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Life-space mobility and dimensions of depressive symptoms among community-dwelling older adults

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ABSTRACT

2 **Objectives.** To examine the association between life-space mobility and different dimensions
3 of depressive symptoms among older community-dwelling people.

4 **Methods.** Cross-sectional analyses of baseline-data of the “Life-space mobility in old age”
5 cohort study. The participants were community-dwelling women and men aged 75-90 years
6 (N=848). Data were gathered via structured interviews in participants’ home. Life-space
7 mobility (the University of Alabama at Birmingham (UAB) Life-Space Assessment –
8 questionnaire) and depressive symptoms (Centre for Epidemiological studies Depression
9 Scale, CES-D) were assessed. Other factors examined included sociodemographic factors,
10 difficulties walking 500m, number of chronic diseases and the sense of autonomy in
11 participation outdoors (subscale of Impact on Participation and Autonomy questionnaire).

12 **Results.** Poorer life-space mobility was associated with higher prevalence of different
13 dimensions of depressive symptoms. The associations were partially mediated through
14 walking difficulties, health and the sense of autonomy in participation outdoor activities.

15 **Conclusion.** Poorer life-space mobility interrelates with higher probability for depressive
16 symptoms, thus compromising older adults’ mental wellbeing. A focus on older adults’ life-
17 space mobility may assist early identification of persons, who have elevated risk for
18 depressive symptoms. The association between life-space mobility and depressive symptoms
19 should be studied further utilizing longitudinal study designs to examine temporality and
20 potential causality.

21 **Key Words:** life-space, depression, aging, older people

22

23 INTRODUCTION

24

25 With aging, major life course events, such as loss of a spouse (Schaan, 2013), changes in
26 health and physical ability (Enkvist, Ekström, & Elmståhl, 2012; Hirvensalo et al., 2007),
27 cognitive decline (Djernes, 2006) and changes in social networks (Glass, De Leon, Carlos F
28 Mendes, Bassuk, & Berkman, 2006), as well as potential effects of cumulative adversity over
29 the life-course (Fiske, Wetherell, & Gatz, 2009) can increase the risk for depressive
30 symptoms. It has been suggested, that regardless of whether the underlying risks for
31 depression are due to psychological, biological or social factors, one of the main reasons for
32 increased depressive symptoms in old age is reduced engagement with the environment
33 (Fiske et al., 2009).

34 A useful way to view older adults' functioning and participation in a real world
35 situation is through life-space mobility. Life-space mobility refers to the size of the spatial
36 area in which a person moves in everyday life, the frequency of going out and the need for
37 assistance (Baker, Bodner, & Allman, 2003; Stalvey, Owsley, Sloane, & Ball, 1999). Life-
38 space mobility does not measure only individuals' ability to walk, but includes also other
39 forms of mobility, such as using public transportation or driving a car. A larger life-space
40 provides an individual with more opportunities to engage with society (Kono, Kai, Sakato, &
41 Rubenstein, 2004), while restricted life-space mobility may reflect limited access to societal
42 amenities (Brown et al., 2009; Rosso, Taylor, Tabb, & Michael, 2013). Thus life-space
43 mobility does not refer merely to older adults' functional ability and the spatial extent of
44 movement.

45 Although major depression among older adults is rather infrequent, affecting
46 only 1-5% of the older population (Hasin, Goodwin, Stinson, & Grant, 2005), the prevalence
47 of sub-threshold levels of depression among community-dwelling older adults is substantially

48 higher, at 8-16% (Blazer, 2003; Djernes, 2006). Besides clinically diagnosed depression, also
49 sub-threshold levels of depression are associated with many disadvantages, such as increased
50 functional limitations, morbidity and mortality (Chopra et al., 2005; Hybels, Blazer, & Pieper,
51 2001; Penninx et al., 1998).

52 Previous studies, which have used multi-item measurement scales to examine
53 different dimensions of depression, have provided evidence that depression is a
54 multidimensional entity (Hays et al., 1998; Johnson, Mcleod, Sharpe, & Johnston, 2008;
55 Schroevers, Sanderman, Van Sonderen, & Ranchor, 2000; Watson & Clark, 1997). For
56 example, the Centre for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977)
57 which has been widely used in epidemiologic studies for assessing depressive symptoms
58 includes four different dimensions of depression: depressed affect, somatic symptoms,
59 positive affect and interpersonal problems. Because of the multidimensionality of these
60 measurement scales, using only global summary score may hide relevant individual
61 variability of depressive symptoms (Schroevers, Sanderman, van Sonderen, & Ranchor,
62 2000). Even though the overall level of depressive symptoms may not vary significantly,
63 there may be differences in the patterns of particular symptoms (Cole, Kawachi, Maller, &
64 Berkman, 2000).

65 It has been found that presentation of depressive symptoms is heterogeneous
66 also among older adults (Chen, Eaton, Gallo, & Nestadt, 2000; Mora et al., 2012). This
67 means that two persons with the same score on a depression scale will not necessarily have
68 similar symptoms. Manifestation of depressive symptoms in older adults may also be
69 different from their manifestation in younger people (Fiske et al., 2009; Sözeri-Varma, 2012).
70 Typical depressive symptoms, such as sadness, may not be prominent (Ready et al., 2011),
71 whereas somatic and vegetative symptoms (i.e. sleeplessness, loss of appetite, pain), lack of
72 positive affect and sense of hopelessness about the future are more common (Chen et al.,

73 2000; Fiske et al., 2009; Sözeri-Varma, 2012). On this account, we should pay attention to
74 the diversity of the manifestations of depressive symptoms as looking only at the threshold of
75 the total score of the depression scale may not be detailed enough to detect these differences.

76 Different dimensions of depression may have different correlates (Clark,
77 Watson, Becker, & Kleinman, 1991; Fonda & Herzog, 2001; Hays et al., 1998; Zich,
78 Attkisson, & Greenfield, 1990). Physical limitations and health have a strong association with
79 somatic symptoms (Fonda & Herzog, 2001; Hays et al., 1998) and depressed affect (Hays et
80 al., 1998). Hays et al. (1998) reported that functional disability was related to lower levels of
81 positive affect, but not to interpersonal problems. Satisfaction with the amount of social
82 interaction was protective for depressed affect and somatic symptoms. Interpersonal
83 problems were found to correlate with an impaired social network. Respectively, Zich et al.
84 (1990) pointed out that lower levels of positive affect may be associated with reductions in
85 social networks or reduction of positive experiences.

86 Some studies have shown that the depressive symptoms presentation pattern
87 may also vary to some extent according to gender (Angst et al., 2002; Glaesmer, Riedel-
88 Heller, Braehler, Spangenberg, & Lippa, 2011; Johnson et al., 2008), although it has been
89 suggested that these differences are not substantial (Fiske et al., 2009). In a study of Johnson
90 et al. (2008) the focal constructs of CES-D scale were compared across gender groups in a
91 population-based sample. They found that women had higher levels of depressed affect and
92 somatic symptoms than men, but no gender differences in the subscales of interpersonal
93 problems or in positive affect were observed. Angst et al. (2002) suggested that there may be
94 gender differences in the total number of depressive symptoms reported so that depressed
95 men report fewer symptoms compared to depressed women.

96 Previous studies have shown that among older adults depressive symptoms and
97 restricted life-space mobility share similar correlates, such as female gender, higher age,

98 lower educational level, poorer financial situation, poorer cognitive functioning (Barnes et
99 al., 2007; Djernes, 2006; Fiske et al., 2009) and chronic diseases (Chang-Quan et al., 2010;
100 Choi & McDougall, 2007; Fiske et al., 2009; Hybels et al., 2001). Mobility limitations are
101 associated with reduced movement outside home (Wilkie, Peat, Thomas, & Croft, 2006) and
102 have also a strong association with depressive symptoms (Hirvensalo et al., 2007; Lampinen
103 & Heikkinen, 2003).

104 The concept of autonomy or mastery, referring to the degree of control which
105 individuals feel to have over their lives and the environment (Jang, Haley, Small, &
106 Mortimer, 2002), is essential for older adults' mental well-being and life satisfaction (Berg,
107 Hassing, McClearn, & Johansson, 2006; Gignac, Cott, & Badley, 2000) and it is also
108 associated with older adults life-space mobility (Portegijs, Rantakokko, Mikkola, Viljanen, &
109 Rantanen, 2014). The sense of autonomy is optimal when an individual perceives to have
110 opportunity to make decisions, and to live life the way one wants to (Cardol, de Haan, de
111 Jong, van den Bos, Geertrudis AM, & de Groot, 2001). Among older adults', the most
112 common restriction in participation is mobility limitation outside the home (Wilkie et al.,
113 2006). Although the sense of autonomy in participation outdoors and physical performance
114 correlate, they are not totally overlapping concepts. This is supported by a previous study
115 where poor lower extremity performance and poor sense of autonomy in participation
116 outdoors were independently associated with lower life-space mobility (Portegijs,
117 Rantakokko, Mikkola, Viljanen, & Rantanen, 2013).

118 The association between life-space mobility and depressive symptoms has been
119 reported in previous studies (Allman, Sawyer, & Roseman, 2006; Baker et al., 2003; Peel et
120 al., 2005; Snih et al., 2012). However, to best of our knowledge, no studies exist on
121 association between life-space mobility and the different dimensions of depression.
122 Furthermore, knowledge on possible mediating factors between life-space mobility and

123 depressive symptoms is limited. Consequently, the purpose of the present study was to
124 examine the association between life-space mobility and different dimensions of depressive
125 symptoms among 75-90-year-old community-dwelling older women and men. Our aim was
126 to 1) examine whether the association between life-space mobility and different dimensions
127 of depression differ, and to 2) assess whether differences in walking difficulties, health and
128 the sense of autonomy in participation outdoor activities accounted in part for the association
129 between life-space mobility and different dimensions of depressive symptoms.

130

131 **METHODS**

132

133 **Design and Study Population**

134 The data for this study were drawn from the baseline measurements of a 2-year prospective
135 cohort study entitled “Life-Space Mobility in Old Age” (LISPE). The study design and
136 methods have been reported in detail elsewhere (Rantanen et al., 2012). In brief, a random
137 sample of 2550 people was taken from the population register and they were informed about
138 the study and interviewed by phone. To be eligible for the study participants had to be able to
139 communicate, reside in the recruitment area and be willing to participate. Baseline-data were
140 gathered on 848 community-dwelling people aged 75 to 90 by in-person interviews in the
141 participants’ homes using computer-assisted personal interview. The Ethical Committee of
142 the University of Jyväskylä approved the project and all the study participants gave their
143 written informed consent. Only persons who were able to answer to the interviews
144 themselves were included in the baseline cohort.

145

146 **Measurements**

147 *Life-Space Mobility*

148 Life-space mobility was assessed by the University of Alabama at Birmingham (UAB) Life-
149 Space Assessment (LSA) -questionnaire (Baker et al., 2003). The LSA is based on self-
150 report, comprises 15 items, and assesses mobility according to the different life-space levels
151 (distance), on which a person reports having moved either by walking or using other forms of
152 transportation, such as driving a car or using public transportations, during the 4 weeks
153 preceding the assessment. Participants were asked how many days a week they attained each
154 life-space level (bedroom, other rooms, outside home, neighbourhood, town, beyond town)

155 and whether they needed help from another person or from assistive devices. In this study, we
156 used a composite score for life-space, which indicates distance, frequency and level of
157 independence (range 0-120). Higher LSA scores indicate better life-space mobility (Baker et
158 al., 2003).

159

160 *Depressive symptoms*

161 Depressive symptoms were assessed with the 20-item Centre for Epidemiological Studies
162 Depression Scale (CES-D)(Radloff, 1977). The CES-D scale is a self-report depressive
163 symptoms measure, which has been widely used in epidemiologic studies. Its validity and
164 reliability have been demonstrated in heterogeneous samples (A. T. Beekman et al., 1997).
165 The participant rated the frequency of each symptom during the previous week. Each item is
166 scored from 0 to 3, with higher scores indicating more depressive symptoms (total score
167 range 0-60). A total score was also calculated for participants with no more than one missing
168 item (n=15). The cut-off score on the CES-D scale indicating a clinically significant level of
169 depressive symptoms in community samples is 16 or more (Radloff, 1977). To examine
170 different dimensions of depression, we computed scores for the four CES-D dimensions.
171 Higher scores always represented a higher level of the dimension in question. The dimensions
172 and their respective items were the following: depressed affect (having the blues, feeling
173 depressed, life a failure, feeling fearful, feeling lonely, crying spells, feeling sad; range 0-21),
174 somatic symptoms (being bothered, poor appetite, trouble concentrating, everything was an
175 effort, restless sleep, talked less than usual, cannot get going; range 0-21), positive affect
176 (feeling as good as others, hopeful about the future, feeling happy, enjoying life; range 0-12),
177 and interpersonal problems (people were unfriendly, people dislike me; range 0-6).

178

179 ***Potential confounders and mediating factors***

180 In this study the selection of potential confounders and mediating factors was based on the
181 findings of previous studies on factors associated with life-space mobility and depressive
182 symptoms (Baker et al., 2003; Barnes et al., 2007; Blazer, 2003; Chang-Quan et al., 2010;
183 Choi & McDougall, 2007; Cohen-Mansfield, Shmotkin, & Hazan, 2010; Djernes, 2006;
184 Hirvensalo et al., 2007; Hybels et al., 2001; Lampinen & Heikkinen, 2003; Peel et al., 2005;
185 Penninx et al., 1998; Stalvey et al., 1999). *Basic demographic and socioeconomic indicators*
186 of the study subjects included age, sex, education (total number of years of education) and
187 self-reported financial situation (very poor or poor / moderate/ very good or good).
188 Participants were also asked whether they lived alone or with another person. *The number of*
189 *physician-diagnosed chronic conditions* was collected by self-report using a list of 22 chronic
190 conditions and an open-ended question about any other physician-diagnosed chronic
191 conditions. The relevance of diseases reported in the open question was checked by a
192 physician. For the analyses, depression was excluded from the total number of chronic
193 diseases. *Cognitive functioning* was assessed with the Mini-Mental State Examination
194 (MMSE), which contains 30 items scored from 0-30. Higher scores indicate better cognitive
195 functioning (Folstein, Folstein, & McHugh, 1975). *Walking difficulty* was studied as
196 perceived difficulties in walking 500m (able without difficulty/ able with some degree of
197 difficulty or unable to manage even with help)(34). *Sense of autonomy in participation*
198 *outdoors* was measured using the domain “autonomy outdoors” from the Impact on
199 Participation and Autonomy questionnaire (Cardol et al., 2001). Participants were asked to
200 rate their perceived opportunities to 1) visit relatives and friends, 2) make trips and travel, 3)
201 spend leisure time, 4) meet other people, and 5) live life the way they want. The response
202 categories ranged from 0 (very good) to 4 (very poor). A sum score (range 0-20) was
203 calculated, higher scores indicating more restrictions in perceived autonomy.

204 **Statistical Analyses**

205 The interaction of gender and life-space mobility on the CES-D total score was tested and a
206 significant interaction was found ($p < .001$). The presence of an interaction implies that the
207 effect of life-space mobility on depressive symptoms varies as a function of gender.
208 Therefore men and women were analyzed separately. Characteristics of the participants are
209 described by using means, medians and interquartile ranges (IQR) or percentages.
210 Differences between men and women in the background characteristics were tested by using
211 the Mann-Whitney U-test for continuous variables and χ^2 - tests for categorical variables.

212 The association of each covariate with the CES-D total score and life-space
213 mobility composite score was determined with χ^2 -tests and Spearman correlation. Only
214 variables with a significant association with both depressive symptoms and life-space
215 mobility were chosen for further analyses because they could, therefore, influence the effect
216 of life-space mobility on depressive symptoms. Life-space mobility data was available for all
217 of the 848 participants and CES-D data for 843 participants (data for CES-D score was
218 missing for 0,6% of the total sample, 2 women and 3 men).

219 Our interpretation of the analyses was based on the following guidelines: 1)
220 fixed demographic characteristics are presumed to precede depressive symptoms; 2) variables
221 which are considered as possible mediating factors (i.e. the sense of autonomy in
222 participation outdoors, walking difficulties, and chronic diseases) are presumed to precede
223 the *current* level of depressive symptoms. However, we acknowledge that some of these
224 variables may have been affected by *prior* depressive symptoms (Hays et al., 1998).

225 Linear regression analyses were used to examine the association between the
226 life-space mobility score and the CES- total score and the scores for four different dimension
227 of the CES-D scale among men and women. We wanted to see whether the associations
228 between life-space mobility and different dimensions of depression are explained by

229 differences in health, walking limitation or sense of autonomy in participation outdoors
230 (James & Brett, 1984). Linear regression models were used to obtain standardized regression
231 coefficient and standard error estimates. Significance of the effects in gender-specific models
232 were tested using the standard single parameter Wald-tests, and gender-differences in
233 regression coefficients were tested using the likelihood ratio test for a single parameter.
234 Confidence intervals are based on the inversion of the Wald-test for the given parameter. In
235 the analyses, the first model was adjusted for confounders (age, financial situation and
236 cohabitation, i.e. living alone or with another person). The second model was additionally
237 adjusted for walking limitation and number of chronic diseases, and in the third model we
238 also added the sense of autonomy in participation outdoors. Persons who had missing data on
239 one or more variables were removed from regression analyses.

240 Statistical significance was set at $p < .05$ for all analyses. Linear regression
241 analyses were accomplished using MPlus version 7 (Muthén & Muthén, 2012) and the other
242 analyses conducted using the IBM SPSS 20.0 (IBM Corp., Armonk, NY, USA).

243

244 **RESULTS**

245

246 The median age of all the participants was 80.0 years (interquartile range 8.0) and 62% were
247 female. Of the total sample, 53% were living alone. Number of chronic diseases was 4.0
248 (IQR 3.0) and years of education 8.0 (IQR 5.0). The median scores for the life-space mobility
249 score and the total CES-D score in the total sample were 64.0 (IQR 30.0) and 9.0 (IQR 9.0),
250 respectively. Altogether, 21% of the women and 12% of the men reported clinically
251 significant depressive symptoms (CES-D total score ≥ 16).

252 Compared to men participants, women participants had significantly poorer life-
253 space mobility score. Women participants were also older, they were more likely to live

254 alone, and they had more chronic diseases and more difficulties in walking 500 meters.
255 Women participants also had more limited sense of autonomy in participation outdoors. Men
256 and women participants did not differ in MMSE total points (Table 1).

257 Mean scores on the total CES-D scale, as well as on four CES-D dimensions
258 showed small but statistically significant differences between women and men. Women had a
259 higher CES-D total score than men (10.4, SD 7.1 vs. 8.2, SD 6.0, $p < .001$). Women also had a
260 slightly higher depressed affect score (2.6, SD 2.8 vs. 1.6, SD 2.0, $p < .001$), and somatic
261 symptom score (3.8, SD 2.9 vs. 3.1, SD 2.5, $p < .001$) than men. For positive affect, women
262 scored 0.5 points lower than men (8.3, SD 2.8 vs. 8.8, SD 2.5, $p = .032$). For the interpersonal
263 problems dimension, no significant sex differences were found ($p = .665$). The bivariate
264 correlation between the life-space mobility score and total CES-D score was $-.297$ ($p < .001$)
265 for women and $-.170$ ($p = .002$) for men. Spearman correlation coefficients between life-space
266 mobility score, CES-D total score and covariates are shown in table 2 for women and in table
267 3 for men.

268 To study whether the associations between the different dimensions of
269 depression and life-space mobility differed, and to search for potential factors mediating the
270 association, linear regression analyses were conducted (Table 4). For both sexes, life-space
271 mobility was associated with the CES-D total score and all the dimensions of depression,
272 with the exception of interpersonal problems among men (Table 4, model 1). After
273 adjustment for walking difficulties and number of chronic diseases (model 2), the regression
274 coefficient for the association between life-space mobility and depressed affect was
275 substantially reduced for both sexes and, for men, also the association with somatic
276 symptoms. This indicates that the association is at least partially mediated by perceived
277 walking difficulties and number of co-morbidity. When the sense of autonomy in
278 participation outdoors was added into the regression model (model 3), the association with

279 positive affect was also attenuated for both women and men. Among women, the association
280 between life-space mobility and interpersonal problems was partially explained by the sense
281 of autonomy in participation outdoors.

282 The association that varied most significantly by gender was the association
283 between life-space mobility and somatic symptoms. This association was stronger among
284 women than among men (Table 4, model 1). For men the association was mainly related to
285 the walking difficulties and number of chronic conditions (model 2). For women, the
286 association was mostly mediated by the sense of autonomy outdoors (model 3). Although the
287 confidence intervals for somatic symptoms in model 3 are overlapping (-0.143, 0.106 for
288 men, -0.277,-0.028 for women), the effect is significant among women, indicating that the
289 association between life-space mobility and somatic symptoms is not entirely mediated by
290 walking difficulties, chronic diseases and sense of autonomy in participation outdoors.

291

292

293 **DISCUSSION**

294

295 The novel finding in this study was that the associations between life-space mobility and
296 different dimensions of depression were partially mediated through different factors and that
297 there were differences between men and women in these associations.

298 Older people with poorer life-space mobility had a higher prevalence of
299 depressive symptoms. These results are in line with those of earlier studies (Allman et al.,
300 2006; Baker et al., 2003; Cohen-Mansfield et al., 2010; Peel et al., 2005; Snih et al., 2012;
301 Stalvey et al., 1999). However, studying each of the four dimensions of the CES-D scale
302 separately showed that the associations between the different dimensions of depressive
303 symptoms and life-space mobility were not direct, but rather were partially mediated by the
304 person's walking difficulties, chronic conditions and more limited sense of autonomy in
305 participation outdoors. We also noted some slight differences between the sexes in these
306 associations. Although we did not have specific pre-assumptions about how life-space
307 mobility would relate to different dimensions of depression, we questioned whether the
308 associations would be different, and whether the associations would be mediated by different
309 variables.

310 Previous studies have shown that health conditions and limitations in physical
311 functioning have stronger associations with somatic symptoms than other dimensions of
312 depression (Fonda & Herzog, 2001). Some items in the somatic symptoms dimension, such
313 as feelings of effort, may though be related more to diseases than to depression (Covic,
314 Pallant, Conaghan, & Tennant, 2007; Johnson et al., 2008). In our study the connection
315 between life-space mobility and both depressed affect and somatic symptoms among men
316 was mainly related to the walking difficulties and chronic conditions, while for women
317 somatic symptoms were more closely related to their perception of autonomy outdoors.

318 Similar gender differences were observed in an earlier study, which reported that the
319 association between physical health and depression was highly significant in men, but not in
320 women (A. Beekman, Kriegsman, Deeg, & Van Tilburg, 1995). Our results suggest that for
321 older women chronic diseases or walking limitations may not directly underlie depressive
322 symptoms. Instead, the perceived difficulties and their consequences on independence and
323 autonomy of daily living may be more crucial.

324 Positive affect and interpersonal problems, in turn, may be less influenced by
325 poor health and functioning. For example, Hays et al. (1998) found that functional disability,
326 including poorer ADL performance, upper and lower extremity function and mobility, had a
327 stronger association with depressed affect and somatic symptoms than with positive affect or
328 interpersonal problems, although, they did not conduct separate analyses for women and men.
329 Our results coincide with this finding. Higher life-space mobility was associated with more
330 positive affect for both men and women, and this association was mediated by the sense of
331 autonomy in participation outdoors. Higher life-space mobility gives more opportunities to
332 engage with the society and to take part in meaningful activities, thus reinforcing sense of
333 autonomy and independence, which in turn is likely to be a source of positive affect (Pinquart
334 & Sörensen, 2000). In this study the pattern of change in regression analyses was similar
335 between CES-D total score and dimension score of positive affect. This may be explained by
336 the fact that the participants had relatively higher scores on positive affect than on other
337 dimensions of depressive symptoms. Hence, in our sample, positive affect may have had
338 somewhat more effect on the CES-D total score than other dimensions.

339 In the present study, there was a trend indicating that the association between
340 life-space mobility and interpersonal problems was significant, even though modest, only for
341 women. It is possible that restricted life-space mobility predisposes to reductions in the social
342 network, potentially leading to feelings of interpersonal problems (Hays et al., 1998).

343 Participation in social activities outside the home has been reported to have a more
344 pronounced role on mental well-being among older women than men (Park, Jang, Lee, Haley,
345 & Chiriboga, 2013). It may be that, for women, social contacts are more closely related to
346 positive feelings than they are for men (Glaesmer et al., 2011; Pinqart & Sörensen, 2000). It
347 should also be noted that the majority of those older adults who are living alone are women,
348 and therefore that older women's social contacts may more strongly rest upon social contacts
349 outside the home. Restrictions on life-space mobility result in fewer opportunities for
350 community participation and involvement with social environment and in turn, fewer
351 opportunities for positive interaction with other people. Larger life-space is associated with
352 both higher frequency of participation in social activities as well with greater number of
353 social networks (Barnes et al., 2007).

354 Several explanations for our findings can be suggested. Previous studies have
355 shown that poor health and mobility increase depressive symptoms among older adults
356 (Chang-Quan et al., 2010; Hirvensalo et al., 2007). For example, being homebound is a
357 significant predictor of depressed affect among older adults (Cohen-Mansfield et al., 2010),
358 whereas better mobility status predicts better mental well-being (Lampinen, Heikkinen,
359 Kauppinen, & Heikkinen, 2006). Mobility difficulties limit older adults' possibilities to move
360 outside home (Wilkie et al., 2006) and thus, restrict life-space mobility and also pose a great
361 threat to person's sense of autonomy (Portegijs et al., 2014). With respect to sense of
362 autonomy in participation outdoors, people who perceive greater control over their lives have
363 shown lower rates of depressive symptoms, even where they might have physical
364 impairments (Boyle, 2005; Jang et al., 2002). An alternative explanation for the present
365 results is that older adults with depressive symptoms are less willing to move outside their
366 home (Cohen-Mansfield et al., 2010; Penninx et al., 1998; Rosqvist et al., 2009), and
367 consequently experience reduced life-space mobility. Unfortunately, our cross-sectional data

368 do not allow us to draw any firm conclusions on the temporal order in this association. It is
369 likely that the association between life-space mobility and depressive symptoms is
370 bidirectional in that each increases the probability of the other, potentially leading to a
371 vicious circle (Cohen-Mansfield et al., 2010).

372 Our results are consistent with the theoretical model of psychological well-
373 being, presented by Ryff (1989). The theory posits that the capacity to control the
374 surrounding world (i.e. “environmental mastery”) and sense of self-determination (i.e.
375 “autonomy”) are two of the six main components of psychological well-being, along with
376 self-acceptance, purpose in life, positive relations with others and personal growth (Ryff,
377 1989). Also in the empirical study by Ryff and Keys (1995) mastery of the surrounding
378 environment had a strong correlation with lower levels of depression. Life-space mobility
379 represents a person’s actual involvement in the environment (Barnes et al., 2007) and
380 consequently probably also reflects a person’s “environmental mastery”.

381 This study has several strengths. We assessed life-space mobility and
382 depressive symptoms in a large population based sample of older adults. The study was
383 originally designed to investigate outdoor mobility and consequently rich data were available
384 on relevant topics. Further, the association between life-space mobility and different
385 dimensions of depression has not been studied earlier; thus the present study contributes a
386 novel viewpoint to the research on older adults’ mental well-being. The participants were
387 interviewed face-to-face in their homes by trained interviewers and there were very few
388 missing data in the sample. The reliability and validity of the questionnaires used has been
389 shown to be good (Baker et al., 2003; A. T. Beekman et al., 1997). Although the participants
390 were rather well-functioning, the sample also included people with health problems
391 (Rantanen et al., 2012). Consequently, the observed associations most likely represent those
392 present in the similar-aged general population, thus supporting the generalizability of our

393 findings. The current analyses of the data may be viewed as a basis for future prospective
394 studies.

395 The study also has some limitations, which need to be recognized. The analyses
396 were cross-sectional and therefore we were not able to examine the causal direction of the
397 association. The association should be studied further utilizing longitudinal study designs. A
398 second limitation of the study is that participants were rather well-functioning and it is likely
399 that older adults with the most depressive symptoms declined to participate. It can be
400 assumed that the associations would have been stronger if persons with severe depression had
401 participated. The utilization of self-report scales assessing depressive symptoms should be
402 also noted as a limitation, although the CES-D scale has been reported to correlate with
403 clinical ratings of depression (Radloff, 1977). Men have also been reported to experience less
404 depressive symptoms than women (Angst et al., 2002), which could lead to bias. To take this
405 possibility into account, we conducted the analyses for both sexes separately.

406 In conclusion, these results indicate that poorer life-space mobility is
407 interrelated with higher risk for different dimensions of depressive symptoms, thus
408 compromising older adults' mental wellbeing. Older adults with depressive symptoms may
409 be harder to identify since they have fewer interactions outside the home. Thus a focus on
410 older adults' life-space mobility may assist early identification of persons, who have elevated
411 risk for depressive symptoms, even before they fulfil the criteria for diagnosis of major
412 depressive disorder. The current study showed also that the association between life-space
413 mobility and different dimensions of depression may partly be mediated through separate
414 underlying factors. This information may help to understand the individual differences in the
415 way older adults express their depressive symptoms. It may also provide information on
416 factors that are important to take into account when developing tools for prevention and
417 treatment of depressive symptoms among older adults. As restricted life-space mobility and

418 depressive symptoms are presumably in a reciprocal relationship, more research is needed to
419 examine the temporal order and potential causality.

420

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- 586

GRAPHICS

Table 1. Baseline characteristics of the participants (n=848) categorized according to sex.

	Women (n=526)			Men (n=322)			p ^a
	Mean	Median	IQR	Mean	Median	IQR	
Age	80.3	80.0	8.0	79.5	79.0	7.0	.005
Education in years	9.2	8.0	5.0	10.3	9.0	5.0	.005
MMSE score (range 0-30)	26.2	27.0	3.0	26.2	27.0	3.0	.630
IPA total score (range 0-20)	6.4	6.0	5.0	5.7	5.0	3.0	.005
Number of chronic conditions	4.5	4.0	3.0	3.9	4.0	3.0	<.001
LSA-C (range 0-120)	59.9	60.0	28.4	71.3	72.0	26.0	<.001
CES-D total score (range 0-60)	10.4	9.0	9.5	8.2	8.0	9.0	<.001
Depressed affect (range 0-21)	2.6	2.0	4.0	1.6	1.0	3.0	<.001
Somatic symptoms (range 0-21)	3.8	3.0	3.0	3.1	3.0	4.0	<.001
Positive affect (range 0-12)	8.3	9.0	5.0	8.8	9.0	4.0	.032
Interpersonal problems (range 0-6)	0.3	.00	0.0	0.3	.00	0.0	.665

	%	(n)	%	(n)	p ^b
Living alone	69.9	367	26.4	85	<.001
Walking difficulty, 500m	30.2	158	18.4	59	<.001
Perceived financial situation					.005
Good or very good	47.1	248	55.9	179	
Moderate	49.6	261	43.4	139	
Poor or very poor	3.2	17	0.6	2	

Notes:

a= Mann-Whitney U-test, comparison between women and men

b= Chi-Square test, comparison between women and men

IQR= Interquartile range; CES-D = Centre for Epidemiological Studies Depression Scale;

MMSE= Mini-Mental State Examination; IPA = Autonomy outdoors from the Impact on Participation and Autonomy questionnaire

588

Table 2. Spearman correlation coefficients between life-space mobility score, depressive symptoms total score and covariates among women (n= 526)

	LSA-C	CES-D score	Age	Education in years	MMSE score	IPA total score	Number of chronic diseases
LSA-C	1.0						
CES-D total score	-.297**	1.0					
Age	-.362**	.127**	1.0				
Education in years	.131**	-.011	-.232**	1.0			
MMSE score	.142**	-.029	-.167**	.365**	1.0		
IPA total score	-.499**	.452**	.258**	-.129**	-.152**	1.0	
Number of chronic diseases	-.355**	.236**	.153**	-.086*	.003	.319**	1.0
Perceived financial situation	.171**	-.282**	-.046	.137**	.083	-.275**	-.176

589 *Notes:* **p<. 01, * p<.05

590 LSA-C= Life-space mobility composite score , CES-D = Centre for Epidemiological Studies

591 Depression Scale; MMSE= Mini-Mental State Examination; IPA = Autonomy outdoors from the

592 Impact on Participation and Autonomy questionnaire

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594

Table 3. Spearman correlation coefficients between life-space mobility score, depressive symptoms total score and covariates among men (n= 322)

	LSA-C	CES-D score	Age	Education in years	MMSE score	IPA total score	Number of chronic diseases
LSA-C	1.0						
CES-D total score	-.170**	1.0					
Age	-.382**	.145**	1.0				
Education in years	.252**	.032	-.252**	1.0			
MMSE score	.189**	-.084	-.231**	.384**	1.0		
IPA total score	-.332**	.344**	.256**	-.103	-.164**	1.0	
Number of chronic diseases	-.238**	.129*	.208**	-.080	-.055	.283**	1.0
Perceived financial situation	.134*	-.029	-.040	.202**	.115*	-.219**	-.101

595 *Notes:* **p<. 01, * p<.05

LSA-C= Life-space mobility composite score, CES-D = Centre for Epidemiological Studies

Depression Scale; MMSE= Mini-Mental State Examination; IPA = Autonomy outdoors from the

Impact on Participation and Autonomy questionnaire

Table 4. Association between life-space mobility score and the different dimensions of depression among men (n=313) and women (n=509) aged 75 to 90 years and comparison of regression coefficients between men and women.

	Model 1 ^a			Model 2 ^b			Model 3 ^c		
	β	SE	p	β	SE	p	β	SE	p
CES-D total score			.16			.34			.91
Women	-.236***	.043		-.168**	.048		-.048	.049	
Men	-.183**	.060		-.127*	.063		-.051	.062	
Depressed affect			.79			.70			.25
Women	-.110*	.046		-.047	.052		.047	.053	
Men	-.140*	.061		-.110	.064		-.046	.064	
Somatic symptoms			.01			.05			.13
Women	-.289***	.043		-.202***	.049		-.128*	.051	
Men	-.125*	.060		-.068	.063		-.019	.064	
Positive Affect			.98			.80			.63
Women	.179***	.045		.150**	.050		.026	.050	
Men	.201**	.060		.149*	.063		.070	.062	
Interpersonal Problems			.08			.09			.29
Women	-.095*	.047		-.113*	.052		-.062	.055	
Men	.032	.062		.023	.066		.027	.067	

Notes: β = Standardized coefficient beta, SE= the standard errors of the coefficients, p= comparison of regression coefficients between men and women. Bold type face indicates a statistically significant difference in regression coefficients between men and women at the 0.05 level of significance based on the likelihood ratio test. CES-D = Centre for Epidemiological Studies Depression Scale

a: adjusted for age, living alone and perceived financial situation

b: adjusted for model 1, walking difficulty (500m walk) and number of chronic diseases

c: adjusted for model 2 and autonomy in participation outdoors.

*p< .05. **p< .01. ***p< .001.

597 **Conflict of Interest**

Elements of Financial/ Personal Conflicts	Author 1 HP		Author 2 TM		Author 3 EP		Author 4 MR		Author 5 KK		Author 6 MK		Author 7 TR		Author 8 AV	
	Yes	No	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Employment or Affiliation		x		x		x		x		x		x		x		x
Grants/Funds		x		x		x		x		x		x		x		x
Honoraria		x		x		x		x		x		x		x		x
Speaker Forum		x		x		x		x		x		x		x		x
Consultant		x		x		x		x		x		x		x		x
Stocks		x		x		x		x		x		x		x		x
Royalties		x		x		x		x		x		x		x		x
Expert Testimony		x		x		x		x		x		x		x		x
Board Member		x		x		x		x		x		x		x		x
Patents		x		x		x		x		x		x		x		x
Personal Relationship		x		x		x		x		x		x		x		x

598

599 The authors declare no conflicts of interest.

600

601 **Author contributions**

602 All authors meet the criteria for authorship stated in the Uniform Requirements for
603 Manuscripts Submitted to Biomedical Journals.

604 HP: analysis and interpretation of the data, writing the article.

605 TM: analysis and interpretation of the data, critical revision of the article.

606 EP: conception, design, data collection, critical revision of the article.

607 MR: conception, design, data collection, critical revision of the article

608 KK: analysis and interpretation of the data, critical revision of the article

609 MK: conception, design, data collection, analysis of the data, critical revision of the article;

610 TR: conception, design, data collection, critical revision of the article, PI for the LISPE

611 project

612 AV: conception, design, data collection, critical revision of the article.

613 All the authors approved the final manuscript.

614

615 **Sponsor's Role**

616 The sponsors did not have any role in the design, methods, subject recruitment, data

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