

# Moving Together - benefits of an online dance program on physical and mental health for older adults: a mixed-method study

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## Research Article

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1 **Moving Together - benefits of an online dance program on**  
2 **physical and mental health for older women: an exploratory**  
3 **mixed-method study**

4

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## 24 **ABSTRACT**

25 **Background** Previous studies show that in-person dance training is a  
26 beneficial form of physical activity that involves mental, social, and physical  
27 dimensions. This exploratory study investigated the benefits of a 12-week  
28 online dance training intervention on mental and physical health outcomes for  
29 older women.

30 **Methods** A convergent parallel mixed-method design was used. Forty-five  
31 older adults ( $74.0 \pm 5.3$  yrs old, 44 women) were recruited through  
32 advertisements at activity and rehabilitation centers in the North Denmark  
33 region. The intervention consisted of two weekly 60-min classes of  
34 improvisation and salsa delivered online through video call applications.  
35 Changes in physical health outcomes (body mass and composition, resting  
36 blood pressure, Senior Fitness Test battery) and self-rated health and  
37 wellbeing (health-related quality of life (HRQOL), feelings of loneliness) were  
38 assessed prior to and after 12 weeks of dancing. Focus group interviews were  
39 conducted post-intervention to further explore the benefits as well as the  
40 participant's experience of the intervention. Thematic analysis of the  
41 qualitative data was conducted.

42 **Results** Thirty-two participants (all women) completed the study. Significant  
43 improvements in fitness were found for the number of arm curls performed  
44 (baseline:  $12.3 \pm 3.0$ ; post-intervention:  $13.7 \pm 3.0$ ,  $P = 0.005$ ), 2-min step test

45 performance (baseline:  $66.5 \pm 20.0$  reps.; post-intervention:  $73.8 \pm 22.6$  reps.,  
46  $P = 0.016$ ), and chair sit-and-reach (baseline:  $0.4 \pm 11.3$  cm; post-  
47 intervention:  $5.5 \pm 10.1$  cm,  $P < 0.001$ ). There was a significant increase in  
48 body mass from baseline to post-intervention ( $P < 0.015$ ). The themes from  
49 the focus groups included (1) Participation, (2) Challenges, (3) Progression,  
50 (4) Motivation, (5) Perceived health and wellbeing, and (6) Online dance  
51 instruction. No significant changes were reported in HRQOL and loneliness  
52 from the quantitative data, although the qualitative data did reveal improved  
53 feelings of physical health and wellbeing.

54 **Conclusions** The intervention improved several aspects of fitness in older  
55 women and improved the participants' perceptions of their own physical  
56 abilities and wellbeing. While most participants found the online intervention  
57 enjoyable, several participants missed the feedback from the instructors that  
58 naturally occurs with in-person instruction.

59

60 **Keywords** Older adults, Physical activity, Dance, Community implementation,  
61 Mental health, Physical health

## 62 **INTRODUCTION**

63 Physical inactivity is commonly observed among older adults (65 years of age  
64 or older) [1]. In addition to elevated mortality risk [2], physical inactivity also  
65 presents increased risks of social isolation and loneliness, which are known to  
66 be major risk factors for negative health outcomes, such as reduced health-  
67 related quality of life (HRQOL) [3, 4], particularly among older adults [5].  
68 Although many older adults have positive attitudes toward physical activity,  
69 there are many factors that limit their participation, including safety concerns,  
70 low self-efficacy, pre-existing medical conditions, low physical fitness, time  
71 constraints, transportation, and culture [6].

72           Previous research has shown that arts and arts-based activities can  
73 positively impact physical and mental health outcomes by fostering creativity  
74 and promoting meaningful social engagement, both of which can improve  
75 HRQOL [7]. More specifically, unlike the majority of other types of physical  
76 activity, dance is an aesthetic form that allows for creative expression and is  
77 socially engaging [8]. Dancing can result in physical benefits comparable with  
78 those of formal exercise training [9], and has been found to improve social  
79 engagement and HRQOL [7, 10, 11]. In addition, Keogh and colleagues found  
80 that dance improved the emotional, psychological, and physical well-being of  
81 individuals [12], and Ambegoankar et al. 2022 found that weekly dance sessions  
82 had a positive impact on physical health and cognition for community dwelling  
83 older adults [7]. Comprehensive assessment of dance activities and movement-  
84 based therapies frequently assess improvement according to physiological

85 benchmarks [12]. However, apart from the above examples, there are scant  
86 studies that fully consider the combined physical, psychological, and social  
87 impacts of dance.

88           Following extensive periods of social isolation, online interventions  
89 have proven to be an effective first-step for returning to physical activity [13],  
90 and for improving functional fitness and mental health [14]. Online  
91 interventions can facilitate social support and connectivity by connecting like-  
92 minded individuals or groups who are ~~also~~ interested in becoming more  
93 physically active [13]. Social support can provide individuals with motivation,  
94 accountability, and a sense of belonging, which can help them stay on track  
95 with their physical activity goals [15] and support independent lifestyles and  
96 healthy aging [7]. Furthermore, online interventions allow more flexibility in  
97 terms of when and where to engage in physical activity [14], factors that are  
98 especially important for individuals who may not have access to traditional  
99 exercise facilities and would like to exercise from home [13] , or who otherwise  
100 face challenges leaving their home.

101           Dance is a complex intervention and thus requires complex methods  
102 for ensuring that the effects of dance training are fully understood from a  
103 holistic point of view. Measuring the impact of online dance training on physical  
104 and mental outcomes thus requires a mixed-methods approach and insights  
105 from across scientific disciplines. Accordingly, the aim of the Moving Together  
106 project was to conduct a mixed-method evaluation to explore the benefits of a

107 12-week online dance training intervention on physical and mental health  
108 outcomes for older adults.

## 109 **METHODS**

### 110 **Study Design**

111 A mixed-method, pre-post study was designed to explore the influence of a 12-  
112 week online dance intervention on physical and mental health in older adults.

113 This exploratory uncontrolled study used a convergent parallel mixed-method  
114 design, which involves collecting and analyzing quantitative and qualitative  
115 data concurrently but separately and merging the data at the interpretation  
116 stage to arrive at a comprehensive and holistic understanding of the data [16].

117 The Moving Together study builds upon a previous randomized controlled trial  
118 from our group [17] which demonstrated that regular circuit training and a  
119 combination of online and in-person dance training significantly reduced the  
120 number of fall accidents in older adults compared with the control group [18].

121 We sought to build on this work by focusing on implementing an online dance  
122 training program, and thus the study was conducted in close collaboration with  
123 regional activity and rehabilitation centers in the North Denmark region that  
124 streamed the online dance classes. The dance intervention was open for all  
125 interested older adults residing in the municipality for an eight-month period,  
126 however only a subgroup of these were included in the current study, based on  
127 a first-come/first-served basis. The duration of the study was from November  
128 2022 to May 2023. The study was approved by the North Denmark Region  
129 Committee on Health Research Ethics (N-20220045) and conducted in

130 accordance with the Declaration of Helsinki. Participants were recruited  
131 through advertisements at the activity and rehabilitation centers and with  
132 assistance from the municipality. After receiving oral and written information  
133 about the study, all participants provided written informed consent.

#### 134 **Participants**

135 To ensure inclusivity of participants, only two inclusion criteria were used: a)  
136 being 65 yrs or older, and b) being able to speak and understand Danish.  
137 Exclusion criteria included drug addiction, being unable to stand and walk  
138 independently, lack of ability to cooperate, and participation in medical trials  
139 or other training intervention studies in parallel. No criteria were used in terms  
140 of prior dance experience. Because of the broad inclusion criteria, there was a  
141 wide range in both age (65 to 87 yrs) and the physical capacity of the study  
142 participants.

143           A total of 45 participants (44 women) were included in the study  
144 (Table 1). This number was based on a sample size calculation using a paired t-  
145 test (two-tailed). With a statistical power of 0.9, an alpha level of 0.05, and an  
146 assumed moderate effect size ( $d = 0.55$ ) in mental health outcome, as  
147 previously demonstrated after Dance Movement Therapy [19], 37 participants  
148 were required to detect a significant change in self-reported loneliness (a main  
149 indicator of mental health and social wellbeing). To account for dropouts during  
150 the 12-week intervention period (estimated 20%), 45 participants were  
151 included.



152 **Description of intervention**

153 The dance intervention consisted of 12 weeks of two weekly classes of 60  
154 minutes (min) training in 'improvisation' (contemporary dance) (Day 1,  
155 Tuesday) and Cuban salsa (Day 2, Thursday), led by professional dance  
156 instructors experienced with online teaching and trained in inclusive dance  
157 practice. The attention to inclusive practice was necessary given the broad  
158 inclusion criteria, and modifications were offered throughout the study to meet  
159 the different experience levels and physical abilities of the study participants.  
160 The improvisation classes were structured around a gradual increase in  
161 intensity through the one hour of practice. The movement language of Laban's  
162 choreological practice [20] was used to inspire and create variations of  
163 movement. The classes both started and finished with a focus on breathing  
164 exercises. The salsa classes were based on Cuban salsa and included a gradual  
165 introduction to the technique and the expressive aesthetics of the dance style.  
166 In time, the class included more improvised salsa and dancing at a faster pace.  
167 No baseline assessment was performed of how familiar participants were with  
168 the two types of dances. Both classes were delivered online through video calls  
169 using the Zoom meeting application (Zoom Video Communications, Inc., San  
170 Jose, CA, USA), with remote instruction by the dance instructors. The classes  
171 followed a similar structure and lasted one hour, which included a warmup,  
172 main session, and a cool down. To allow flexibility, participants could choose to  
173 attend the online classes from home (alone) or at one of four activity centers in  
174 the municipality (group-based). Recordings of the dance instructor were made  
175 at each online class and uploaded to a designated YouTube channel created

176 specifically for the project [21]. The YouTube channel was a resource made  
177 available for all participants, and anyone else interested, where participants  
178 could review and replay the classes if they were unable to attend a scheduled  
179 class. Participants were instructed to follow the dance classes (live or  
180 asynchronous) at least once a week but were strongly encouraged to dance  
181 twice weekly. To promote engagement and raise awareness of the intervention,  
182 a 60-min in-person salsa dance class followed by lunch was conducted once  
183 every month with physical attendance by both the instructor and the  
184 participants (up to three sessions in total per participant). Besides this monthly  
185 in-person dance class, no further social activities were encouraged as part of  
186 the study. Given the exploratory uncontrolled study design and focus on  
187 implementation in practice, no specific restrictions were made on the  
188 participants regarding participation in other sports or training activities during  
189 the study period.

## 190 **Quantitative outcomes**

191 All outcome measurements (except focus group interviews; only post  
192 intervention) were performed immediately prior to (baseline) and after the 12-  
193 week intervention period (post-intervention) and conducted at activity centers  
194 in the municipality (physical assessment and questionnaires) or online  
195 (interviews).

## 196 ***Resting blood pressure***

197 After at least five min of rest, systolic blood pressure and diastolic blood  
198 pressure were measured with the participants comfortably seated in a chair

199 with uncrossed legs using an automated monitoring device (OMRON M3,  
200 OMRON Healthcare, Hoofddorp, The Netherlands). Measurements were  
201 performed in duplicate, with a third measurement performed if the  
202 measurements deviated by >5%. The lowest values were used for further  
203 analyses.

#### 204 ***Body composition and anthropometric assessments***

205 Body mass and height were measured with the participants wearing light  
206 clothing, without shoes and rounded to the nearest 0.1 kg and 0.5 cm,  
207 respectively. BMI was calculated as body mass divided by height squared  
208 ( $\text{kg}/\text{m}^2$ ). Waist circumference was measured at the midpoint between the top of  
209 the iliac crest and the lower margin of the last palpable rib with a non-elastic  
210 tape measure, standing with the feet together and arms down following a  
211 normal expiration [22]. Hip circumference was measured around the greater  
212 trochanter [22]. Waist-hip ratio was calculated as waist circumference divided  
213 by hip circumference. For both waist and hip circumference, measurements  
214 were performed in duplicate, and reported as the mean. If the difference  
215 between the first and second measure was >0.5 cm, a third measure was  
216 obtained. Skinfold thickness was measured at four standard sites (biceps,  
217 triceps, subscapular, and suprailiac) using a Harpenden Skinfold Caliper.  
218 Skinfold thickness was then converted to body density using Durnin and  
219 Wormersleys linear regression equation, used in the Siri Equation for  
220 estimation of body fat percentage [23]. The same experienced investigator  
221 performed all waist and hip circumference and skinfold measurements and was

222 blinded at the post-intervention assessment to the results obtained at the  
223 baseline visit.

### 224 ***Senior Fitness Test***

225 The Senior Fitness Test (SFT) battery was used to assess functional fitness,  
226 which can be defined as the capacity to perform usual everyday activities safely  
227 and independently [24]. The SFT has shown high content and criterion validity  
228 and consists of six field-based test items to evaluate upper and lower body  
229 muscle strength and flexibility, aerobic endurance, and dynamic balance/agility  
230 [25]. The SFT is comprised of a 30-second chair stand test and arm curl (that  
231 assess lower and upper body strength, respectively), a 2-min step test  
232 (evaluating aerobic endurance), chair-sit-and-reach and back scratch (assessing  
233 hamstring and shoulder flexibility, respectively), and 8-foot-up-and-go  
234 (evaluating dynamic gait/agility) [26]. The procedures for administering the  
235 SFT were standardized as described in detail by [25]. Scoring for each item was  
236 performed on a continuous scale, with no total score. For five of the items, the  
237 higher the score the better, whereas for one item (the 8-foot-up-and-go), the  
238 lower (i.e., faster) the score the better.

### 239 ***Self-rated health and wellbeing***

240 The Short-Form Health Survey 36 (SF-36) and UCLA Loneliness Index were  
241 used to assess participants perceived mental health and wellbeing. The Danish  
242 translated version [27] of the SF-36 was completed for assessment of self-  
243 reported HRQOL [28]. Data was scored using the RAND 36-item Health Survey  
244 (version 1.0) method [29]. Pre-coded numeric values for each of the 36

245 questions were transformed into a score from 0 to 100, with a higher score  
246 representing a more favorable health status. Questions belonging to the same  
247 subscale were then averaged together to create eight health summary scores  
248 (four representing mental quality of life (QoL) and four representing physical  
249 QoL) (Ware, 1992). Loneliness and social isolation were evaluated through the  
250 Danish translated version [30] of the University of California, Los Angeles  
251 (UCLA) Loneliness Scale version 3 [31]. A total of 20 questions were answered  
252 on a 4-point Likert scale ranging from 1 (Never) to 4 (Often). Based on the  
253 scoring of each of the 20 items, a Total Loneliness Score (TLS) was calculated,  
254 ranging from 20 to 80, with higher scores indicating greater degrees of  
255 loneliness. The Danish translated version of the UCLA loneliness has good  
256 psychometric properties that support the reliability and validity of the scale  
257 [30]. For descriptive purposes, the extent of loneliness was categorized as  
258 follows: 20-34 (low degree of loneliness); 35-49 (moderate degree of loneliness);  
259 50-64 (moderately high degree of loneliness); and 65-80 (high degree of  
260 loneliness) [32].

### 261 ***Qualitative Outcomes***

262 Focus group interviews were conducted post-intervention and following the  
263 post-physical assessments. All participants, including those who did not  
264 complete the intervention, were invited for interviews. The interviews were  
265 performed online via the Zoom meeting application, and conducted by the  
266 same experienced interviewer who was also one of the interventionists and a  
267 member of the research team. The interviews contained questions about the

268 participants' experiences of the intervention, self-perception of impact on  
269 physical and mental health, including possible effects of the intervention in  
270 other areas of their life, such as activities of daily living (ADL). Participants  
271 were also prompted to give qualitative feedback on the instruction and the  
272 experience of participating in online classes.

## 273 **Data analysis**

### 274 ***Quantitative analysis***

275 Normal distribution of data was confirmed with the Shapiro-Wilk Test.  
276 Standardized effect sizes (Cohen  $d$ ) were calculated to determine the  
277 magnitude of change (pre-post), with the following thresholds: trivial ( $<0.2$ ),  
278 small ( $\geq 0.2$ ), moderate ( $>0.5$ ), and large ( $>0.8$ ). Before and after comparisons  
279 on outcomes were performed using two-sided student paired-t tests. Statistical  
280 analyses were performed using SPSS (version 27; IBM, Armonk, New York).  
281 Statistical significance was accepted at alpha  $<0.05$ . In the text and tables,  
282 values are means with SD, unless otherwise stated.

### 283 ***Qualitative analysis***

284 A total of eight focus groups were conducted with two to four participants per  
285 focus group. Participants were given the option either to take part in the  
286 interview from their home or in a room at the activity center and were  
287 interviewed by a member of the research team through Zoom. The interviews  
288 lasted approximately 60 min; audio recordings were made and transcribed  
289 using an automatic transcription tool (Mygoodtape.com) and following manual  
290 corrections and were manually reviewed by the interviewer and corrected for  
291 typographical mistakes or spelling errors. The transcriptions were then

292 translated into English by the interviewer (a native Danish speaker fluent in  
293 written and spoken English). Transcripts from the interviews were analyzed  
294 independently by two members of the research team: the interventionist, and a  
295 researcher familiar with the study but not present at the interviews. The two  
296 researchers conducted thematic analysis of the textual data separately,  
297 following the six general steps outlined by Braun and Clarke [33] using a  
298 combination of inductive and deductive approaches, as well as a combination of  
299 semantic and latent approaches. After the researchers completed this task  
300 independently, they met to discuss commonalities and differences and then  
301 repeated the steps together. Textual data was coded, and sub-themes and  
302 themes emerged (Table 2), which were then presented in plenum to the entire  
303 research team. The research team also followed Braun and Clark's 15-point  
304 criteria to ensure sound research practice [33]. As the interview data was  
305 translated and coded in a different language than the interviews took place in,  
306 attention to these criteria was especially important during the transcription,  
307 coding, and analysis phases.

## 308 **RESULTS**

### 309 *Participants*

310 Of the 45 participants included at baseline, 32 participants (all women)  
311 completed the study. All 32 participants were included for analyses  
312 irrespective of how they attended the dance classes (live or recorded class  
313 uploaded to YouTube) and where (at activity center or at home). Reasons for  
314 dropping out included non-study related health issues (N = 5); COVID-19

315 infection (N = 1); being the only man (N = 1); lack of motivation (N = 4); and  
316 finding it too physically demanding to complete the dance sessions (N = 2).

### 317 ***Body composition, anthropometric, and resting blood pressures***

318 There was a significant increase in BMI from baseline ( $26.4 \pm 4.7$  kg/m<sup>2</sup>) to  
319 post-intervention ( $26.7 \pm 4.6$  kg/m<sup>2</sup>,  $P = 0.016$ ,  $d = 0.45$ ). Similarly, there was  
320 an increase in body mass from baseline ( $69.4 \pm 13.0$  kg) to post-intervention  
321 ( $70.1 \pm 12.7$  kg,  $P = 0.015$ ,  $d = 0.45$ ). In contrast, there was no significant  
322 change in waist circumference from baseline ( $95.3 \pm 11.6$  cm) to post-  
323 intervention ( $94.0 \pm 12.9$  cm,  $P = 0.051$ ,  $d = 0.36$ ). There were no changes  
324 from baseline to post-intervention in sum-of-skinfolds ( $72.8 \pm 22.4$  mm vs.  
325  $74.2 \pm 24.2$  mm,  $P = 0.352$ ,  $d = 0.17$ ), body fat percentage ( $37.6 \pm 4.4\%$  vs.  
326  $37.8 \pm 4.4\%$ ,  $P = 0.271$ ,  $d = 0.20$ ), or waist-hip-ratio ( $0.91 \pm 0.05$  vs.  $0.90 \pm$   
327  $0.06$ ,  $P = 0.613$ ,  $d = 0.09$ ). No changes were observed from baseline to post-  
328 intervention in systolic blood pressure ( $132 \pm 15$  mmHg vs.  $132 \pm 18$  mmHg,  
329  $P = 0.850$ ,  $d = 0.03$ ) or diastolic blood pressure ( $79 \pm 9$  mmHg vs.  $79 \pm 8$   
330 mmHg,  $P = 0.932$ ,  $d = 0.02$ ).

### 331 ***Functional fitness (Senior Fitness Test)***

332 Data from the SFT battery are shown in Figure 1. Significant improvements in  
333 fitness from baseline to post-intervention were found for the number of arm  
334 curls performed (baseline:  $12.3 \pm 3.0$ ; post-intervention:  $13.7 \pm 3.0$ ,  $P =$   
335  $0.005$ ,  $d = 0.54$ , Figure 1B), 2-min step test performance (baseline:  $66.5 \pm$   
336  $20.0$  reps.; post-intervention:  $73.8 \pm 22.6$  reps.,  $P = 0.016$ ,  $d = 0.45$ , Figure  
337 1C), and chair sit-and-reach (baseline:  $0.4 \pm 11.3$  cm; post-intervention:  $5.5 \pm$



338 10.1 cm,  $P < 0.001$ ,  $d = 1.05$ , Figure 1D). There were no significant changes  
339 in the number of chair stands performed ( $P = 0.143$ ,  $d = 0.27$ ), shoulder  
340 flexibility ( $P = 0.630$ ,  $d = 0.09$ ), or in the time to complete the 8-foot Up and  
341 Go ( $P = 0.697$ ,  $d = 0.07$ ).

### 342 ***Self-rated health and wellbeing***

343 Results for total loneliness score (TLS) and HRQOL summary scores are  
344 shown in Table 3. There was no significant change in TLS from baseline to  
345 post-intervention ( $P = 0.054$ ,  $d = 0.36$ ). There were no significant changes in  
346 any of the eight HRQOL summary scores (all  $P \geq 0.118$ ) with small effect sizes  
347 ( $d \leq 0.28$ ).

### 348 ***Qualitative responses***

349 Of the 45 study participants invited to the interviews, 28 took part (various  
350 reasons were given for declining, mostly schedule conflicts or illness). Six  
351 main themes were identified: (1) Participation, (2) Challenges, (3)  
352 Progression, (4) Motivation, (5) Perceived health and wellbeing, and (6) Online  
353 dance instruction. Table 2 presents the main themes and subthemes identified  
354 through thematic analysis.

### 355 ***Participation***

356 Within this main theme, four subthemes were identified: description of  
357 individual participation, preferences for instruction, level and quality of  
358 instruction, and obstacles to participation. The subthemes reflect variety of  
359 ways that study participants received the instruction: the majority chose to  
360 participate in-person at one of the activity centers, and only a few participants

361 reported training alone at home. The subthemes also reflect the variety of  
362 ways the online classes were screened. Depending on the activity center,  
363 online classes were either streamed live (where the instructor could see and  
364 interact with the participants at home and the activity center), or else they  
365 were streamed from pre-recorded sessions available on the YouTube channel  
366 (no interaction between instructor and participants). One center streamed  
367 only the salsa classes, and another used an on-site physiotherapist to guide  
368 and facilitate the participants during the pre-recorded classes, pausing, and  
369 resuming the video at various points throughout the class (non-continuous, no  
370 interaction with instructor). Among all the different modes of participation  
371 there was a clear preference for participating in-person:

372 *“I would probably say that the activity center is the most fun. To come*  
373 *down to the (activity) center and dance rather than having to stand at*  
374 *home in the kitchen alone.”*

375

376 *“I think the very best thing is when we are together, because then you*  
377 *also see what the others are doing and can perhaps learn something*  
378 *from them too. Just when you think ‘this is impossible for me’, I think*  
379 *that at the same time you can also learn how others manage this. And I*  
380 *also think it's really nice that we're together (...). At home it is not the*  
381 *same at all.”*

382 There was a clear preference for participating in-person, and especially for  
383 the monthly sessions when an instructor was present in-person:

384 *"Twice I have been there with instructors physically present. It's*  
385 *absolutely the most fun. And I seem to be "on" when the instructor is on.*  
386 *It's also better than streaming from YouTube."*

387

388 *"It was definitely much nicer to be there physically. It means a lot that*  
389 *there is a living person in front of you. And with whom you can have a*  
390 *little eye contact once in a while, and (an instructor) who also sees us*  
391 *and notices that we may have to do that turn 4 or 5 more times before*  
392 *everyone is on board."*

393 Those who participated at via pre-recorded classes found the instruction  
394 (especially the salsa) repetitive and boring at times:

395 *"We didn't get that far in salsa either. I felt the same and the same steps*  
396 *we kept going on and on and on."*

397

398 *" I don't think I'm getting as much out of it as I expected (...). We*  
399 *expected more that we got to learn to dance a little salsa, and those*  
400 *steps, it's repetition, repetition, repetition... But we never really learned*  
401 *how to start salsa dancing."*

402 The main obstacles to participation were busyness, prior commitments to  
403 other activities, lack of enthusiasm for dancing alone, and illness.

404 *"It's not something I would want to do in the future, because I have so*  
405 *many other activities that it's kind of squeezed in. So, I don't think I will*  
406 *choose it in the future."*

### 407 **Challenges**

408 Within this main theme, five subthemes were identified: technical difficulties,  
409 challenges with their own movement, challenges with the instruction, self-  
410 consciousness, and challenges with the method. Many participants reported  
411 frustration and difficulty following the instruction due to technical difficulties.  
412 This was not the fault of the participants, but due to technical difficulties  
413 associated with audio streaming and transmitting over lives-tream.

414 *"Sometimes the music was too loud and other times it was too low.*  
415 *There were also some technical things that were a bit tedious."*

416

417 *"The difficulties with online instruction might be that there is a little bit*  
418 *of a delay... so that the sound and image are not completely followed.*  
419 *(The instructor) also mentioned at one point, when she looked at us, that*  
420 *'it's as if you don't quite follow the rhythm.'* And I think it is simply that  
421 *sound and image were not synchronized. So, there is a slight shift,*  
422 *which might make it a bit difficult to follow along, especially if you have*  
423 *difficulty hearing the rhythm in the music.*

424 Participants also reported challenges with their own movement during the  
425 instruction, due to self-consciousness or physical difficulties:

426 *"I had problems with balance. First, I didn't want to go backwards.*  
427 *When it went too fast and the others moved too fast, I got dizzy. I tried*  
428 *to move, but I got dizzy very often."*

429 Participants also reported that they overcame these challenges as they grew  
430 more accustomed to the intervention:

431 *"The challenge was that in the beginning, you had to learn to free*  
432 *yourself and your body and everything. Until you thought, 'I can*  
433 *probably also do it, if the others can.'* So, that has probably been the  
434 *biggest challenge - to free oneself."*

435 Participants describe a wide range of experiences, which resulted in different  
436 challenges with regards to the instruction. For some, the level was too easy  
437 and boring, whereas others found the instruction too fast-paced. Some  
438 participants did not feel they got much out of the lessons because they  
439 perceived the level of instruction was not matched to their ability:

440 *"Salsa has been a challenge for me because it is very different from*  
441 *what I usually dance and it is also pure rhythm, but it is very different*  
442 *from (what I'm used to). But it's exciting to try something different and*  
443 *I'd like to continue with that, too."*

444

445 *"Well, I was also expecting us to get a bit more dancing out of it,*  
446 *instead of it being the same and the same and the same. And it was*  
447 *basic and basic and basic all the time."*

448 Participants who attended centers with streaming of pre-recorded classes  
449 expressed the most difficulties:

450 *" I think maybe also the difference for us who (had pre-recorded*  
451 *classes), from those who had the live-streamed (classes), was that there*  
452 *you could ask some questions (...). We didn't really have the opportunity*  
453 *to do that because it wasn't live."*

454

455 *"It was a little frustrating to sit and look at something like that. It was*  
456 *streamed, and we could see that she had a dialogue with someone who*  
457 *was not us. So, it was then, what to say, it was not particularly*  
458 *conducive, I think."*

459 Although the intervention lasted 12 weeks, the study ran over a period of  
460 seven months, which meant the participants had different starting and  
461 completion times. While this allowed for greater flexibility in recruiting,  
462 several participants found it frustrating because it limited their perceived  
463 progress in learning the dance forms, due to the varying experience levels of  
464 the new people joining the study:

465 *"Because we started at many different times: some were tested for the*  
466 *first time already in November, and I joined in January... There were*  
467 *many of the others who were much further along than we were. I think*  
468 *that was perhaps a bit of a disadvantage and a bit of a chore for them*  
469 *too, because it was repetition for them."*

470

471 *"I came in after the project had already been running. So, the first*  
472 *couple of times I think they were a bit difficult, but then things gradually*  
473 *got better with those salsa steps."*

474 ***Progression***

475 Within this main theme, two subthemes were identified: physical progression  
476 and skill transference. Most participants were previously familiar with salsa  
477 dance but were new to improvisation and were reluctant at first. The main  
478 reasons for initial discomfort were (1) being observed by others (reluctance to  
479 turn cameras on, or be seen by people passing by, and (2) unfamiliarity with  
480 the lack of rhythmic movements, which is a feature of improvised dance.  
481 However, many participants reported that their attitudes towards improvised  
482 dance changed over time, and they grew to appreciate the freedom of  
483 improvisation, which they eventually found challenging and fun.

484 *"I actually came to like (free dance) a lot, and I could feel that the body*  
485 *liked it; I think this is a good development."*

486 Participants also appreciated the opportunity to move with their entire bodies,  
487 not only focusing on hips and footwork. Many participants reported a  
488 progression in their comfort level and ability with improvisation dance during  
489 the 12-week intervention.

490 *"We were always asked (by the dance instructor) if we had got our heart*  
491 *rate up, and at least I don't think I did at first. But then it's like the more*  
492 *you go there, and the more times you dance with the others, the pulse*  
493 *starts to come up, so we know where to start the exercise."*

494

495 *"It was very 'strange' for me until I got used to it. But fun. And... it is*  
496 *true that you get hold of some other muscles than you otherwise think*  
497 *you use."*

498 Overall, participants were less likely to feel they had progressed with learning  
499 salsa, either because they had already been attending salsa classes prior to  
500 the study, or because they didn't have the opportunity to learn several dance  
501 styles:

502 *"I love salsa, but the two different dance styles are two very different*  
503 *dances if you can put it that way. And I haven't developed that much in*  
504 *the salsa area."*

505 Some participants noted that the two different styles were complementary,  
506 and could see a good connection and transference of skills from one style to  
507 the other:

508 *"I think it was cool that you did something to loosen up your body. And*  
509 *then we used it to loosen up the body on Thursday and danced the*  
510 *combination of the two (salsa and free dance). I think is really good. ... I*  
511 *can dance myself, but I can also see that my body needs the other, so I*  
512 *think the combination is great."*

### 513 **Motivation**

514 Within this main theme, three subthemes were identified: (1) social  
515 connection, (2) involvement in research study, and (3) interest in dancing.



516 Participants were motivated in part by the opportunity to be together in a  
517 group, and the social dimensions and opportunities that were created around  
518 the dance sessions held at the activity center. Participants reported that the  
519 social connection was a major motivating factor for their participation in the  
520 study, and their overall enjoyment:

521 *“There is also a social aspect to being together and I certainly wanted that*  
522 *too.”*

523 *“I would say half of it was the social interaction, so you get to meet*  
524 *people you know, and (whom) I have also gone to yoga with. It's always*  
525 *nice - that togetherness.”*

526 In general, most participants preferred dancing together in a joint location  
527 than dancing alone at home:

528 *“I've tried to (dance) at home a few times, I guess it wasn't very fun,*  
529 *because there wasn't any laughter, there wasn't anyone to talk to. (...).*  
530 *So, I like best that it was with others. To have that community and that*  
531 *laugh, and just the small talk you get at the same time. That's why I've*  
532 *had the best time getting out among others and doing that.”*

533

534 *“Especially when you're alone like I am, it's good to get out and be social*  
535 *with others. I use my activities for that, that is primarily you can say the*  
536 *social, and then it's so nice that you get to use your body in a good way*  
537 *at the same time. But it's mainly the social thing I'm after.”*

538 Participation in a research study was a motivating factor for some  
539 participants, who were interested in contributing to a research study, get  
540 opportunities to learn something new, and were keen to find out their  
541 individual results:

542 *“If you sign up for something, you also complete it, at least that's how I*  
543 *feel. Otherwise, it's a waste of people's time.”*

544

545 *“I want to continue until it's over and it's like to see how far we can*  
546 *really go with dance and learn something.”*

547 General interest in dancing and enthusiasm for learning new dance styles was  
548 a motivating factor for many participants:

549 *“It was an opportunity to be allowed to dance, because otherwise I*  
550 *wouldn't have joined. But then, I train balance and strength training*  
551 *every day, and I walk a lot. So, I move quite a lot, and then I think there*  
552 *is no music (in those other activities). So, this was a welcome gift to*  
553 *me.”*

554

555 *“I thought it could be very exciting to see what could come of it. And us*  
556 *older people, we like to move. Besides swimming and aqua-gymnastics*  
557 *and yoga, this could also come in.”*

558 Despite that only women completed the study, the focus groups did not  
559 discuss whether the group makeup influenced their enjoyment, motivation, or  
560 participation in the program.

### 561 ***Perceived Health and Wellbeing***

562 Within this main theme, three subthemes were identified: (1) physical  
563 changes, (2) social, emotional, and mental health, and (3) connection to  
564 everyday life. Some participants found the movement challenging, but the  
565 majority found the dance instruction very enjoyable. Many responded that  
566 they noticed physical changes in their own health and wellbeing, especially  
567 concerning balance, improved posture, muscle strength, greater flexibility,  
568 and reduced lower back pain:

569 *“I could actually feel in my body that it wasn't so crooked at all even.*  
570 *Because I got it after all; I could feel my whole body, it was somehow*  
571 *activated.”*

572

573 *“I don't think I had been (dancing) many times before I could feel that I*  
574 *was more flexible in my body, and I can also feel that I have gained*  
575 *more muscle strength in my legs.”*

576 A few participants reported that the intervention caused them pain and  
577 soreness, from using muscles they were not accustomed to using:

578 *“(I noticed feelings of) well-being and a little bit of soreness because*  
579 *that was something I didn't have (before). ...I haven't tried to activate so*

580 *many small muscles in my body. But you hit them. And it was only*  
581 *positive."*

582

583 *"I've gotten better at standing on one leg. (I know this) because I go to*  
584 *yoga, and there I couldn't keep my balance for very long, and it's better*  
585 *now. (...) Sometimes had to stand on one leg during the dance, and I*  
586 *could actually do that for a long time, whereas I had problems with it in*  
587 *yoga. So that's why I think it's because of the dance's that it's gotten*  
588 *better."*

589

590 *" I think it actually gave me a sense of well-being, and it gave me some*  
591 *good, and some tips on how to stay flexible."*

592

593 *"In the first few times I think I was in pain. Now, I have osteoporosis,*  
594 *and I think I had pain in my back. But after quite a few times, it has*  
595 *loosened up somehow. And I love those different movements, it does*  
596 *something really good for my body, I can feel it. (...) you become much*  
597 *more flexible, and especially your classes there, I love them. Because*  
598 *you get the whole body, legs, arms, and everything moving, and it does*  
599 *something really good. And I would also say balance, I can feel that too.*  
600 *Yeah, standing and putting on socks and all that stuff now is a lot easier*  
601 *than it was before I started this project."*

602

603 *"I really just enjoyed getting my upper body going. I can feel that my*  
604 *movements around the salsa day, they have really changed in the period*  
605 *that has passed, in fact in a relatively short time. There is a different*  
606 *movement in the upper body because of salsa, and also because we sat*  
607 *on a chair (in free dance) and really used the body for the warm-up (...)."*

608

609 *"So, the flexibility thing, I actually notice that after three times or*  
610 *something like that. Muscle strength, I can see that, some fat has*  
611 *disappeared on the legs and muscles have come instead, and I can feel it*  
612 *too. The demanding exercise that I do for yoga is much easier now than*  
613 *before."*

614

615 *"I definitely think I can feel in my balance, that it has improved.*  
616 *(Although) I haven't had much trouble with the balance, but it has*  
617 *improved."*

618

619 *"I think I have gained greater body awareness and a straighter back. And*  
620 *you can say that I feel more grounded. I have also gotten better at*  
621 *feeling my feet in the ground. And like the others, I think that I have*  
622 *become more agile and flexible in my body. It also feels like the ability*  
623 *to balance has improved. ... I notice that when I go to yoga, where we do*

624 *balance exercises. I have become better at keeping my balance on one*  
625 *leg in different postures for longer than before.”*

626 Other participants were less sure that the perceived changes were a result of  
627 the dance training, because of their already active lifestyles:

628 *“I also go to several things, and it can be difficult to distinguish which is*  
629 *which. (...) I always take the stairs rather than the lift, and I’m not*  
630 *someone who goes for long walks, but I move a lot in everyday life. But I*  
631 *have an awfully big house with stairs up and stairs down. (...) I would*  
632 *like to be able to say, it’s your dance, it’s (the instructor’s) dance that*  
633 *has done it, but I can’t say that. I don’t know, unfortunately.”*

634

635 *“It is difficult to decide, because we have so much other training that*  
636 *has fallen in the same period. So, I can’t separate that. I have definitely*  
637 *improved in both balance and flexibility.”*

638 Only a few participants reported experiencing no change at all:

639 *“I don’t feel that I have become physically stronger.... I do so much in*  
640 *advance and train so much balance and fitness on the side. But it has of*  
641 *course been different and exciting to be here, but I don’t think it has*  
642 *helped physically.”*

643

644 *“I can’t feel any difference because I’m already used to moving a lot*  
645 *both in the swimming pool and when I walk. I can’t feel that it has*

646 *gotten better or worse or anything else. So, it's been a good experience,*  
647 *it's physical; I can't feel any difference there."*

648 Several participants reported making new acquaintances and friendships as a  
649 result of the intervention, and increased social activities, such as arranging to  
650 meet for coffee or lunch after the dance classes:

651 *"But it has been nice to be with someone. When we finished, we were*  
652 *such a bunch. Who could go in and have a good time and have a cup of*  
653 *coffee and talk afterwards. And you wouldn't have done that if you were*  
654 *sitting alone at home."*

655

656 *"It's been good (...) and there have also been people who don't usually*  
657 *come to the center but want to continue coming here. I think that is a*  
658 *good place to come."*

659 Some participants became inspired to self-organize group activities for online  
660 streaming of other classes:

661 *"I live in community (housing), so at half past five I have invited my*  
662 *roommates over to dance in the communal house. So now we do that*  
663 *once a week, and it's somewhat inspired by the fact that we danced*  
664 *online down at the center."*

665 Those participating at home had fewer opportunities for social engagement.  
666 Predictably, responses to perceived changes in social and emotional health  
667 differed based on whether the participants followed instruction at the activity

668 center or at home. For those who danced both in-person and online, they all  
669 preferred social aspects on dancing in-person with others. One participant  
670 who only participated online said:

671 *“When I’ve danced, I’ve danced via YouTube and others haven’t been on*  
672 *that. And since I’ve pretty much always run most of the sessions on*  
673 *YouTube. So, when I’ve been online and I’ve danced online, I was kind of*  
674 *attuned to it. So, I don’t know if I missed being able to look at someone.”*

675 Several participants reported noticing the benefits of the dance in other areas  
676 of their everyday life, including activities of daily living (ADLs):

677 *“Dancing makes you more flexible. Then it becomes easier when you*  
678 *have dropped something, and you must go down after it and wash*  
679 *windows and things like that. So it is, as we like to say, both hands and*  
680 *feet, so that you get a lighter body in one way or another, a flexible body*  
681 *– it’s great.”*

682

683 *“I think the body is lighter in one way or another. And you find it easier*  
684 *to do the different things. It can be both cleaning, it can be vacuuming,*  
685 *it can be anything. I think the body has become lighter, and not so stiff*  
686 *in the limb.”*

687

688 *“I have had many good stretches there, and balance. But I haven’t*  
689 *improved in balance either, at least in the test. I can’t understand that.*  
690 *But I feel I have a better balance. For example, I think I’ve gotten better*



691 *at relaxing, because when you're afraid of falling, you tense up. I think*  
692 *I've gotten better at relaxing. (...) So there has been improved balance, I*  
693 *am absolutely sure of that."*

#### 694 ***Online Dance***

695 Within this main theme, six subthemes were identified: familiarity/enjoying  
696 freedom of movement, connection to instructors, lack of feedback, flexibility of  
697 YouTube, individual effort, suggestions for improvement. Participants were  
698 reluctant to have cameras on initially, and it took some convincing from the  
699 instructors to put on their cameras (if at home), and others who participated  
700 at the activity centers experienced feelings of self-consciousness with the  
701 unfamiliar movements (especially in free dance):

702 *"It may well be that I run a little wild sometimes during (salsa). Because*  
703 *maybe it went too slow or too fast. But it was great with you, you could*  
704 *choose for yourself. There wasn't such a firm frame."*

705 Many reported that they became less inhibited over time and learned to enjoy  
706 the free movement.

707 *"I think I learned to be more free. I wasn't as inhibited when we finished*  
708 *dancing as I was before we started."*

709 Participants reported that they mostly felt connected to the instructors,  
710 although they would have wished for in-person and more personalised  
711 instruction:

712 *"I also think that I 'know' both (instructors) because you become close*  
713 *in one way or another. We do silly things with (them), and (they) do the*  
714 *same with us.*

715

716 Participants noted that while online instruction was different than the  
717 presence of live instructors, the instructors accommodated their needs and  
718 established a relationship with them:

719 *"It cannot be compared to being together and the instructor also being*  
720 *physically present. And the thing about dancing together. But I've been*  
721 *really happy with the online instruction, and I really think I've gotten*  
722 *good instructions from both (instructors)."*

723

724 *" I think it has been perfectly okay to follow along online. I felt*  
725 *connected to what was happening on the screen."*

726

727 *"As far as I'm concerned, I don't think it matters that much. Of course,*  
728 *it's nice to have someone physically there, but when it can't be*  
729 *otherwise, I think it's fine."*

730 Several participants mentioned lack of feedback on their dance steps from the  
731 instructors as a main criticism of the project and online dance instruction,  
732 with several participants mentioning that they specifically wanted to "be  
733 corrected" when they had done something wrong. This was especially

734 pronounced among participants who participated at activity centers that  
735 chose to stream pre-recorded videos (YouTube), where there was no  
736 opportunity for the instructors to give personalised feedback or motivation to  
737 individuals:

738

739 *“That’s probably what I miss the most: it’s that you have to be corrected*  
740 *and you can’t do that very well when, for example, (the instructor) is*  
741 *standing in front of the screen at home and we’re standing in a room.*  
742 *After all, you can’t stand around shouting ‘now you have to do such and*  
743 *such.’ Otherwise, I think it’s fantastic that it can be realized with such*  
744 *an online program, it’s fantastic.”*

745 Online dancing was preferable for some, as it addressed some of their  
746 challenges:

747 *“Online, that’s the advantage, of course you can do it from home, so you*  
748 *don’t have to spend time on transport, and the disadvantage is simply*  
749 *that the community isn’t there. And the fact that you can learn a little*  
750 *from each other even when you are standing there and are a little more*  
751 *active. At least that’s how I think. It’s such immediate advantages and*  
752 *disadvantages.”*

753

754 *“The advantage of it being online is that we can go to YouTube when we*  
755 *get home and then we can try to practice a little more if it’s something*

756 *we just can't figure out, and then rewind it. We can't do that when*  
757 *you're physically present. So, you can't go home and say to him, how did*  
758 *we do there? We can do that when you have it on YouTube, that's an*  
759 *advantage."*

760

761 *"One of the things that attracted me when I signed up for (the study)*  
762 *was that it was online (...) After all I live far away and have to drive for*  
763 *it. And it's fantastic that you can just press a few buttons and still be*  
764 *involved."*

765 Several participants who attended both in-person at activity centers and at  
766 home reported differences in their perceived effort, depending on where they  
767 participated:

768 *"I think I get more out of it if I make more of an effort when I'm with*  
769 *others. At home I like to go and cheat a little."*

770

771 *"I think the difference is that when I am with others and see others, it is*  
772 *easier to get other ideas than to follow the verbal instructions that you*  
773 *have to give. It becomes a little less imaginative when I have to use my*  
774 *own movement patterns and cannot be inspired by others."*

775

776 *"I've been streaming it at home, so I've been alone and it's a very big*  
777 *difference, and not nearly as rewarding, and it's been hard for me to*

778 *keep myself engaged dancing around at home. So, it is clearly the social*  
779 *aspect that plays a role and the attendance which is important: it is*  
780 *what gives joy that you have the others and the persistence as well."*

## 781 **DISCUSSION**

782 The main findings of this exploratory study were that several indices of  
783 functional fitness in older women improved over time after taking part in a 12-  
784 week online, community-implemented dance intervention consisting of salsa  
785 and improvisation, whereas the participants' feelings of loneliness did not  
786 appear to change. Although the quantitative measures for loneliness and  
787 HRQOL did not reveal a significant change, the qualitative results from the  
788 post-intervention interviews suggest that the intervention had an overall  
789 positive impact on health and wellbeing, especially the social engagement.  
790 Specifically, the qualitative results suggest that when implemented in a  
791 community setting with mutual participation by others, online dancing may  
792 positively influence social engagement and the older women's perception of  
793 their own physical abilities as well as mental and emotional wellbeing.  
794 Interestingly, the older women's self-perception of enhanced physical abilities  
795 and emotional wellbeing was observed in the qualitative data, but not in the  
796 surveys, which should be considered when designing future studies to  
797 evaluate wellbeing and HRQOL.

798 The discrepancy in the results from the quantitative and qualitative  
799 data concerning wellbeing and HRQOL evidence the need for more mixed-  
800 methods research into the impact of dance and other complex interventions. A  
801 limited number of mixed-method studies have explored the impact of dance

802 training on mental and physical health in older adults. Ambegoankar et al.  
803 reported that twice weekly ballroom dance sessions for ten weeks had a  
804 positive impact on cognition and physical health determined by the Short  
805 Physical Performance Battery [7]. In another study, O'Toole et al. showed that  
806 one weekly session for six weeks of creative expression and contemporary  
807 dance routines for older adults enhanced community and social participation  
808 as well as the participants perception of their own emotional well-being [11].  
809 Taken together, the findings from our study are consistent with the findings  
810 from previous investigations suggesting that dance training may provide a  
811 strategy for engaging older adults in physical activity and support mental and  
812 physical health outcomes. A novel contribution of this study is the  
813 demonstration of the feasibility of an online, group dance intervention that  
814 contributed to positive benefits in physical health and wellbeing, including  
815 social connection as well as significant improvements in functional fitness.  
816 However, our findings also show there were differences in the experiences of  
817 those who participated with live-streaming instruction and those who  
818 participated with pre-recorded instruction, due to the lack of interaction and  
819 feedback on specific dance steps when dancing to the pre-recorded  
820 instruction videos.

821           Online instruction implies that participants can follow the dance  
822 training via a computer at their homes (i.e., remotely), which may directly  
823 address frequently reported physical activity barriers for older adults,  
824 including transportation issues, time constraints, and inclement weather [6],  
825 while at the same time reducing the need for public space requirements and

826 physical presence by the instructors. Therefore, when considering the  
827 reported health effects from dancing combined with the practical advantages  
828 of remote instruction, online interventions could potentially provide one  
829 possible solution for mitigating the increasing economical public healthcare  
830 burdens associated with the still growing older adult population.

831           We identified a few challenges with the online group dance  
832 training. These challenges primarily concerned sound and streaming, namely  
833 the ability of the participants to hear both the music and the vocal instructions  
834 given by the dance instructors. There was no trouble with connectivity. The  
835 research team was made aware of the sound issue early on, and the sound  
836 issues were resolved within the first three weeks that the study ran. Another  
837 challenge identified within the Online Dancing theme (*Subtheme 6.3: Lack of*  
838 *Feedback*). The instructors only found out at a very advanced point in the  
839 study period that some of the participants were streaming the lessons  
840 regularly outside of the live instruction dance times. This was not how the  
841 intervention was intended, so the research team had limited ability to control,  
842 or course correct for this.

### 843 **Physical health**

#### 844 ***Functional fitness***

845 As the majority of risk factors for chronic diseases increase with age, the  
846 adoption of regular physical activity is crucial to buffer the decline in  
847 physiological reserve of organ systems associated with aging [34] and to  
848 improve mental and physical health outcomes among older adults. However,

849 maintaining a certain level of physiological capacity during aging is not only  
850 important for attenuating chronic disease risk but also for retaining the ability  
851 to perform ADL independently. Using the SFT, we observed significant  
852 increases over time in several aspects of fitness, including upper body  
853 strength (arm curls), aerobic endurance (2-min step test), and hamstring  
854 flexibility (chair-sit-and-reach). Such improvements in fitness were generally  
855 supported by the qualitative results where many participants responded that  
856 they had noticed positive physical changes in their own health, especially  
857 concerning balance, muscle strength, improved posture, and greater  
858 flexibility. That in-person dance training can improve flexibility, muscle  
859 strength, and aerobic endurance in older women is congruent with the  
860 existing literature [35, 36]. In a systematic review and meta-analysis of 29  
861 randomized clinical trials (all but one trial included mainly women), Mattle et  
862 al. reported benefits of in-person dance-based mind-motor activities on several  
863 aspects of fitness, including balance, mobility, and muscle strength [35]. In  
864 another systematic review including 18 studies using various dance styles,  
865 Hwang et al. reported that the dancing, regardless of style, generally seem to  
866 improve measures of aerobic fitness and muscle strength in older adults when  
867 delivered in-person [36]. Overall, the results from these systematic reviews  
868 are complemented by the findings from the current study and suggest that  
869 online dancing may be considered a beneficial method for improving several  
870 aspects of functional fitness concurrently, while at the same time allowing for  
871 flexibility in where and when to exercise and for delivering this opportunity to  
872 more people than would be financially feasible with in-person instructions.



873 Considering that older adults frequently report time constraints as a reason  
874 for not being physically active [6], reducing the time-commitment that could  
875 otherwise occur in in-person training settings (i.e., strength training, aerobic  
876 training, and flexibility at a fitness center) could be of great value. Such  
877 perspectives were also supported by the qualitative results as several of the  
878 participants mentioned that they have busy schedules that include various  
879 responsibilities such as physical activities and social engagements.

880           The significant and large effect size for the pre-post change in  
881 chair-sit-and-reach performance indicates that the dance training was  
882 associated with profound demands to hamstring flexibility suggesting that  
883 weekly online dance sessions, throughout 12 weeks, improve hamstring  
884 flexibility in older women. Consistent with the quantitative results, results  
885 from the interviews confirmed that several of the participants felt that they  
886 were more flexible after 12 weeks of dancing.

887           The significant increase in the number of arm curls performed after  
888 12 weeks of dance training may seem surprising as a recent meta-analysis did  
889 not show any significant effect of dance training on arm curls test  
890 performance in older adults [37]. A possible reason for improvement in the  
891 arm curls test after 12 weeks could be enhancement of neuromuscular  
892 recruitment and coordination in the upper limb. Indeed, when older adults  
893 experienced in dancing are compared with matched controls without dancing  
894 experience, better multi-muscle coordination and synergism were found in the  
895 dancing group [38]. However, it is important to note that the findings

896 presented by Wang et. al. [38] was observed in the lower limb, while the  
897 present results show improvement in the upper arm.

898 Finally, results showed a significant increase in 2-min step test  
899 performance, indicative of improved aerobic endurance. While we did not  
900 measure cardiorespiratory fitness directly, the 2-min step test has shown to  
901 correlate significantly with other more direct measures of cardiorespiratory  
902 fitness suggesting that the 2-min step test can be used a valid field-based  
903 surrogate measure of cardiorespiratory fitness [25]. Not only is retainment of  
904 a certain level of fitness required for maintaining the ability to perform ADL,  
905 such as climbing the stairs, mounting evidence also suggests that low levels of  
906 cardiorespiratory fitness may be an even stronger predictor of mortality than  
907 established cardiovascular disease risk factors such as smoking, high  
908 cholesterol, hypertension, and type 2 diabetes mellitus [39]. Accordingly,  
909 dance classes might be a way to maintain functional independence and  
910 reducing overall mortality risk through enhancement or preservation of  
911 cardiorespiratory fitness.

### 912 ***Body mass and composition***

913 An interesting observation was the significant increase in body mass (and  
914 BMI) over time. However, such gross measures of body composition are  
915 insensitive for distinguishing between changes in fat and lean body mass.  
916 Indeed, the increase in body mass was not accompanied by similar changes in  
917 surrogate measures of body fat and distribution (i.e., sum of skin folds and  
918 waist circumference). In fact, waist circumference, a valid surrogate measure

919 of visceral adiposity, was, if anything, lower at the post-intervention  
920 assessment (mean  $\Delta$  from baseline: -1.3 cm,  $P = 0.051$ ). Considering such  
921 almost significant reduction in waist circumference, despite increases in body  
922 mass, could indicate that the dance training may have led to accretion in lean  
923 mass, which was also supported by the qualitative results, where several  
924 participants reported experiencing increased muscle strength over the period.  
925 However, direct measurements of body composition by magnetic resonance  
926 imaging or dual energy X-ray absorptiometry scans are needed to test this  
927 hypothesis.

## 928 **Mental health and Wellbeing**

### 929 ***Questionnaires***

930 Although the change over time in TLS, as a measure of loneliness, almost  
931 reached statistical significance, the small effect size indicate that such change  
932 may not have been clinically meaningful. The small effect could relate to the  
933 fact that none of the participants were feeling lonely at baseline. In fact, at  
934 baseline all the participants could be categorized as having either a 'low' or  
935 'moderate' degree of loneliness according to Perry et al. [32], leaving little  
936 room for improvement. This was supported by the qualitative results in which  
937 most of the participants responded that they were already extremely social  
938 before the study began and involved in several ongoing activities. Notably,  
939 there were, however, three participants less at the post-intervention who  
940 reported a moderate degree of loneliness (and instead reported a low degree  
941 of loneliness), suggesting a positive change in mental health for these

942 participants. Similarly, there were no changes in any of the SF-36 summary  
943 scores suggesting that the intervention did not impact either mental or  
944 physical components of HRQOL. Again, the explanation may relate to the  
945 generally healthy cohort of older women included in the study, as the  
946 participants at baseline already reported their HRQOL to be at the high end of  
947 the summary scores. Nonetheless, evidence of positive changes in wellbeing  
948 was found in the qualitative results, wherein several participants responded  
949 during the interviews that the dance training resulted in joyful social activities  
950 (*"It gives such joy to be here with others"*), and a different self-consciousness  
951 about their own body, which made them feel "freer" and happier.

### 952 ***Participants' experiences of the intervention***

953 In general, most participants found the dance instruction very enjoyable and  
954 self-reported noticeable positive changes in both their physical health and  
955 wellbeing, including perceived improvements in flexibility and balance,  
956 improved posture, muscle strength, greater flexibility, and reduced lower back  
957 pain. Moreover, participants were mostly satisfied with the level and quality of  
958 online instruction. However, there was a significant difference in the  
959 experiences of those who participated with live-streaming instruction, and  
960 those who participated with pre-recorded instruction. One important factor  
961 from the qualitative results was that several participants who attended both at  
962 activity centers and at home reported differences in their perceived effort and  
963 motivation, depending on where they participated. Participants were more

964 likely to remain physically and mentally engaged if they were participating in  
965 a group at an activity center than if they were at home alone.

966           Several participants mentioned lack of feedback on their dance  
967 steps from the instructors as a main criticism of the online dance instruction.  
968 This was especially pronounced among participants who took part at activity  
969 centers that chose to stream pre-recorded videos, where there was no  
970 opportunity for the instructors to give personalized feedback or motivation to  
971 individuals. Many participants struggled with this one-sided dimension. This is  
972 not normally a problem that is encountered during in-person or live-streamed  
973 dance classes and should be addressed in future studies with online dance  
974 training. On the other hand, some participants with more familiarity with  
975 technology emphasized the flexibility of online dancing from YouTube as  
976 preferable, because it could be done on their own time and did not require  
977 parking or other hassles.

### 978 **Strengths and limitations**

979 A major strength of this exploratory study is the use of both qualitative (focus  
980 group interviews) and quantitative (blood pressure, body composition, SFT,  
981 and questionnaires) measures, which allowed us to explore the benefits of  
982 online dance training on health from a holistic perspective, i.e., assessment of  
983 both mental and physical health outcomes with multiple instruments.  
984 Additionally, the qualitative data for perceived physical health and wellbeing  
985 revealed benefits of the intervention that would not have been captured if  
986 relying on quantitative instruments alone (loneliness and HRQOL  
987 questionnaires). Such observations emphasize the merits of mixed-method

988 research when evaluating complex health interventions. Another noticeable  
989 strength is the high degree of external validity in the study, as the  
990 intervention was implemented in practice, thereby closely approximating the  
991 environment that we aim to generalize our findings to.

992           Nonetheless, the study does have some limitations. The lack of a  
993 control group is a limitation, as we are unable to compare the changes in the  
994 intervention group against natural time-course changes over 12 weeks for this  
995 population, or quantify the inherent variability in outcome measures,  
996 including a potential “learning effect” from the repeated testing. Similarly, no  
997 restrictions were made regarding participation in other sports or training  
998 activities during the study period. While this may have enhanced the  
999 ecological validity of the study, it may also limit the ability to distinguish the  
1000 benefits of the intervention from other activities.

1001           Consistent with the majority of previous studies [35, 36], our  
1002 results might not be generalizable to older men, as all but one of the  
1003 participants were women, with the only man dropping out due to feeling  
1004 uncomfortable with being outnumbered. The overwhelmingly female bias is  
1005 consistent with the literature on dance interventions, and sex-related barriers  
1006 in recruitment and retention should be addressed in future studies.

1007           The current study is limited by the lack of control of participant  
1008 attendance, which may negatively affect the accuracy of objectively assessing  
1009 the effectiveness of the intervention. By design, participants were allowed to  
1010 play (and replay) the dance classes from YouTube on their own, and thus we

1011 were unable to accurately record participant attendance. Accordingly, some  
1012 participants may have attended the classes more than twice weekly, while  
1013 others may have attended only once weekly, resulting in uncertainty in the  
1014 exact frequency of training and thus total volume of dancing during the  
1015 intervention period. While this was a limitation, it also approximated a more  
1016 realistic, real-life context for our study. Future studies may consider applying  
1017 a stricter control of participant attendance, or alternatively instruct  
1018 participants to log the number of attended classes. In this way, it may also be  
1019 possible to evaluate a potential dose-response relationship between the  
1020 number of weekly classes and the change in health outcomes. Also, we did not  
1021 control or monitor the exercise intensity during the dance classes, which is a  
1022 limitation as we are unable to report the exact physiological stimuli that the  
1023 participants were exposed to.

1024           A common risk of physical activity interventions conducted with  
1025 older adults is high dropout rates [40]. A high dropout rate was also evident in  
1026 our study, as 13 out of 45 participants (29%) dropped out of the study before  
1027 the final post-intervention assessment. Although not all dropouts were study-  
1028 related, a dropout rate of almost 30% should be considered when evaluating  
1029 the viability of online dance interventions among older adults. As a result of  
1030 the high dropout rate and the lack of intention-to-treat analysis, our results  
1031 may be somewhat biased towards those who completed the intervention and  
1032 found the intervention enjoyable. To address this limitation, we did invite all  
1033 participants for the post-intervention interview, so those participants who  
1034 dropped out could share their perspectives and have a more comprehensive

1035 and balanced reflection of both the positive and negative aspects of the  
1036 intervention. Unfortunately, none of those participants who dropped out were  
1037 able to attend the interview. Finally, as the dropout was higher and the effect  
1038 size lower than expected, the study was underpowered to detect a significant  
1039 change in loneliness (obtained power = 50%).

#### 1040 **Barriers for future implementation**

1041 Important insights and experiences were obtained from this exploratory study  
1042 that may help to improve future implementation of online dance training  
1043 interventions in community settings. Specifically, we identified several  
1044 barriers that should be addressed prior to successful implementation:

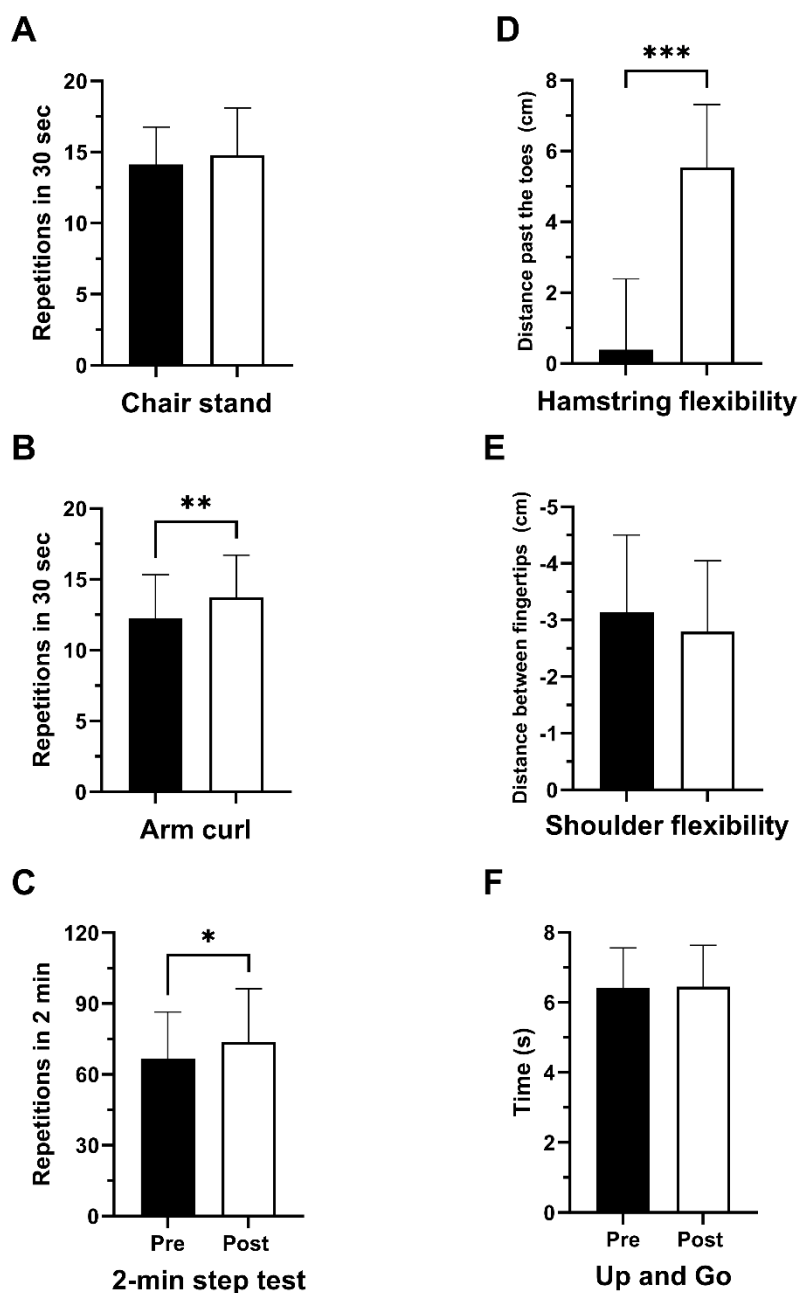
- 1045     □ Adequate time should be devoted prior to the intervention to resolve any  
1046     technical difficulties associated with audio streaming and transmitting  
1047     over live-stream.
- 1048     □ While pre-recorded online dance classes offer flexibility in terms of  
1049     when and where to attend, the lack of personalized feedback on dancing  
1050     technique and one-sided communication from the instructor may  
1051     negative impact the participants enjoyment and motivation to attend.
- 1052     □ Participant retention and enjoyment may potentially be improved with  
1053     live-instruction, allowing for a more personalized instruction and  
1054     feedback and instructor-participant interaction. Even intermittent  
1055     contact with a live instructor might improve participants' overall  
1056     experience.

#### 1057 **Conclusion**



1058 This exploratory mixed-methods study showed that 12 weeks of community-  
1059 implemented online dance training improved several aspects of physical  
1060 health among older women, including aerobic endurance, upper-body  
1061 strength, and hamstring flexibility, as well as the older women's self-  
1062 perception of their own improved physical abilities, self-efficacy, and  
1063 wellbeing. While most participants found the online intervention enjoyable  
1064 and socially rewarding, several participants missed the feedback from the  
1065 instructors that otherwise would occur with in-person instruction. The results  
1066 speak to participants' self-perception of increased flexibility and range and  
1067 ease of movement, as well as increased social activities as a result of the  
1068 online intervention. Further research with stricter control of study variables is  
1069 warranted to further investigate the efficacy of online dance training on  
1070 physical and mental health in older adults. Finally, given the multifactorial  
1071 risk of fall accidents among older adults, future research may explore the  
1072 benefits of online dance training on fall-related risk factors, such as gait speed  
1073 and postural control, and other positive changes in behavior.

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1077 **Figure 1. Changes in Senior Fitness Test items following 12 weeks of**  
 1078 **dance training.**

1079 (A), number of chair stands performed in 30 seconds, (B) number of arm curls  
 1080 performed in 30 seconds, (C) number of steps performed in 2 minutes, (D)  
 1081 fingertip distance behind (-) or past (+) the toes during chair sit-and-reach, (E)  
 1082 distance behind (-) or past (+) fingertip to fingertip during back scratch, (F)  
 1083 time in seconds to complete the 8-foot Up-and-Go. Data are means  $\pm$  SD,  
 1084 except for panel D and E where error bars represent SEM. \*\*\* $P < 0.001$ ,  
 1085 \*\* $P < 0.01$ , \* $P < 0.05$ .

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Table 1. Baseline participant characteristics

	<b>Online dance intervention (N = 45)</b>
Sex, W/M	44/1
Age, yr	74.0 ± 5.3
Height, m	1.62 ± 0.58
Body mass, kg	69.7 ± 13.0
BMI, kg/m <sup>2</sup>	26.4 ± 4.9
SBP, mmHg	133 ± 15
DBP, mmHg	79 ± 8

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W=Women; M=Men; BMI=Body mass index; SBP=Systolic blood pressure; DBP=Diastolic blood pressure. Values are n, or mean ± SD.

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Table 2. Focus group main themes and subthemes identified through thematic analysis (focus groups, N = 8; participants, N = 28)

<b>Theme 1: Participation</b>	
Subtheme 1.1	Description of individual participation
Subtheme 1.2	Preferences for instruction
Subtheme 1.3	Level and quality of instruction
Subtheme 1.4	Obstacles to participation

<b>Theme 2: Challenges</b>	
Subtheme 2.1	Technical difficulties
Subtheme 2.2	Challenges with their own movement
Subtheme 2.3	Challenges with the instruction
Subtheme 2.4	Self-consciousness
Subtheme 2.5	Challenges with the method
<b>Theme 3: Progression</b>	
Subtheme 3.1	Physical progression
Subtheme 3.2	Skill transference
<b>Theme 4: Motivation</b>	
Subtheme 3.1	Social connection
Subtheme 3.2	Involvement in research study
Subtheme 3.3	Interest in dancing
<b>Theme 5: Perceived Health &amp; Well-Being</b>	
Subtheme 5.1	Physical changes
Subtheme 5.2	Social, emotional, and mental health
Subtheme 5.3	Connection to everyday life
<b>Theme 6: Online Dancing</b>	
Subtheme 6.1	Familiarity / freedom of movement
Subtheme 6.2	Connection to instructors
Subtheme 6.3	Lack of feedback
Subtheme 6.4	Flexibility of YouTube
Subtheme 6.5	Individual effort
Subtheme 6.6	Suggestions for improvement

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1101 Table 3. Self-reported loneliness and health-related quality of life at baseline  
 1102 and after 12 weeks of online dance (N = 32)

	<b>Baseline</b>	<b>Post-intervention</b>	<b>P-value</b>	<b>Effect size (d)</b>
<b>Loneliness (TLS)</b>	35.5 ± 7.1	33.5 ± 7.0	0.054	0.36
<b>Degree of loneliness</b>				
Low (20-34)	15 (47%)	18 (56%)		
Moderate (35-49)	17 (53%)	14 (44%)		
Moderate-high (50-64)	0 (0%)	0 (0%)		
High degree (65-80)	0 (0%)	0 (0%)		
<b>HRQOL</b>				
<b>Physical health</b>				
Physical functioning	85.2 ± 16.0	85.9 ± 12.9	0.633	0.09
Role-Physical	82.8 ± 31.4	82.0 ± 30.6	0.879	0.03
Bodily pain	85.2 ± 19.0	86.6 ± 14.1	0.551	0.11
General health	77.7 ± 14.4	76.6 ± 14.5	0.699	0.07
<b>HRQOL</b>				
<b>Mental health</b>				
Vitality	75.6 ± 15.2	76.6 ± 13.6	0.764	0.05
Social functioning	95.3 ± 9.9	93.8 ± 14.9	0.619	0.09
Role-Emotional	94.8 ± 12.3	86.5 ± 27.9	0.118	0.28
Mental health	86.1 ± 12.9	85.6 ± 11.6	0.854	0.03

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1106 **DECLARATIONS**

1107 **Ethics approval and consent to participate**

1108 The study was approved by the North Denmark Region Committee on Health

1109 Research Ethics (N-20220045) and conducted in accordance with the  
1110 Declaration of Helsinki. All participants provided written informed consent.

1111 **Consent for publication**

1112 Not applicable

1113 **Availability of data and materials**

1114 The datasets used and analyzed in the presented study are available from the  
1115 corresponding author on reasonable request.

1116 **Competing interests**

1117 The authors declare that they have no competing interests.

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1119 This work was supported by TrygFonden. The foundation did not play any role  
1120 in the design of the study, in collection, analysis, and interpretation of data  
1121 nor in writing the manuscript.

1122 **Authors' contributions**

1123 RKH, EJ, MV, and RPH conceived and designed the study. Data collection and  
1124 analysis were performed by RKH, DE, EJ, and RPH. RKH, EJ, and RPH drafted  
1125 the manuscript. All authors read, revised, and approved the manuscript.

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