**Author(s):** Polku, Hannele; Mikkola, Tuija; Portegijs, Erja; Rantakokko, Merja; Kokko, Katja; Kauppinen, Markku; Rantanen, Taina; Viljanen, Anne

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

Hannele Polku[1], MSc , Tuija M. Mikkola[1],PhD, Erja Portegijs[1],PhD, Merja Rantakokko[1],PhD, Katja Kokko [1],PhD, Markku Kauppinen[1],MSc Taina Rantanen[1],PhD, Anne Viljanen[1], PhD

[1] Gerontology Research Center and Department of Health Sciences, University of Jyväskylä, Finland

Corresponding author:
Hannele Polku
tel. + 358 408054157
E-mail: hannele.polku@jyu.fi

Co-authors telephone numbers and e-mail addresses:
Tuija M. Mikkola (tuija.m.mikkola@jyu.fi, + 358405025772)
Erja Portegijs (erja.portegijs@jyu.fi, +358404814347)
Merja Rantakokko (merja.rantakokko@jyu.fi, +358408053589)
Katja Kokko (katja.r.kokko@jyu.fi, +358408053500)
Markku Kauppinen (markku.kauppinen@sport.jyu.fi, +358408053559)
Taina Rantanen (taina.rantanen@jyu.fi, +358408053590)
Anne Viljanen (anne.viljanen@jyu.fi, +358408053603)

Postal address: Gerontology Research Center and Department of Health Sciences
P.O. Box 35
FI-40014 University of Jyväskylä, Finland

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## ABSTRACT

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

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

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

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


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

## INTRODUCTION

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

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

Although major depression among older adults is rather infrequent, affecting only 1-5% of the older population (Hasin, Goodwin, Stinson, & Grant, 2005), the prevalence of sub-threshold levels of depression among community-dwelling older adults is substantially higher, at 8-16% (Blazer, 2003; Djernes, 2006). Besides clinically diagnosed depression, also sub-threshold levels of depression are associated with many disadvantages, such as increased functional limitations, morbidity and mortality (Chopra et al., 2005; Hybels, Blazer, & Pieper, 2001; Penninx et al., 1998).

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

It has been found that presentation of depressive symptoms is heterogeneous also among older adults (Chen, Eaton, Gallo, & Nestadt, 2000; Mora et al., 2012). This means that two persons with the same score on a depression scale will not necessarily have similar symptoms. Manifestation of depressive symptoms in older adults may also be different from their manifestation in younger people (Fiske et al., 2009; Sözeri-Varma, 2012). Typical depressive symptoms, such as sadness, may not be prominent (Ready et al., 2011), whereas somatic and vegetative symptoms (i.e. sleeplessness, loss of appetite, pain), lack of positive affect and sense of hopelessness about the future are more common (Chen et al., 2000; Fiske et al., 2009; Sözeri-Varma, 2012). On this account, we should pay attention to the diversity of the manifestations of depressive symptoms as looking only at the threshold of the total score of the depression scale may not be detailed enough to detect these differences.

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

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

Previous studies have shown that among older adults depressive symptoms and restricted life-space mobility share similar correlates, such as female gender, higher age, lower educational level, poorer financial situation, poorer cognitive functioning (Barnes et al., 2007; Djernes, 2006; Fiske et al., 2009) and chronic diseases (Chang-Quan et al., 2010; Choi & McDougall, 2007; Fiske et al., 2009; Hybels et al., 2001). Mobility limitations are associated with reduced movement outside home (Wilkie, Peat, Thomas, & Croft, 2006) and have also a strong association with depressive symptoms (Hirvensalo et al., 2007; Lampinen & Heikkinen, 2003).

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

The association between life-space mobility and depressive symptoms has been reported in previous studies (Allman, Sawyer, & Roseman, 2006; Baker et al., 2003; Peel et al., 2005; Snih et al., 2012). However, to best of our knowledge, no studies exist on association between life-space mobility and the different dimensions of depression. Furthermore, knowledge on possible mediating factors between life-space mobility and depressive symptoms is limited. Consequently, the purpose of the present study was to examine the association between life-space mobility and different dimensions of depressive symptoms among 75-90-year-old community-dwelling older women and men. Our aim was to 1) examine whether the association between life-space mobility and different dimensions of depression differ, and to 2) assess whether differences in walking difficulties, health and the sense of autonomy in participation outdoor activities accounted in part for the association between life-space mobility and different dimensions of depressive symptoms.

# METHODS

## Design and Study Population

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

## Measurements

### *Life-Space Mobility*

Life-space mobility was assessed by the University of Alabama at Birmingham (UAB) Life-Space Assessment (LSA) -questionnaire (Baker et al., 2003). The LSA is based on self-report, comprises 15 items, and assesses mobility according to the different life-space levels (distance), on which a person reports having moved either by walking or using other forms of transportation, such as driving a car or using public transportations, during the 4 weeks preceding the assessment. Participants were asked how many days a week they attained each life-space level (bedroom, other rooms, outside home, neighbourhood, town, beyond town) and whether they needed help from another person or from assistive devices. In this study, we used a composite score for life-space, which indicates distance, frequency and level of independence (range 0-120). Higher LSA scores indicate better life-space mobility (Baker et al., 2003).

***Depressive symptoms***

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

***Potential confounders and mediating factors***

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

**Statistical Analyses**

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

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

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

Linear regression analyses were used to examine the association between the life-space mobility score and the CES- total score and the scores for four different dimension of the CES-D scale among men and women. We wanted to see whether the associations between life-space mobility and different dimensions of depression are explained by differences in health, walking limitation or sense of autonomy in participation outdoors (James & Brett, 1984). Linear regression models were used to obtain standardized regression coefficient and standard error estimates. Significance of the effects in gender-specific models were tested using the standard single parameter Wald-tests, and gender-differences in regression coefficients were tested using the likelihood ratio test for a single parameter. Confidence intervals are based on the inversion of the Wald-test for the given parameter. In the analyses, the first model was adjusted for confounders (age, financial situation and cohabitation, i.e. living alone or with another person). The second model was additionally adjusted for walking limitation and number of chronic diseases, and in the third model we also added the sense of autonomy in participation outdoors. Persons who had missing data on one or more variables were removed from regression analyses.

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

**RESULTS**

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

Compared to men participants, women participants had significantly poorer life-space mobility score. Women participants were also older, they were more likely to live alone, and they had more chronic diseases and more difficulties in walking 500 meters. Women participants also had more limited sense of autonomy in participation outdoors. Men and women participants did not differ in MMSE total points (Table 1).

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

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

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

## DISCUSSION

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

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

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

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

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

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

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

Several explanations for our findings can be suggested. Previous studies have shown that poor health and mobility increase depressive symptoms among older adults (Chang-Quan et al., 2010; Hirvensalo et al., 2007). For example, being homebound is a significant predictor of depressed affect among older adults (Cohen-Mansfield et al., 2010), whereas better mobility status predicts better mental well-being (Lampinen, Heikkinen, Kauppinen, & Heikkinen, 2006). Mobility difficulties limit older adults' possibilities to move outside home (Wilkie et al., 2006) and thus, restrict life-space mobility and also pose a great threat to person's sense of autonomy (Portegijs et al., 2014). With respect to sense of autonomy in participation outdoors, people who perceive greater control over their lives have shown lower rates of depressive symptoms, even where they might have physical impairments (Boyle, 2005; Jang et al., 2002). An alternative explanation for the present results is that older adults with depressive symptoms are less willing to move outside their home (Cohen-Mansfield et al., 2010; Penninx et al., 1998; Rosqvist et al., 2009), and consequently experience reduced life-space mobility. Unfortunately, our cross-sectional data do not allow us to draw any firm conclusions on the temporal order in this association. It is likely that the association between life-space mobility and depressive symptoms is bidirectional in that each increases the probability of the other, potentially leading to a vicious circle (Cohen-Mansfield et al., 2010).

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

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

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

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

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**GRAPHICS**

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

| | Women (n=526) | | | Men (n=322) | | | |
|---|---|---|---|---|---|---|---|
| | **Mean** | **Median** | **IQR** | **Mean** | **Median** | **IQR** | **p[a]** |
| 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

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 |

*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 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 |

*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.

**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 |

The authors declare no conflicts of interest.

## Author contributions

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

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

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

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

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

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

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

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

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

All the authors approved the final manuscript.

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The sponsors did not have any role in the design, methods, subject recruitment, data collection, analysis, or preparation of this manuscript.