessed by surveys in all participants at the conclusion of the exercise
711 program. The satisfaction survey includes five items measured on a Likert scale and three yes/no
712 questions. The Likert items will assess degree of satisfaction with various components of the
713 exercise program (i.e. the exercises, instructor, music, space, and the overall program). We will
714 also use a series of yes/no questions to determine if the program has meet the participants'
715 expectations, if they feel they have benefited from the program, and if they would recommend
716 the program to others.

717
718

719 **7 SAFETY ASSESSMENTS**

720 **7.1 Expected Adverse Experiences**

- 721 1. Major risks such as a cardiac event or a fall are expected to be rare – expected to occur in
722 less than 1% of people (less than 1 out of 100 people).(55) Gardner et al, 2000,(55)
723 reviewed controlled clinical trials of exercise interventions for older adults at-risk for
724 falling. No cardiac events or falls were reported in the 12 clinical trials reviewed. The
725 at-risk older adults in the studies reviewed have slightly poorer physical performance
726 than the older persons we expect to recruit for our study. In our recent MOBILE study, a
727 1 year cohort study of 120 older adults participating in 3 clinic visits over a 1 year period
728 there were no cardiac events or falls reported. In all conditions of testing in which the

729 participant is standing and/or walking (eg conditions with a potential risk for falling), the
730 participant will be directly supervised by the trained tester. The trained tester is present
731 for all testing sessions. We expect this level of supervision reduces the risk of falling to
732 an even greater degree.

733 2. Less severe risks of participation such as such as muscle soreness, fatigue, or minor
734 sprains or strains with each assessment, are expected to be infrequent – expected to occur
735 in 1-10% of people (1-10 out of 100 people). Gardner et al, 2000,(55) reviewed
736 controlled clinical trials of exercise interventions for older adults at-risk for falling,
737 finding reports of such side effects of the intervention reported in only 4 of the 12 studies
738 reviewed. The side effects were not a reason for dropout from the study and were
739 described as soreness or musculoskeletal symptoms, but no injuries.

740 3. There is a rare risk that confidentiality could be breached. All of the research records
741 will be kept in a locked file cabinet and/or password protected files. All of the
742 investigators and staff that assist with the management of the files are trained in the
743 privacy and confidentiality regulations that govern research.

744

745 7.2 **Minimizing Risk during Assessments and Interventions.**

746 All assessments approved in this study are considered to be a part of everyday clinical practice.
747 We have minimized risks we believe by applying usual safeguards for the assessment of gait.
748 Assessment side effects, such as muscle soreness, fatigue, or minor sprains or strains with each
749 assessment, will be recorded by the physical therapist and monitored by Dr. Brach, the Principal
750 Investigators in consultation with the physician investigator, Dr. Nadkarni. Based upon the
751 existing literature and our own clinical experience, we anticipate the frequency of these side
752 effects to be extremely low.(55)

753 We will maximize the safety of our subjects with the following procedures.

- 754 1. Individuals with absolute contraindications to testing will be excluded based on the
755 inclusion/exclusion criteria.
- 756 2. Testing will be carefully monitored by trained testers and will be adjusted according to
757 the American College of Sports Medicine Guidelines for Exercise Testing and
758 Prescription.(34)
- 759 3. In all conditions of testing in which the participant is standing and/or walking (eg
760 conditions with a potential risk for falling), the participant will be directly supervised by
761 the trained tester.

762

763 7.3 **Confidentiality.**

764 Participant's confidentiality will be protected in the data collection process. All personnel
765 involved with the research have read and signed a Confidentiality statement, and approval is
766 being obtained from the University of Pittsburgh Biomedical Institutional Review Board.
767 Consent forms and data collection forms that identify the participant by name will be stored in a
768 locked cabinet. All computers are password protected. If the data are used in scholarly
769 presentations or journal articles, the investigators will protect the anonymity of individual

770 participants and will report only aggregate data (eg group means) where appropriate. The
771 Principal Investigator will review data confidentiality processes monthly or as indicated with the
772 project staff. The Investigators are all certified in Research Practice Fundamentals, Human
773 Subjects Research Module.

774

775 **7.4 Participant Education about Potential Risks**

776 Potential risks associated with study-related activities and interventions will be explained to each
777 participant by trained study personnel during the informed consent process. Each participant will
778 be instructed to report the occurrence of an AE to appropriate study staff at scheduled data
779 collection times, to PTs administering the intervention, or spontaneously at any other time.
780 Participants also will be encouraged to report concerns about the safety of participating in the
781 study to any research staff.

782

783 **7.5 Adverse Events and Serious Adverse Events**

784 If an adverse event occurs during testing or intervention, staff or activity personnel will assess
785 the situation and provide immediate assistance to the participant if necessary. If a medical
786 emergency should occur, staff will immediately contact 911. They will describe the incident to
787 the 911 operator and provide their location. They will also contact the facility director to make
788 them aware of the situation. In each testing/exercise space, we will post a copy of the emergency
789 plan which will include the number to call (911) and the address of the facility. All staff will be
790 informed of the emergency procedures prior to starting the interventions and they will be
791 reviewed every 6 months. Once the emergency situation is under control, the staff will contact
792 the study PI to notify them of the situation. The PI will report unexpected or adverse events in
793 accordance with the University of Pittsburgh IRB guidelines. As a group the PI and Co-Is
794 review the adverse events to determine if they are expected vs unexpected and serious vs not
795 serious. All events are reported to the irb who will also review the events. The study
796 coordinator (Ms. Betts), study biostatistician (Dr. Subashan Perera) and study physician (Dr.
797 Neelesh Nadkarni) who are unblinded will track the events to determine if there are an unequal
798 number of events between the groups.

799 A clinical complication form will be completed any time an incident (accident, injury, illness,
800 problems with medication, etc.) occurs or a subject reports an episode. Complications will be
801 categorized as study related, possibly study related, or not study related. Any complications that
802 are categorized as either study related or possibly study related will be reported to the IRB per
803 protocol if the event is an unexpected event, and/or is of serious or moderate to severe in nature
804 as defined by the IRB. A separate clinical complication form will be completed for each incident
805 that may occur in each subject. The form will be kept in the subject's research record.

806

807 7.5.1 Classifying Adverse Events (AE)

808 An AE is any unfavorable or unintended medical occurrence in a human study participant that
809 has taken place during the course of a research project, including any abnormal sign, symptom,
810 or disease, whether or not related to participation in the research.

811
812 For the purposes of this study, any event that meets the criteria for a severe adverse event (SAE),
813 is unexpected, or results in injury to the participant while he/she is under the supervision of study
814 related personnel will be classified as a reportable adverse event (RAE). Adequate review,
815 assessment, and monitoring of RAEs require they be classified as to severity, expectedness, and
816 potential relatedness to the study intervention.

817

818 7.5.2 Severity

819 The following guidelines will be used to determine level of severity:

820

821 Mild: Awareness of signs and symptoms, but easily tolerated and causing no loss of time from
822 normal activities. No specific medical attention is required.

823

824 Moderate: Discomfort enough to cause a low level of inconvenience or concern to the participant
825 and may interfere with daily activities. Symptoms may require minimal, local or noninvasive
826 medical intervention.

827

828 Severe: Events interrupt the participant's normal daily activities and are usually incapacitating.
829 Significant symptoms may require hospitalization or invasive medical intervention.

830

831 Life-threatening/Disabling: Events that may involve acute, life-threatening metabolic or
832 cardiovascular complications (such as circulatory failure, hemorrhage, sepsis) or life –
833 threatening physiological consequences. Intensive care or emergent invasive procedure is
834 required.

835

836 Death: Causing death.

837

838 Severity is not synonymous with seriousness. A severe headache is not necessarily an RAE.
839 However, mild chest pain may result in a day's hospitalization and thus would be classified as a
840 RAE.

841

842 7.5.3 Expectedness

843 AEs will be assigned as to whether they were expected or unexpected based on current
844 knowledge. Categories are defined as follows:

845

846 Expected: An AE that is anticipated on the basis of prior experience with the intervention under
847 investigation; an event that can be attributed to the underlying condition of the participant being
848 studied; or an event that can be attributed to the patient population being studied (see section---
849 Expected AEs). Expected AEs are captured in a standardized way by study personnel.

850

851 Unexpected: An AE that was not anticipated on the basis of prior experience with the underlying
852 intervention under investigation; an event that can be attributed to the underlying condition of the
853 participant being studied; or to the patient population being studied or an expected event whose
854 frequency or severity exceeds what is anticipated. Unexpected events are reportable.
855

856 7.5.4 Relatedness

857 The PI in consultation with the Co-Investigators and an independent safety monitor will
858 determine the degree to which RAEs are related to study procedures using the criteria below.
859

860 Definitely related: The adverse event is clearly related to the investigational procedure – i.e., an
861 event that follows a reasonable temporal sequence from administration of the study intervention,
862 follows a known or expected pattern of response to the study intervention, that is confirmed by
863 improvement on stopping and reappearance of the event on repeated exposure, and that could not
864 be reasonably explained by the known characteristics of the participant’s clinical state.
865

866 Possibly related: An adverse event that follows a reasonable temporal sequence from
867 administration of the study intervention of that follows a known or expected pattern of response
868 to the study intervention, but that could readily have been produced by a number of other factors.
869

870 Unrelated: The adverse event is clearly not related to the investigational procedure (i.e. another
871 cause of the event is most plausible; and/or a clinically plausible temporal sequence is
872 inconsistent with the onset of the event and the study intervention and/or a causal relationship is
873 considered biologically implausible).
874

875 7.6 Expected AEs

876 Expected adverse events (AEs) will be captured through interviews at 12, 24 and 36 weeks,
877 based on the Health Status Update questionnaire. The following are expected adverse events that
878 have been listed in the informed consent form:

- 879 • Muscle soreness
- 880 • Fatigue
- 881 • Chest pain
- 882 • Breathing problems
- 883 • Cardiac event
- 884 • Fall (with or without injury)
- 885

886 7.7 Reportable AEs (RAEs)

887 Reportable AEs are events that have potential implications for participant safety and that require
888 individual reporting. RAEs will be defined as events that fall into at least one of the following
889 categories:

- 890 1. Serious adverse event (SAEs) - SAEs will be defined as any adverse event that results in
891 death, is life threatening, or places the participant at immediate risk of death from the
892 event as it occurred, requires or prolongs hospitalization, causes persistent or significant

893 disability or incapacity, results in congenital abnormalities or birth defects, or is another
894 condition which investigators judge to represent significant hazards.
895 2. Unexpected AEs - An unexpected AE is defined as medical events that occur during
896 study participation, but do not commonly occur in the study population and which are not
897 listed in the informed consent document or study protocol.
898 3. AEs related or possibly related to the research intervention – defined as any AE which in
899 the opinion of the principal investigator, the incident, experience or outcome more likely
900 than not was caused by the procedures involved in the research.
901
902 Events that cannot be clearly defined as “reportable” will be discussed with the study physician
903 and the PI to determine if they should be reported. All reportable events will be captured on an
904 Adverse Event form which will be filed in the participant binder and then reported using the
905 following guidelines.

906

907 **7.8 Reporting of Events**

908 The study PI has primary responsibility for the safety of participants as it relates to the study
909 protocol. The study coordinator will be responsible for reviewing adverse events and assuring
910 accurate and timely reporting of the adverse events. The co-investigators (including study
911 physician) will review, evaluate and classify adverse events and provide follow-up for events
912 until they are resolved. The PI will be responsible for reporting study-defined AEs and SAEs to
913 the University of Pittsburgh institutional review board (IRB) according to their timeline and
914 format.

915

916 **8 INTERVENTION DISCONTINUATION**

917 **8.1 Interruption to Exercise Participation**

918 Attendance will be taken at all exercise session and will be documented on the attendance sheet.
919 Participants who miss three consecutive classes will be contacted by phone to determine the
920 reason for the absences. Participants who miss three or more consecutive classes due to illness
921 or injury will be required to obtain medical clearance from their physician prior to returning to
922 the exercise class. Participants who miss three consecutive classes for other reasons (vacation, ill
923 spouse, caregiving responsibilities, transportation etc.) will be encouraged to attend as many
924 classes as possible.

925

926 **8.2 Intervention Discontinuation**

927

928 At any time, the study team may recommend discontinuation of any component of the
929 intervention or intervention group of the study for any of the following reasons:

- 930 1. Compelling evidence from this or any other study of an adverse effect of the study
931 intervention(s) that is sufficient to override the potential benefit of the interventions to the
932 target population
- 933 2. Compelling evidence from this or any other study of a significant beneficial effect of the
934 study intervention(s), such that it is continued denial to other study group(s) would be
935 unethical
- 936 3. A very low probability of addressing the study goals within a feasible timeframe.
937

938 The research team may decide at any time to remove a participant from the research study if the
939 team feels the participant is unsafe to continue. Participation in the research study will be
940 discontinued if a participant's walking ability worsens; for example, if a subject who has
941 osteoarthritis of the knees exhibits a significant increase in pain that negatively affects their
942 walking ability. Participants can be removed from the study if they have unstable vital signs as a
943 response to exercise. A participant can also be removed from the study if any new medical
944 condition, injury or illness is discovered during the course of treatment that would make the
945 participant unsafe to continue.
946

947 The research team may decide at any time to discontinue training of a staff activity person if the
948 teams feels the staff activity person is unsafe to continue. If training of a staff activity person is
949 discontinued, an exercise leader will take over as instructor for the exercise class to keep our
950 obligation of the exercise class to the community. If such a change becomes necessary after the
951 class has begun, we will exclude that particular class from all analyses. If such a change
952 becomes apparent before the class begins, and the entire class is taught by an exercise leader, we
953 will include the class in Aim 1 analysis.
954
955
956

957 8.3 Voluntary Participation

958 The participants' participation in this research study is completely voluntary. The participant
959 may withdraw, at any time, their consent for participation in this research study. Any
960 identifiable research information recorded for, or resulting from, their participation in this
961 research study prior to the date that they formally withdrew their consent may continue to be
962 used and disclosed by the investigators. To formally withdraw consent for participation in this
963 research study the participant should provide a written and dated notice of this decision to the
964 principal investigator of this research study. If the participant withdraws from the intervention,
965 study staff will ask permission to continue to follow the participant for follow-up assessment. If
966 participation is discontinued for medical reasons and the participant is unable to complete the
967 performance-based testing, all attempts will be made to obtain the self-reported outcomes.
968

969

970 9 STATISTICAL CONSIDERATIONS

971 9.1 **General Design Issues**

972 A randomized trial is needed to control for confounding factors that affect the outcome. There
973 are no ethical issues regarding a randomized trial since both groups will be receiving an active
974 exercise intervention delivered by trained personnel. We carefully considered the advantages and
975 disadvantages of randomizing at the level of the facility and the resident. Given the amount of
976 interaction that occurs between subjects within a facility, it is imperative that we conduct a
977 cluster randomized trial, and randomize by facility to exercise programs. If we randomize at the
978 resident, participants would discuss details of their intervention and cause cross-contamination
979 between the intervention arms. Unlike a traditional trial in which participants are randomized as
980 they are being recruited, a cluster randomized trial also affords the additional benefit of
981 examining the facility characteristics such as type (independent living/senior high rise) and size,
982 and ensuring a balance in those characteristics is achieved by design rather than chance. Once the
983 facilities are randomized to exercise program, we will then randomize within facility for
984 delivery mode (i.e. subjects will be randomized to either an exercise leader or staff activity
985 person led exercise program). Randomization for delivery mode will occur after baseline testing.
986 We will use a commercially available high quality pseudo-random deviate generator such as that
987 available in SAS® (SAS Institute, Inc., Cary, North Carolina) known to be free of serial
988 correlations(56) to randomize facilities to the two arms in a 1:1 ratio, stratified by facility type.
989 In addition, the proposed design reaps the advantages of a paired comparison for the exploratory
990 hypothesis (Aim 2) as both exercise leaders and staff activity personnel will be delivering On the
991 Move in the same set of facilities, where feasible to train a staff person ready to lead the class
992 safely and per protocol.

993
994 The main outcomes are self-reported function and disability (Late Life Function and Disability
995 Index/LLFDI) and walking ability (6-minute walk test/6MWT and gait speed). We will also
996 examine satisfaction, attendance rates and adverse event (falls, soft tissue injuries, muscle
997 soreness, etc) rates.

998 9.2 **Sample Size**

999 We base our sample size justification on prior data from our RESTORE and PRIME pilot
1000 studies, two-tailed tests conducted at the $\alpha=0.05$ level, a conservative attrition rate of 10%
1001 between baseline and follow-up assessments, practical consideration of a class size of 10
1002 participants for group exercise, computational techniques that match our study design and
1003 proposed analytical approach as much as possible within the constraints of already published
1004 methodologies and commercially available sample size and power software (PASS 2002®,
1005 Number Cruncher Statistical Systems, Inc., Kayesville, Utah), and ability to detect differences
1006 that correspond to published meaningful change criteria(57) or moderate Cohen's effect sizes of
1007 $d=0.5$.(58)

1008 The numbers needed to enroll in order to detect statistical significance of intervention effect
1009 when delivered by an exercise leader (Aim 1), are presented in **Table 1**. We take into account
1010 the clustering of participants by facility by assuming an intracluster correlation of 0.1 and a
1011 resulting design effect of 1.90 to appropriately inflate the sample size accordingly.(59) In

1012 summary, a total of 280 participants with 140 in each arm will allow us to detect statistical
 1013 significance in intervention effects in all main outcomes with at least 80% statistical power.

1014

1015 **Table 1. Number needed to enroll for detecting effects of intervention incorporating**
 1016 **clustered design (x1.90), attrition (10%), and rounded up to class size of 10.**

| Outcome | Prior Information | | | Estimated Sample Size | |
|----------------------------|----------------------------------|---------------------------------|---|--|---------------------------------|
| | Baseline Standard Deviation (SD) | SD in Baseline-Follow up Change | Meaningful Difference Targeted (Source) | Completers Needed Per Arm assuming No Clustering | Number Needed to Enroll Per Arm |
| LLFDI Overall Function | 6.15 | 4.86 | 3.08 ($d=0.5$) | 41 | 90 |
| LLFDI Disability Frequency | 6.35 | 4.76 | 3.18 ($d=0.5$) | 37 | 80 |
| Gait Speed (m/s) | 0.13 | 0.20 | 0.10 ⁶⁵ | 64 | 140 |
| 6MWD (m) | 62.0 | 42.8 | 50 ⁶⁵ | 13 | 30 |

1017

1018 Our sustainability Aim 2 depends on whether we are able to train a staff activity person ready to
 1019 lead a class safely and per protocol. Further, we do not have a priori data in sufficient detail that
 1020 allows us to reliably estimate the likelihood of suitably training a staff activity person in each of
 1021 the main types of facility. Thus Aim 2 is exploratory in nature and we will also focus on barriers
 1022 to suitably training a staff activity person. We anticipate that we will enroll approximately 120
 1023 participants into Aim 2. The power available to detect a statistically significant difference in gains
 1024 attributable to *On the Move* when delivered by exercise leaders and staff activity personnel
 1025 (sustainability hypothesis – Aim 2) are in **Table 4**. Power is $\geq 90\%$ for all outcomes except for
 1026 gait speed when comparing *On the Move* to Standard when delivered by facility staff in which
 1027 case power is 78%.

1028

1029 **Table 4. Number needed to enroll for establishing sustainability of *On the Move*, incorporating clustered design**
 1030 **(x0.90), attrition (10%), and rounded up to class size of 10.**

| Outcome | Prior Information | | | Estimated Sample Size | | New Aim 2 Statistical Power with Anticipated N=140+140+60+60 | |
|----------------------------|----------------------------------|---------------------------------|---|---|---------------------------------|---|---|
| | Baseline Standard Deviation (SD) | SD in Baseline-Follow up Change | Meaningful Difference Targeted (Source) | <u>Completers</u> Needed Per Arm assuming No Clustering | Number Needed to Enroll Per Arm | Facility Staff as Good as Exercise Leader in Delivering OTM? N=140 vs 60 | OTM More Effective than Standard Even when Delivered by Facility Staff? N=60 vs 60 |
| LLFDI Overall Function | 6.15 | 4.86 | 3.08 ($d=0.5$) | 66 | 70 | 98% | 93% |
| LLFDI Disability Frequency | 6.35 | 4.76 | 3.18 ($d=0.5$) | 60 | 60 | 99% | 95% |
| Gait Speed (m/s) | 0.13 | 0.20 | 0.10 ⁶⁵ | 105 | 110 | 90% | 78% |
| 6MWD (m) | 62.0 | 42.8 | 50 ⁶⁵ | 21 | 30 | >99% | >99% |

1031
 1032
 1033

1034
1035
1036

1037 9.3 Data Analyses

1038 9.3.1 Overview

1039 All statistical analyses will be performed or overseen by Dr. Perera using SAS[®] version 9 (SAS
1040 Institute, Inc., Cary, North Carolina) and Salford Predictive Miner[®] (Salford Systems, Inc., San
1041 Diego, California) based on the **intention-to-treat** philosophy. We will begin by summarizing
1042 data by arm and time point as well as pre- to post-intervention change using appropriate
1043 descriptive statistics for continuous (mean, standard deviation, median, range) and categorical
1044 (frequencies, percentages) to elicit information about general data quality and their distributional
1045 characteristics. Next, we will perform the modeling and inferential analyses to address the main
1046 hypotheses. First, the baseline participant characteristics will be compared between the two arms
1047 (see Avoidance of Bias below). Although no significant differences are expected, any significant
1048 differences will be noted and accounted for as covariates in the main analyses. Second, main
1049 analyses to address Aims 1-3 will be performed as outlined below. If residuals reveal violations
1050 of linear models assumptions, we will Box-Cox transform(60) the response variables. The two-
1051 step protected test approach will be used to control the experimentwise type I error rate from
1052 multiple outcomes, and multiple imputation(61, 62) will be used to account for any missing data
1053 in the main analysis. Third, we will perform the exploratory analyses to address Aim 4, using a
1054 data mining philosophy. Finally, we will perform a set of exploratory analyses to potentially
1055 extend our findings and generate new hypotheses, as well as a set of sensitivity analyses to assess
1056 the robustness of our findings.

1057 9.3.2 Main Analysis for Aims 1 and 3a

1058 Aim1:

1059 First, we will perform a multivariate Hotelling *t*-test to simultaneously compare the baseline to
1060 follow-up change in the three primary outcomes between the arms to protect the type I error rate
1061 from multiplicity. If significant, subsequent analyses will be performed without further
1062 multiplicity adjustment. If not, subsequent comparisons will be performed with a conservative
1063 Bonferroni correction at the $\alpha=0.05/4=0.0125$ level. This protected test approach has been
1064 recommended in the statistical literature(63) and used in other exercise intervention trials with
1065 multiple outcomes.(64)

1066 Second, we will fit a series of linear mixed models(65) using the SAS[®] MIXED procedure with
1067 baseline to follow-up change in each of the continuous outcomes (LLFDI function/disability,
1068 walking ability, other measures of mobility performance) as the dependent variable; intervention
1069 arm (standard/*On the Move*), as the fixed effect of primary interest; baseline value of outcome as
1070 an additional fixed effect covariate; and a facility random effect to account for greater similarity
1071 of participants from the same facility compared to different facilities and resulting non-
1072 independence of observations within facility (ie. clustering). We will construct appropriate
1073 means contrasts to estimate difference in gains in the two interventions when delivered by
1074 exercise leaders (Aim 1) whose statistical significance of the estimates will serve as formal tests
1075 of hypotheses. We will consider adding other baseline measures found to be significantly

1076 different between the arms or deemed important as additional fixed effect covariates in the model
1077 to assess robustness of the findings. We note that waiting of participants randomized to staff
1078 activity personnel classes constitute a group of control participants, if smaller, without any
1079 intervention. Therefore, we will perform another sensitivity analysis employing a similar
1080 analytic strategy but with three intervention arms (*On the Move*/Standard/Wait List Control).

1081

1082 Aim 3(a):

1083 We will fit a series of generalized estimating equations (GEE) models(66) using the SAS[®]
1084 GENMOD procedure with each of the dichotomous adverse events, adherence (21+ sessions or
1085 $\geq 90\%$) and satisfaction outcomes as the dependent variable; a binomial distribution for the
1086 outcome and a logit canonical link function; intervention arm, as the effect of primary interest;
1087 baseline value of outcome and any other measures found to be different between arms or deemed
1088 important as additional fixed effects covariates; and an exchangeable working correlation
1089 structure to account for clustering due to facility. We will appropriately construct contrasts to
1090 test hypotheses of differential proportions with adverse events based on intervention when
1091 delivered by exercise leaders.

1092 9.3.3 Aims 2, 3(b) and 4 exploratory Analyses

1093 Aim 2:

1094

1095 We propose an analytic strategy with an exploratory philosophy for Aim 2 sustainability aim,
1096 because of the uncertainty surrounding our ability to recruit and train a staff activity person to
1097 lead a class safely and per protocol.

1098

1099 We will fit a series of linear mixed models⁶³ using the SAS[®] MIXED procedure with baseline to
1100 follow-up change in each of the continuous outcomes (LLFDI function/disability, walking
1101 ability, other measures of mobility performance) as the dependent variable; intervention arm
1102 (standard/*On the Move*), delivery mode (by exercise leader/staff activity personnel) and their
1103 interaction as fixed effects of interest; baseline value of outcome and any other measures found
1104 to be different between arms or deemed important as additional fixed effects covariates; and a
1105 facility random effect to account for greater similarity of participants from the same facility
1106 compared to different facilities and resulting non-independence of observations within facility
1107 (ie. clustering). We will construct appropriate means contrasts to estimate difference in gains in
1108 the two interventions when delivered by staff exercise personnel (Aim 2 effectiveness
1109 hypothesis); and difference in gains attributable to *On the Move* intervention when delivered by
1110 exercise leaders and staff activity personnel (Aim 2 sustainability hypothesis). Statistical
1111 significance of the estimates will serve as formal tests hypotheses. We note that participants
1112 randomized to staff activity personnel had to wait 12 weeks since their baseline assessment and
1113 randomization to start the intervention, during which they may have changed; and that they
1114 underwent a second baseline assessment immediately prior to starting the exercise intervention.
1115 Therefore, we will repeat the above analysis using their second baseline assessment instead of
1116 the first one to assess the sensitivity of results.

1117

1118 Aim 3(b):

1119 will fit a series of generalized estimating equations (GEE) models⁶⁴ using the SAS[®] GENMOD
1120 procedure with each of the dichotomous adverse events, adherence (21+ sessions or $\geq 90\%$) and
1121 satisfaction outcomes as the dependent variable; a binomial distribution for the outcome and a
1122 logit canonical link function; intervention arm, delivery model and their interaction as effects of
1123 interest; baseline value of outcome and any other measures found to be different between arms or
1124 deemed important as additional fixed effects covariates; and an exchangeable working
1125 correlation structure to account for clustering due to facility. We will appropriately construct
1126 contrasts to test hypotheses of differential proportions with adverse events based on intervention
1127 when delivered by staff activity personnel and delivery mode.

1128

1129 Aim 4:

1130 We will perform the exploratory analyses to identify combinations of baseline predictors of
1131 treatment response and risks of participating in *On the Move* program. We do not anticipate
1132 differences in outcomes of *On the Move* program based on delivery mode when a suitable staff
1133 person can be trained (Exploratory sustainability Aim 2), and thus propose to combine *On the*
1134 *Move* groups led by exercise leaders and staff activity personnel in the present analysis to
1135 maximize sample size and amount of information available for this analysis. In the unlikely
1136 event of differences due to delivery mode, we will stratify the Aim 4 analysis by delivery mode.

1137

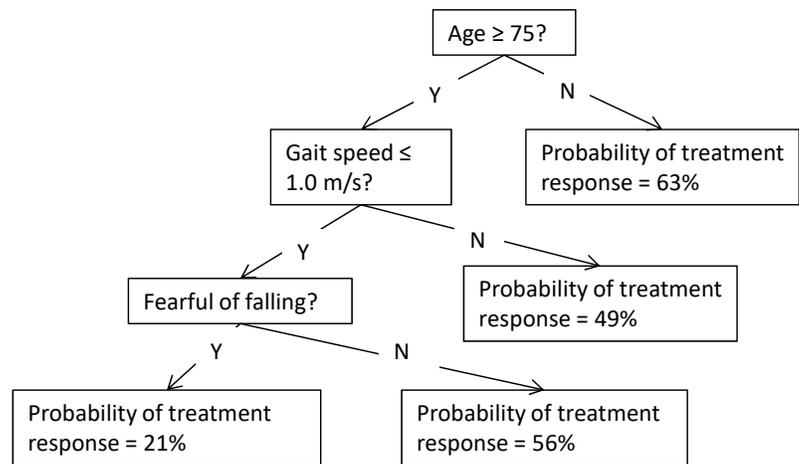
1138 Adverse events and markers of response to treatment in walking ability have readily available
1139 dichotomous operational definitions based on simply presence/absence of an event or evidenced
1140 based criteria for having achieved meaningful change in gait speed (0.1+ m/s) and 6MWT
1141 (50m).(57) For such dichotomous markers of benefit and harm, we will fit a series of logistic
1142 regression models using the SAS[®] LOGISTIC procedure and classification tree models(67, 68)
1143 using Salford Predictive Miner[®] software with each measure of whether there was a benefit/harm
1144 from *On the Move* as the dichotomous response variable; and baseline physical, psychosocial and
1145 demographic characteristics as predictors. Logistic regression models are more efficient when
1146 associations are linear, and hard-to-discover higher order interactions and non-linearity and/or
1147 multicollinearities among predictors do not exist, while classification tree models are more
1148 efficient when they do exist. In terms of practically applying prediction criteria, results from
1149 logistic regression models require substituting values of predictors to a regression equation while
1150 classification tree model produces a flowchart that can be used as is in a clinical setting when a
1151 new individual is presented with known predictors. Thus we will use both methods to obtain
1152 areas under the receiver operator characteristic curve (AUROCC) to quantify predictive
1153 accuracy, and use the results from the method with a greater AUROCC. If the AUROCCs are not
1154 substantially different, we will favor the classification tree results due to ease of interpretation
1155 and utility in the clinical setting (see **Figure 2** for a hypothetical template for summarization of
1156 results). For logistic regression modeling, we will include all available baseline information
1157 simultaneously in the model as predictors, and use the backward elimination stepwise procedure
1158 to guard against model over-fitting to obtain a parsimonious model with a small number of most
1159 relevant predictors to facilitate interpretation, communication and clinical utility of the model.
1160 For the classification tree models, we will use all predictors available and use a minimum
1161 misclassification-complexity cost tree to achieve the same objectives. We will use the method of
1162 DeLong(69) to obtain the statistical significance of the improvement in predictive accuracy, as
1163 measured by AUROCC.

1164 Our LLFDI function and disability outcomes do not have the same level of evidence based for
 1165 creating intuitively appealing dichotomous measures of treatment response. Thus we will
 1166 consider pre- to post-intervention change as a continuous variable, and perform analogous
 1167 analysis to that for dichotomous outcomes but with appropriate statistical models. Specifically,
 1168 we will fit standard multiple linear regression models using the SAS[®] REG procedure and
 1169 regression tree models(67, 68) using Salford Predictive Miner[®]; and use proportion of explained
 1170 variance (R^2) to quantify predictive accuracy.

1171 9.3.4 Additional
 1172 Exploratory/Sensitivity
 1173 and
 1174 Compliance/Dropout
 1175 Analyses

Figure 2. Hypothetical template for summarization of Aim 4 results.

Figure 1. Predictors of treatment response using age, gait speed, and fear of falling. Area under ROC curve=0.797



1176 We will perform additional
 1177 analyses to extend our
 1178 findings, generate new
 1179 hypotheses, assess robustness
 1180 and potentially refine
 1181 conclusions. They will
 1182 include using an alternative
 1183 threshold besides 90% to
 1184 operationally define high level
 1185 of adherence/compliance
 1186 calculating proportion missing
 1187 each session to describe the
 1188 pattern of
 1189 adherence/compliance over
 1190 time; assessing intervention effects using as-treated instead of intention-to-treat philosophy; and
 1191 alternative operational definitions of treatment response such as combinations of walking ability,
 1192 function and/or disability, and reaching a published threshold such as 0.4(0.8) m/s in gait speed
 1193 for limited(full) community ambulation.(70)

1194

1195 **10 DATA COLLECTION AND QUALITY ASSURANCE**

1196 **10.1 Data Collection Forms**

1197 Data collection will consist of paper forms. Data collected on paper forms will be entered into
 1198 the electronic database by the research staff.

1199

1200 Screening and baseline data collection, which will occur prior to randomization, will be
 1201 conducted by research staff trained in the outcomes and may include the study coordinator if
 1202 necessary. Outcome assessments post-intervention will only be conducted by research staff
 1203 trained in the outcomes and who are blinded to the intervention group assignment.

1204

1205 Participants' confidentiality will be protected in the data collection process. All study personnel
1206 are certified in Research Practice Fundamentals, Human Subjects Research Module. Consent
1207 forms and paper data collection forms will be stored in locked file cabinets. All computers are
1208 password protected. Only authorized team members will have access to personal information
1209 needed for tracking and informed consent.

1210

1211 10.2 Data Management

1212 An electronic tracking system will monitor enrollment, track follow-up rates and the data entry
1213 process, providing up-to-date status reports. All completed data collection forms will be entered
1214 into a secure relational database located in a local network, and stored in a secure location. To
1215 improve accuracy, the data entry screens are identical in appearance to the paper forms. The data
1216 entry system includes automatic and routine data quality checks for out-of-range and extreme
1217 values, and automatic enforcement of skip patterns. In addition, functionality will be built in to
1218 the data entry system to facilitate double data entry and comparison of two versions so that
1219 discrepancies can be resolved against the authoritative paper forms. All screened subjects will be
1220 assigned unique subject identifiers that will appear on all data collection forms and files and
1221 serve as an index in database tables. The database will have access restricted to only those study
1222 personnel who need it and the level of access (read/write) will depend on the specific role. All
1223 files will be backed-up daily and archived weekly, including storage of back-up copies in an off-
1224 site location.

1225

1226 10.3 Quality Assurance

1227 10.3.1 Intervention

1228 Program monitoring: Periodically throughout the exercise program we will be videotaping the
1229 exercise sessions. These videos will be used primarily to monitor the quality and consistency of
1230 the exercise program and to further develop the training manual for the exercise instructors. The
1231 videos may be used to train future exercise instructors.

1232

1233 At each session, the exercise leaders and activity staff personnel will complete the exercise class
1234 log (see 9.3 above). Dr. VanSwearingen will review the exercise logs monthly to make sure the
1235 interventionists are following the protocol and progressing the exercise class appropriately. If
1236 deficiencies are noted, we will review the program with the interventionist and discuss potential
1237 modifications to the administration of the program.

1238

1239 10.3.2 Protocol Deviation Tracking

1240 Protocol deviations may occur in the randomization process, exercise intervention protocols, the
1241 timing or completion of testing sessions, and in the completion of data forms. A Protocol
1242 Deviation Form has been developed for the study and will be completed, dated, and signed for
1243 each protocol deviation that may occur for each subject. This form will be kept in a folder for

1244 protocol deviations. The protocol deviation will also be noted in the progress section of the
1245 subject's research record.

1246

1247 10.3.3 Subject Termination

1248 If subject participation in the study is terminated for any reason (death, self-withdrawal, lost-to-
1249 follow-up, or change in health) a Study Termination form will be completed by the trial
1250 coordinator and placed in the subject's research record.

1251

1252 **11 PARTICIPANT RIGHTS AND CONFIDENTIALITY**

1253 11.1 Institutional Review Board (IRB) Review

1254 The study protocol, the informed consent document and any subsequent modifications will be
1255 reviewed and approved by the University of Pittsburgh IRB.

1256 11.2 Informed Consent Forms

1257 All potential participants will be adults (65 years of age or older) who are capable of providing
1258 direct consent for their participation in the study. Written informed consent will be obtained at
1259 the clinic screening visit prior to performing any of the clinic screening procedures. One of the
1260 study investigators will explain the study and the participant will be given a copy of the consent
1261 form to read. The consent form will describe the purpose of the study, the procedures to be
1262 followed, and the risks and benefits of participation. The investigator will answer any questions
1263 that the participant may have about the study. Finally, the participant will be asked to sign and
1264 date the consent form. The participant will be given a copy of the consent form for their records.

1265 11.3 Participant Confidentiality

1266 Research assessments and interventions are conducted in the community/activities room. This
1267 space includes several small tables in different portions of the room that can be used to privately
1268 conduct questionnaires and simple physical examination measures. Many of the walking
1269 assessments are done in the open area. Participants may be screened individually, which further
1270 protects their privacy. Participants are informed via the consent process that the treatment
1271 programs are conducted in groups. Although not completely private, this level of exposure to
1272 others during exercise is similar to what one might experience at a physical therapy appointment
1273 or during an exercise class at a public gym.

1274
1275 Participant's confidentiality will be protected in the data collection process. All personnel
1276 involved with the research have read and signed a Confidentiality statement. All study related
1277 data will be maintained in secure locked hard copy files and password protected computer files.
1278 To facilitate referring to our older adult subjects by name throughout all testing sessions and to
1279 minimize errors that could occur while multiple testers collect data on multiple participants in the
1280 same research space at the same time, data sets will not be de-identified. Subjects' names and
1281 emergency contact information will be maintained in both the hard copy and computer files, and
1282 subjects will be made aware of this during the informed consent process.

1283
 1284 If data are used in scholarly presentations or journal articles, the investigators will protect the
 1285 anonymity of individual participants and will report only aggregate data (eg group means) where
 1286 appropriate. The Principal Investigator will review data confidentiality process monthly or as
 1287 indicated with the research staff. The Investigators are all certified in Research Practice
 1288 Fundamentals, Human Subjects Research Module.
 1289

1290 **11.4 Study Discontinuation**

1291 The study may be discontinued at any time by the IRB, the NIA, the OHRP, or other government
 1292 agencies as part of their duties to ensure that research participants are protected.

1293 **12 STUDY TIMELINE**

1294 In this three year project we will conduct a single-blind cluster randomized intervention trial.
 1295 The trial will be conducted in at least 28 facilities (ILFs and Senior High Rises) and will include
 1296 280 community-dwelling older adults for Aim 1 and up to 280 community-dwelling older adults
 1297 for Aim 2. We will attempt to train 28 staff activity personnel and will conduct 56, 12 week
 1298 group exercise sessions. The table below contains the timeline for all research activities.

Table - Project Timeline.

| Research Activity | Year 1 | | | | Year 2 | | | | Year 3 | | | |
|---|--------|---|---|---|--------|---|---|---|--------|---|---|---|
| Hire and train research staff | X | X | | | | | | | | | | |
| Develop manual of operations | X | X | | | | | | | | | | |
| Assemble Advisory Board | X | | | | | | | | | | | |
| Train staff activity personnel | | | X | X | X | X | X | X | | | | |
| Finalize data collection forms | X | X | | | | | | | | | | |
| Construct database | | X | X | | | | | | | | | |
| Recruitment | | | X | X | X | X | X | X | X | X | | |
| Baseline testing | | | X | X | X | X | X | X | X | X | | |
| Conduct exercise programs | | | | X | X | X | X | X | X | X | | |
| Post testing | | | | X | X | X | X | X | X | X | X | |
| In-depth satisfaction interviews | | | | X | X | X | X | X | X | X | | |
| In-depth interviews of Community Advisory Board | | | | | X | X | | | | | | |
| Data entry | | | | X | X | X | X | X | X | X | X | |
| Analysis | | | | | | | | | | X | X | X |
| Review and interpret results | | | | | | | | | | X | X | X |
| Dissemination | | | | | | | | | | | | X |

| | | | | | | | | | | | | |
|--------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Meetings | | | | | | | | | | | | |
| Advisory Board meetings | X | | X | | X | | X | | X | | X | |
| Research staff | X | X | X | X | X | X | X | X | X | X | X | X |
| Data Safety Monitoring Meeting | | X | | | | X | | | | X | | |

1299

1300

1301 **Year 1**

1302 In the first 6 months of funding, we will hire and train research staff, develop the manual of
 1303 operations, assemble to Advisory Board, finalize the data collection forms, and construct the
 1304 database. In the second 6 months of Year 1 we will initiate recruitment and baseline testing of
 1305 research subjects. The group exercise programs will begin in a minimum of 4 facilities in
 1306 months 10-12 of Year 1. The deliverables for Year 1 are outlined in the milestone schedule.

1307

1308 **Year 2**

1309 At the beginning of Year 2 we will conduct the in-depth interviews of the Community Advisory
 1310 Board members. The majority of the group exercises classes will be conducted in Year 2. We
 1311 will continue to train the staff activity personnel (months 1-9 Year 2) as we include additional
 1312 facilities in the research study. Our goal is that every quarter we would introduce the exercise
 1313 program to 6 facilities and train the staff activity personnel to conduct the exercise program. In
 1314 Year 2 we will recruit subjects to participate, baseline test the subjects, conduct the 12 week
 1315 exercise program, and conduct the post testing. By the end of year 2, we will have trained 24
 1316 staff activity personnel to conduct the exercise program and completed forty-eight 12 week
 1317 exercise sessions within 24 facilities. The deliverables for Year 2 are outlined in the milestone
 1318 schedule.

1319

1320 **Year 3**

1321 In Year three we will complete subject recruitment and the exercise group sessions and complete
 1322 all post testing. The second six months of Year 3 will be dedicated to data entry, data analysis,
 1323 review and interpretation of results and dissemination of research findings. See the milestone
 1324 schedule for Year 3 deliverables.

1325

1326 **13 PUBLICATION OF RESEARCH FINDINGS**

1327 Publications will be operationally defined as manuscripts for publications; abstracts for platform
 1328 or poster presentation at scientific meetings and other professional meetings; slides for
 1329 presentation at scientific and other meetings; doctoral dissertations; and master’s theses.

1330

1331 The goal of the publication policy is to encourage and facilitate publication of study results. The
 1332 purposes of this policy are to ensure the following:

- 1333 • On the Move publications will be of the highest scientific quality
- 1334 • On the Move will be described in a consistent manner across publications
- 1335 • Measures are reported in consistent ways across publications
- 1336 • Proper acknowledgements are included
- 1337 • Appropriate authorship credit is determined prior to submission of manuscripts for
- 1338 publication consideration.

1339

1340 Publications from On the Move will be overseen by the PI and Co-Investigators.

1341

1342 **14 REFERENCES**

1343 1. Guralnik J, Ferrucci L, Simonsick E, Salive M, Wallace R. Lower extremity function in
 1344 persons over the age of 70 years as a predictor of subsequent disability. *New Engl J Med.*
 1345 1995;332:556-61.

1346 2. Cesari M, Kritchevsky S, Bauer D, Visser M, Rubin S, Harris T, et al. Prognostic value
 1347 of usual gait speed in well-functioning older people--results from the Health, Aging and
 1348 Body Composition Study. *J Am Geriatr Soc.* 2005;53:1675-80.

1349 3. Guralnik J, Ferrucci L, Pieper C, Leveille S, Markides K, Ostir G, et al. Lower extremity
 1350 function and subsequent disability: consistency across studies, predictive models, and
 1351 value of gait speed alone compared with the short physical performance battery. *J*
 1352 *Gerontol Med Sci.* 2000;55A:M221-M31.

1353 4. Guralnik J, Simonsick E, Ferrucci L, Glynn R, Berkman L, Blazer D, et al. A short
 1354 physical performance battery assessing lower extremity function: Association with self-
 1355 reported disability and prediction of mortality and nursing home admission. *J Gerontol.*
 1356 1994;49:M85-M94.

1357 5. Studenski S, Perera S, Patel K, Rosano C, Faulkner K, Inzitari M, et al. Gait speed and
 1358 survival in older adults. *JAMA.* 2011;305(1):50-8.

1359 6. Fried L, Bandeen-Roche K, Chaves P, Johnson B. Preclinical Mobility Disability Predicts
 1360 Incident Mobility Disability in Older Women. *Journal of Gerontology.*
 1361 2000;55A(1):M43-M52.

1362 7. Hoffman J, Ciol M, Huynh M, Chan L. Estimating transitions probabilities in mobility
 1363 and total costs for Medicare beneficiaries. *Arch Phys Med Rehabil.* 2010;91:1849-55.

1364 8. Guralnik J, Ferrucci L, Balfour J, Volpato S, Di I, A. Progressive versus catastrophic loss
 1365 of the abilit to walk: Implications for the prevention of mobility loss. *J Am Geriatr Soc.*
 1366 2001;49:1463-70.

1367 9. Brach J, Studenski S, Perera S, VanSwearingen J, Newman A. Gait variability and the
 1368 risk of incident mobility disability. *J Gerontol Med Sci.* 2007;62A:983-8.

1369 10. Hausdorff J, Rios D, Edelberg H. Gait variability and fall risk in community-living older
 1370 adults: a 1-year prospective study. *Arch Phys Med Rehabil.* 2001;82:1050-6.

1371 11. Judge J, Underwood M, Gennosa T. Exercise to improve gait velocity in older adults.
 1372 *Arch Phys Med Rehabil.* 1993;74:400-6.

1373 12. Mian O, Thom J, Ardigo L, Morse C, Narici M, Minetti A. Effect of a 12-month physical
 1374 conditioning programme on the metabolic cost of walking in healthy older adults. *Eur J*
 1375 *Appl Physiol.* 2007;100:499-505.

1376 13. Brown M, Holloszy J. Effects of a low intensity exercise program on selected physical
 1377 performance characteristics of 60- to 71-year olds. *Aging (Milano).* 1991;3:129-39.

- 1378 14. Manini T, Marko M, VanArnam T, Cook S, Fernhall B, Burke J, et al. Efficacy of
1379 resistance and task-specific exercise in older adults who modify tasks of everyday life. *J*
1380 *Gerontol Med Sci.* 2007;62A:616-23.
- 1381 15. Wolf S, O'Grady M, Easley K, Guo Y, Kressig R, Kutner M. The influence of intense Tai
1382 Chi training on physical performance and hemodynamic outcomes in transitionally frail,
1383 older adults. *J Gerontol Med Sci.* 2006;61A:184-9.
- 1384 16. Helbostad J, Sletvold O, Moe-Nilssen R. Home training with and without additional
1385 group training in physically frail older people living at home: effect on health-related
1386 quality of life and ambulation. *Clinical Rehabilitation.* 2004;18:498-508.
- 1387 17. Buchner D, Cress M, de L, BJ, Esselman P, Margherita A, Price R, et al. A comparison
1388 of the effects of three types of endurance training on balance and other fall risk factors in
1389 older adults. *Aging Clin Exp Res.* 1997;9:112-9.
- 1390 18. Buchner D, Cress M, de L, BJ, Esselman P, Margherita A, Price R, et al. The effects of
1391 strength and endurance training on gait, balance, fall risk, and health services use in
1392 community-living older adults. *Journal of Gerontology: Medical Sciences.*
1393 1997;52A(4):M218-M24.
- 1394 19. Bean J, Herman S, Kiely D, Frey I, Leveille S, Fielding R, et al. Increased velocity
1395 exercise specific to task training: a pilot study exploring effects on leg power, balance,
1396 and mobility in community dwelling older women. *J Am Geriatr Soc.* 2004;52(5):799-
1397 804.
- 1398 20. LIFE S, Investigators. Effects of a physical activity intervention on measures of physical
1399 performance: results of the Lifestyle Interventions and independence for elders pilot
1400 (LIFE-P) study. *J Gerontol Med Sci.* 2006;61A:1157-65.
- 1401 21. Liu C, Latham N. Progressive resistance strength training for improving physical
1402 function in older adults. *Cochrane Database of Systematic Reviews.* 2009(3).
- 1403 22. Nelson M, Rejeski W, Blair S, Duncan P, Judge J, King A, et al. Physical activity and
1404 public health in older adults: recommendation from the American College of Sports
1405 Medicine and the American Heart Association. *Med Sci Sports.* 2007;39(8):1435-45.
- 1406 23. VanSwearingen J, Perera S, Brach J, Cham R, Rosano C, Studenski S. A randomized trial
1407 of two forms of therapeutic activity to improve walking: effect on the energy cost of
1408 walking. *J Gerontol A Biol Sci Med Sc.* 2009;64A:1190-8.
- 1409 24. Nelson W. Physical principles for economies of skilled movements. *Biol Cybernetics.*
1410 1983;46:135-47.
- 1411 25. Daly J, Ruff R. Construction of efficacious gait and upper limb functional interventions
1412 based on brain plasticity evidence and model-based measures for stroke patients. *The*
1413 *Scientific World Journal.* 2007;7:2031-45.
- 1414 26. Lay B, Sparrow W, Hughes K, O'Dwyer N. Practice effects on coordination and control,
1415 metabolic energy expenditure, and muscle activation. *Human Movement Science.*
1416 2002;21:807-30.
- 1417 27. Newman M, Dawes H, van d, Berg, M, Wade D, Burrridge J, Izadi H. Can aerobic
1418 treadmill training reduce the effort of walking and fatigue in people with multiple
1419 sclerosis: a pilot study. *Multiple Sclerosis.* 2007;13:113-9.
- 1420 28. Brooks V. *The Neural Basis of Motor Control.* New York: Oxford University Press;
1421 1986.

- 1422 29. Gentile A. Skill acquisition: action, movement, and neuromotor processes. In: JH C, RB
1423 S, J G, AM G, JM H, eds. *Movement Sciences*. 1 ed. Rockville: Aspen Publishers;
1424 1987:93-154.
- 1425 30. Polcyn A, Lipsitz L, Kerrigan C, Collins J. Age-related changes in the initiation of gait:
1426 degradation of central mechanisms for momentum generation. *Arch Phys Med Rehabil*.
1427 1998;79:1582-9.
- 1428 31. Capaday C. The special nature of human walking and its neural control. *Trends in*
1429 *Neurosciences*. 2002;25(7):370-6.
- 1430 32. Alexander R. Walking made simple. *Science*. 2005;308:58-9.
- 1431 33. Schmidt R. Organizing and Scheduling Practice. In: RA S, ed. *Motor Learning and*
1432 *Practice: From Principles to Practice*. Champaign, IL: Human Kinetics Books; 1991:199-
1433 225.
- 1434 34. ACSM's Guidelines for Exercise Testing and Prescription. 5th ed. Baltimore, MD:
1435 Williams & Wilkins; 1995.
- 1436 35. Haley S, Jette A, Coster W, Kooyoomijian J, Levenson S, Heeren T, et al. Late life
1437 function and disability instrument:II. Development and evaluation of the function
1438 component. *J Gerontol*. 2002;57A:M217-M22.
- 1439 36. Jette A, Haley S, Coster W, Kooyoomijian J, Levenson S, Heeren T, et al. Late life
1440 function and disability instrument: I. Development and evaluation of the disability
1441 component. *J Gerontol*. 2002;57A:M209-M16.
- 1442 37. Butland R, Pang J, Gross E, Woodcock A, Geddes D. Two-, six-, and 12-minute walking
1443 tests in reespiratory disease. *BMJ*. 1982;284:1607-8.
- 1444 38. Lerner-Frankiel M, Vargas S, Brown M, Krusel L, Schoneberger W. Functional
1445 community ambulation: what are your criteria? *Clinical Management*. 1986;6((2)):12-5.
- 1446 39. Robinett C, Vondran M. Functional ambulation velocity and distance requirements in
1447 rural and urban communities. *Phys Ther*. 1988;68(9):1371-3.
- 1448 40. Solway S, Brooks D, Lacasse Y, Tomas S. A qualitative, systematic overview of the
1449 measurement properties of the functional walk tests used in the cardiorespiratory
1450 domain. *Chest*. 2001;119:256-70.
- 1451 41. Harada N, Chiu V, Damron-Rodriguez J, Fowler E, Siu A, Reuben D. Screening for
1452 balance and mobility impairment in elderly individuals living in residential care facilities.
1453 *Physical Therapy*. 1995;75(6):462-9.
- 1454 42. Harada N, Chiu V, Stewart A. Mobility-related function in older adults: assessment with
1455 a 6-minute walk test. *Arch Phys Med Rehabil*. 1999;80:837-41.
- 1456 43. Guyatt G, Sullivan M, Thompson P. The 6-minute walk: a new measure of exercise
1457 capacity in patients with chronic heart failure. *Can Med Assoc*. 1985;132:919-23.
- 1458 44. Brach J, Perera S, Studenski S, Newman A. Reliability and validity of measures of gait
1459 variability in community-dwelling older adults. *Arch Phys Med Rehabil*. 2008;89:2293-6.
- 1460 45. McAuley E, Mihalko S, Rosengren K. Self-efficacy and balance correlates of fear of
1461 falling in the elderly. *J Aging Phys Activity*. 1997;5:329-40.
- 1462 46. Rosengren K, McAuley E, Mihalko S. Gait adjustments in older adults: Activity and
1463 efficacy influences. *Psychology and Aging*. 1998;13:375-80.
- 1464 47. Newell A, VanSwearingen J, Hile E, Brach J. The modified gait efficacy scale:
1465 establishing the psychometric properties in older adults. *Phys Ther*. 2012;92:318-28.
- 1466 48. Hess R, Brach J, Piva S, VanSwearingen J. Walking skill can be assessed in older adults:
1467 Validity of figure-of-8 walk test. *Phys Ther*. 2010;90:89-99.

- 1468 49. Brach J, Perera S, VanSwearingen J, Hile E, Wert D, Studenski S. Challenging gait
1469 conditions predict 1-year decline in gait speed in older adults with apparently normal gait.
1470 *Phys Ther.* 2011;91:1857-64.
- 1471 50. Gabell A, Nayak U. The effect of age and variability in gait. *Journal of Gerontology.*
1472 1984;39(6):662-6.
- 1473 51. Perera S, Brach J, Talkowski J, Wert d, Studenski S. Measuring stride time variability:
1474 estimating test-retest reliability and required walk length using bootstrapping. *Program &*
1475 *Abstracts of the ISPGR 18th International Conference.* 2007:55-6.
- 1476 52. Brach J, Berlin J, VanSwearingen J, Newman A, Studenski S. Too much or too little step
1477 width variability is associated with a fall history in older persons who walk at or near
1478 normal gait speed. *J Neuroengineering Rehabil.* 2005;2(21).
- 1479 53. Madden DJ, Whiting WL, Cabeza R, Huettel SA. Age-related preservation of top-down
1480 attentional guidance during visual search. *Psychol Aging.* 2004;19(2):304-9.
- 1481 54. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity
1482 measure. *J Gen Intern Med.* 2001;16(9):606-13.
- 1483 55. Gardner M, Robertson C, Campbell A. Exercise in preventing falls and fall related
1484 injuries in older people: a review of randomized controlled trials. *Br J Sports Med.*
1485 2000;34:7-17.
- 1486 56. Meinert C. *Clinical Trials.* New York: Oxford University Press; 1986.
- 1487 57. Perera S, Mody S, Woodman R, Studenski S. Meaningful change and responsiveness in
1488 common physical performance measures in older adults. *J Am Geriatr Soc.* 2006;54:743-
1489 9.
- 1490 58. Cohen J. *Statistical Power Analysis for the Behavioral Sciences.* New York: Academic
1491 Press; 1977.
- 1492 59. Eldridge S, Ashby D, Kerry S. Sample size for cluster randomized trials: effects of
1493 coefficient of variation of cluster size and analysis method. *International Journal of*
1494 *Epidemiology.* 2006;35:1292-300.
- 1495 60. Box G, Cox D. An analysis of transformations. *Journal of the Royal Statistical Society-*
1496 *Series B.* 1964;26:211-43.
- 1497 61. Rubin D. *Multiple Imputation for Nonresponse in Surveys:* John Wiley and Sons; 1987.
- 1498 62. Rubin D. Multiple imputation after 18+ years. *Statistics in Medicine.* 1991;14:1913-25.
- 1499 63. Johnson D. *Applied Multivariate Statistics.* Belmont, CA: Duxbury Press; 1998.
- 1500 64. Duncan P, Studenski S, Richards L, Gollub S, Lai S, Reker D, et al. Randomized clinical
1501 trial of therapeutic exercise in subacute stroke. *Stroke.* 2003;34(9):2173-80.
- 1502 65. Milliken G, Johnson D. *Analysis of Messy Data Volume 1: Designed Experiments.* New
1503 York: Van Nostrand Reinhold; 1992.
- 1504 66. Diggle P, Liang K, Zeger S. *Analysis of Longitudinal Data.* Oxford: Clarendon Press;
1505 1994.
- 1506 67. Breiman L, Friedman J, Stone C, Olshen R. *Classification and Regression Trees:* CRC
1507 Press; 1984.
- 1508 68. Strobl C, Malley J, Tutz G. An introduction to recursive partitioning: rationale,
1509 application, and characteristics of classification and regression trees, bagging, and
1510 random forests. *Psychological Methods.* 2009;14(4):323-48.
- 1511 69. DeLong E, DeLong D, Clarke-Pearson D. Comparing the areas under two or more
1512 correlated receiver operating characteristic curves: a nonparametric approach. *Biometrics.*
1513 1988;44:837-45.

1514 70. Schmid A, Duncan P, Studenski S, Lai S, Richards L, Perera S, et al. Improvements in
1515 speed-based gait classifications are meaningful. *Stroke*. 2007;38(7):2096-100.

1516

1517